# PARAVERTEBRAL ANAESTHESIA IN GOATS USING BUPIVACAINE HYDROCHLORIDE

By

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**THESIS**

Submitted in partial fulfilment of the
requirement for the degree

**Master of Veterinary Science**

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Surgery
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy, Thrissur

**1994**

## DECLARATION

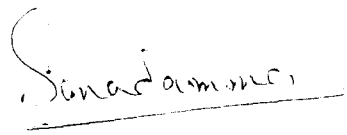
I hereby declare that the thesis entitled **"Paravertebral Anaesthesia in Goats Using Bupivacaine Hydrochloride"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Mannuthy,
30.8.1994.

**JOHN MARTIN, K.D.**

# CERTIFICATE

Certified that the thesis entitled **"Paravertebral Anaesthesia in Goats Using Bupivacaine Hydrochloride"** is a record of research work done independently by **Dr. John Martin, K.D.**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.



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## ACKNOWLEDGEMENT

I wish to express my sincere gratitude to **Dr. T. Sarada Amma**, Associate Professor, Department of Surgery, Chairperson, Advisory Committee, for the keen interest in the study, valuable guidance and untiring support rendered throughout the period of study.

I am deeply indebted to **Dr. K.N. Muraleedharan Nayar**, Professor, Department of Surgery, for his meticulous guidance and valuable help rendered as a member of advisory committee.

I express my extreme gratitude to **Dr. C. Abraham Varkey**, Professor, Department of Surgery for his valuable guidance and support as a member of the advisory committee.

I am very much grateful to **Dr. Jose John Chungath**, Associate Professor, Department of Anatomy, for his timely help, advice and encouragement as a member of advisory committee.

I am extremely thankful to **Dr. P.O. George**, Former Professor and Head, Department of Surgery, for the valuable suggestions and constructive criticism rendered during the study.

I am very much thankful to **Dr. A.M. Jalaluddin, Dr. S. Ravindran Nayar,** Professors, **Dr. K. Rajankutty,** Associate Professor, **Dr. T.P. Balagopalan** and **Dr. C.B. Devanand,** Assistant Professors, Department of Surgery, for their valuable suggestions, encouragement and timely advice during my study.

My thanks are due to **Dr. P.A. Oommer,** formerly Professor and Head, **Dr. Lucy Paily,** Professor and **Dr. K.R. Harshan,** Associate Professor, Department of Anatomy, for the valuable guidance, timely help and wholehearted cooperation rendered by them during the dissection studies.

I pay thankful remembrance to late **Dr. G. Nirmalan,** Dean in-charge, College of Veterinary and Animal Sciences, Mannuthy, who personally inspired me throughout my work.

This work would not have been possible but for the sincere helping hand, remarkable cooperation, tremendous patience and encouragement extended by my colleagues **Dr. Syam K. Venugopal** and **Dr. Deepak S. Tulpule,** all throughout my work. I am short of words to acknowledge their help.

With great affection, I profoundly appreciate my friends **Dr. Fabiana Lobo, Dr. K.A. Bindu, Dr. P.R. Pradeepkumar, Dr. E.D. Benjamin, Dr. Sheela Yohannan,**

**Dr. K.P. Mini, Dr. A.G. Karpe, Dr. D.D. Kulkarni, Dr. Regi Varghese George, P., Dr. A.M. Vahida** and **Dr. Krupesha Sharma** for their wholehearted help, cooperation and motivation.

The help and assistance rendered by **Ms. Mary**, is gratefully acknowledged.

I express my extreme gratitude to **Dr. A Rajan**, Dean, College of Veterinary and Animal Sciences, Mannuthy, for providing the necessary facilities to carry out this work.

I am thankful to the Kerala Agricultural University, for awarding me the KAU fellowship for the period of study.

The help rendered by the Librarian and staff of College Library are appreciated with thanks.

I am thankful to **M/s Peagles**, Mannuthy for typing this manuscript neatly.

I am short of words to express my gratitude to my parents and other family members who had been the main support during my study.

**Dr. JOHN MARTIN, K.D.**

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# Introduction

# INTRODUCTION

Regional anaesthesia with or without narcosis is chosen for surgery in ruminants because of the problems in general anaesthesia like prolonged recumbency and the hazards caused by the size of the abdominal viscera. Nerve blocking techniques are the preferred methods of regional anaesthesia in ruminants, since it is safe, the dose required is less and is easy to perform. It produces satisfactory analgesia and muscle relaxation. It is not accompanied by any complication and the recovery is smooth and quick.

Paravertebral anaesthesia has been advocated for all types of abdominal surgery in ruminants - both large and small. It is a method of regional anaesthesia where the thoracic and lumbar spinal nerves are blocked at the beginning of their course. The technique of paravertebral anaesthesia has been introduced in cattle by Farquharson (1940). Later, many workers modified the technique, based on detailed neuroanatomic studies (Formston, 1945; Magda, 1949; Neal, 1957 and Roe, 1986). Assuming that there may not be much variations in the neuroanatomy of the flank, Lumb and Jones (1973) stated that the technique of paravertebral anaesthesia in bovine can be applied in small ruminants also.

A number of local anaesthetics have been recommended for paravertebral anaesthesia in ruminants. Bupivacaine hydrochloride is one of the most potent local anaesthetics that is available and used extensively in human surgery. In addition to the potency, it has low toxicity and it produces long duration of anaesthesia even at a low concentration of 0.25 per cent (Moore et al., 1970).

A detailed study for mapping the neuroanatomy and dermatomes of the flank region in goats was found necessary on reviewing the available literature. Due to the lack of adequate knowledge of the neuroanatomy in relation to the dorsal spines and transverse processes of vertebrae in goats, interpolating the information available in cattle may not always be accurate. The quantity of anaesthetic solution required for satisfactory anaesthesia can also be decided only if correct neuroanatomy is known. Prevention of overdosage or accidental intravascular injection of local anaesthetic can also be achieved only if attention is paid to anatomy of the part. Hence the present study was undertaken with the following objectives.

1. To study the distribution of thoracic and lumbar spinal nerves in relation to the flank region in goats.

2. a. To choose the spinal nerves to be blocked for effective anaesthesia of the flank region in goats and

   b. To find out the suitable site(s) for blocking those spinal nerves.

3. To assess the extent of analgesia of the flank region.

# Review of Literature

# REVIEW OF LITERATURE

## Part I : Course and distribution of spinal nerves

Farquharson (1940) stated that the ventral branches of 13th thoracic, first and second lumbar spinal nerves emerged out through the intervertebral foramen approximately at the same level and immediately divided into dorsal and ventral branches. The ventral branches innervated the skin, fascia, muscles and peritoneum of the paralumber fossa. The third lumbar spinal nerve do not innervate the flank, but a cutaneous branch from it supplied the area anterior to the tuber coxae. He opined that the area innervated by the superficial cutaneous branches of successive nerves overlapped.

Wright (1952) stated that the last dorsal and first and second lumbar spinal nerves innervated the flank. The nerves emerged through the intervertebral foramen and divided into dorsal and ventral branches. The ventral branch passed obliquely downward and backward and supplied the skin, musculature and the peritoneum of flank. The third lumbar spinal nerve provided cutaneous branches to the area anterior to the tuber co xae.

Schaller (1956) has conducted an extensive study on cattle and plotted the course of spinal nerves.

Arnold and Kitchell (1957) conducted detailed studies on the innervation of abdominal wall of cattle and found that the 11th, 12th and 13th thoracic and all the lumbar spinal nerves emerged through the intervertebral foramina and then divided into dorsal and ventral branches. The dorsal branch divided into two - a dorsomedial branch, which innervated the back muscles and a dorsolateral branch, which passed through the muscles and thoracolumbar fascia to form the cutaneous innervation to the dorsal part of the body wall. The dorsolateral branch of the third lumbar nerve supplied skin in front of the prefemoral lymph gland, and that of the fourth lumbar nerve penetrated the back muscles close to the median plane and ended as cutaneous fibres. The ventral branches of 11th and 12th thoracic nerves passed ventrally between the intercostal muscles and ended as cutaneous branches. The ventral branches of 13th thoracic, first and second lumbar nerves terminated as fine cutaneous branches below the rectus abdominis muscle. The lateral cutaneous branches of these nerves passed caudally and ventrally to reach the skin of the lateral abdominal wall. The ventral branch of third lumbar spinal nerve ended as fibres distributed to inguinal and lateral cutaneous nerve of the thigh. The ventral branch of

the fourth lumbar nerve entered into the formation of lateral cutaneous, femoral and obturator nerves. The dermatomes of each of these spinal nerves were mapped and it was concluded that the 13th thoracic, first and second lumbar spinal nerves had to be blocked to get satisfactory analgesia of lateral abdominal wall.

Larson and Kitchell (1958) conducted dissection studies in bull and ram and found that the lateral thoracic nerve of brachial plexus, ninth to 13th thoracic spinal nerves and first two lumbar spinal nerves provided innervation to the cranial part of prepuce and second, third and fourth lumbar spinal nerves innervated its middle portion. They stated that the protractor and retractor muscles of prepuce received supply from the lateral thoracic nerve.

Westhues and Fritsch (1964) described the course and distribution of the thoracic and lumbar spinal nerves in bovines. The nerves emerged through the intervertebral foramen, divided into dorsal and ventral branches. The dorsal branch divided into medial, which innervated the spinal musculature and lateral, which innervated the muscles and skin of the upper half of the body wall. The ventral branch passed between the endothoracic fascia and the internal intercostal muscle and divided into lateral and medial branches. The former passed through the intercostal muscles and ramified

into the skin of middle part of chest wall. The latter passed between the rectus and transverse abdominis muscles and ramified into the skin adjacent to the midventral line. Last thoracic and first two lumbar nerves were involved in the innervation of abdominal wall. The third lumbar nerve innervated the tuber coxae, anterior portion of quadriceps muscle, dorsolateral aspect of stiffle and scrotum. They reported that the branches of the spinal nerves ran caudoventrally, and their fields of innervation was two to three vertebrae more posteriorly.

Hall (1971) had listed out in detail the motor and sensory supply by the spinal nerves to various regions of the trunk in sheep.

Khatra and Tyagi (1972a) studied the innervation of the thoracic wall in buffalo calves, and pointed out that the lateral branch of 12th thoracic spinal nerve innervated the skin just behind the posterior margin of last rib.

Nascimento and Godinho (1973) observed that the lumbar anaesthesia left considerable area of abdominal wall sensitive in cattle and concluded that the external thoracic nerve of brachial plexus provided nerve supply to an area extending from elbow to the level of groins, the umbilicus, prepuce or udder and that for effective analgesia of abdominal wall, this nerve also has

to be blocked by infiltration of local anaesthetic at the point where it crosses the sixth rib.

Ohme and Prier (1974) have given a detailed account of the course and distribution of the nerves of the flank in cattle. According to them the last thoracic, first and second lumbar spinal nerves and fibres from the dorsolateral branches of third lumbar spinal nerve provided sensory and motor innervation to all layers of the lateral abdominal wall. These spinal nerves after emergence through their corresponding intervertebral foramen, divided into two branches - the dorsal and the ventral. The dorsal branch supplied the muscles and skin of the lumbar area. The ventral branch passed backward and downward and divided into ventrolateral and ventromedial branches. The former supplied the skin and cutaneous muscles of middle part of the flank, while the latter ramified into fine cutaneous branches. The area innvervated by these nerves extended from the umbilicus to the anterior edge of the base of the scrotum over the ventral midline. Only the dorsolateral branch of the third lumbar nerve contributed to the innervation of the flank - an area of the caudal flank in front of the tuber coxae ventrally upto the pre-femoral lymph gland. They stated that considerable overlapping existed between the fields supplied by these nerves.

Getty (1977) stated that the ventral branches of thoracic spinal nerves from $T_2$ to $T_{12}$ passed ventrally between the ribs and provided innervation to all layers of chest wall, whereas the last thoracic and first two lumbar nerves passed caudoventrally to innervate the flank. The dorsal branches of the $T_{13}$, $L_1$ and $L_2$ spinal nerves supply the lumbar region and an area of lateral abdominal wall. The lateral thoracic nerve which is motor in function, join the lateral cutaneous branches of intercostal nerves to form intercostobrachial nerve and supplied the cranial and caudal preputial muscles and ventral part of abdominal wall. He also pointed out that the ventral branches of first and second lumbar spinal nerves communicated with each other unilaterally in goats, in exceptional cases.

Prasad and Sinha (1981) studied the structure of brachial plexus in buffalo and observed that the external thoracic nerve extended upto the anterior border of the pubis and terminated by anastamosing with the posterior cutaneous nerve of abdomen. In its course it gave off branches to the deep pectorals, latissimus dorsi, subcutaneous muscles and fascia and the skin of the ventral region of chest and abdomen.

Prakash and Kumar (1983) found that in the goats the lateral thoracic nerve of the brachial plexus innervated

preputialis cranialis and caudalis muscles along with the genitofemoral and cutaneous femoris nerves.

Baily et al. (1984) investigated the anatomy of cutaneous nerves innervating the thorax and abdomen in dogs and the dermatome was mapped using electrophysiologic techniques. They reported that the ventromedial branches of eleventh thoracic to third lumbar spinal nerves do not have the ventral cutaneous branches and the ventral part of the abdominal wall is innervated by the lateral cutaneous branch of ventral primary branches.

**Part II: Paravertebral anaesthesia of flank**

Farquharson (1940) introduced the technique of paravertebral anaesthesia in cattle, as he found that the technique was simple,safe and produced analgesia of all tissues of the flank, including peritoneum. A slight curvature of the back on the side blocked was noticed, due to the blockade of motor nerves. He adopted the last rib and the posterior border of summits of first and second lumbar spinous processes as the landmarks to locate the site for blocking 13th thoracic, first and second lumbar spinal nerves. The site was just behind the last rib for 13th thoracic nerve and two inches lateral to the dorsal midline, on a transverse line drawn over the posterior border of the dorsal spines for first

and second lumbar nerves. The anaesthetic solution was deposited above and below the level of transverse processes.

Formston (1945) (Cited by Wright, 1952) modified the technique for blocking of 13th thoracic, first and second lumbar spinal nerves in cattle. The site was at a point 5 cm lateral to the dorsal midline, on a transverse line connecting the posterior edge of summits of the spinous process of corresponding vertebra and the anterior edge of the transverse process. The skin was penetrated in level with the anterior border of the transverse process.

Magda (1949) (Cited by Cakala, 1961) described the method of distal paravertebral anaesthesia in bovine. The 13th thoracic, first and second lumbar spinal nerves were blocked at sites, above and below the lateral edge of transverse process of first, second and fourth lumbar vertebra. As the branches of the second lumbar nerve was situated more posteriorly, the nerve was blocked at the edge of fourth lumbar transverse process. The needle was inserted horizontally at the site, at right angles to the median plane.

Wright (1952) discussed the techniques of Farquharson and Formston and stated that this technique of anaesthesia produced analgesia of all layers of abdominal wall. For

surgery involving the ventral aspect of the abdominal wall, the nerves anterior to 13th thoracic nerve were to be blocked. He observed that the animals subjected to paravertebral anaesthesia developed a curvature of the back towards the side of anaesthesia.

Milne (1953) used paravertebral anaesthesia for performing laparotomy and considered this as a good method for flank analgesia. He found it difficult to perform, in excessively fat animals.

Link and Smith (1956) used Farquharson's method of paravertebral anaesthesia in cattle for comparing the effects of four local anaesthetic agents. Thirty two out of 40 trials were successful. They obtained analgesia lasting upto 312 min. with cyclaine, 258 min. with xylocaine, 287 min. with pyribenzamine and 120 min. with procaine.

Messervey et al. (1956) successfully conducted Caesarean section in 48 cattle under paravertebral anaesthesia where the 13th thoracic, first and second lumbar spinal nerves were blocked. They observed that the technique had the advantages of satisfactory analgesia of all layers of abdominal wall, adequate relaxation of abdominal muscles, absence of anaesthetic at the site of operation, minimal

quantity of anaesthetic utilized and avoidance of hazards of general anaesthesia.

Neal (1957) (Quoted by Hall, 1971) described the site for blocking the lumbar spinal nerve as 6 cm lateral to the centre point of corresponding spinous process and behind the posterior border of lumbar transverse process. The 13th thoracic spinal nerve was blocked at a site 6 cm lateral to the anterior extremity of the first lumbar spinous process.

Cakala (1961) observed that Farquharson's method of paravertebral anaesthesia was difficult to perform and resulted in the hazard of penetration of aorta or longitudinal thoracic vein on the left and posterior vena cava on the right side. Animals subjected to this technique of paravertebral anaesthesia showed scoliosis towards the side of analgesia. He opined that the method of distal paravertebral anaesthesia described by Magda (1949) was easier, safer and more satisfactory.

Jennings (1961) studied Farquharsons method of paravertebral anaesthesia and found it to be the most useful form of regional anaesthesia for the flank.

Westhues and Fritsch (1964) suggested the mammillary process of the 13th thoracic vertebra as the landmark to block the 13th thoracic spinal nerve. For lumbar spinal nerves they

suggested the craniolateral extremities of the lumbar transverse process and the articular process of the vertebra caudal to the nerves to be blocked, as the landmarks. The sites for distal paravertebral anaesthesia of 13th thoracic, first and second lumbar spinal nerves were between the last rib and tip of first lumbar transverse process, between tips of first and second lumbar transverse processes and between tips of second and third lumbar transverse process respectively. They opined that the entire flank was not always anaesthetized due to overlapping innervation of the fibres of 12th thoracic nerve and the lack of anaesthetic effect on the dorsal branches. They suggested that 13th thoracic, first and second lumbar nerves were to be blocked for midflank laparotomy, and for more anterior incisions, the 12th and 13th thoracic and first lumbar nerves be blocked. For surgery, anterior to the level of umbilicus, blocking the 9th to 12th thoracic spinal nerves had to be done. They observed that the paravertebral anaesthesia produced slight convex inclination of the spine towards the anaesthetized side due to the regional muscular paralysis.

Gabel (1964) listed out a few drawbacks of paravertebral anaesthesia in cattle including the time required for preparation, delay in onset, incomplete anaesthesia and bowing of back. He stated that paravertebral

anaesthesia was useful in conditions like presence of inflammation or infection where local infiltration of the site was impractical.

Frank (1964) described blocking of 13th thoracic, first and second lumbar spinal nerves in bovines, at the site of emergence through the intervertebral foramen approaching through posterior border of the last rib and first two lumbar transverse processes. He observed that paravertebral block anaesthetized all the tissues of abdominal wall and produced a lateral curvature of the back.

Hall (1971) reported that dissection study indicated that in bovine the spinal nerves could more precisely be located by directing the needle towards the anterior border of transverse process of the vertebra, behind the nerve to be blocked, at a point 5 cm lateral to the dorsal midline. When two per cent lignocaine hydrochloride solution was used for paraverterbral blocking in bovine, it produced analgesia of abdominal wall in 10 min, and the anaesthesia lasted for 90 min. A curvature of the spine towards the side of analgesia was observed in unilateral block. Paravertebral anaesthesia adopting similar technique using lignocaine in goats and sheep produced analgesia in 5 min. and it persisted for 60 min.

Khatra and Tyagi (1972b) performed paravertebral blocking of 13th thoracic, first and second lumbar nerves in buffalo calves using Novocaine - Suprarenin as the anaesthetic. The anaesthetic was administered at a point 3-4 cm lateral to the midline, just behind posterior border of the transverse process of 13th thoracic, first and second lumbar vertebra. The whole of the flank, and lower abdominal wall including skin, muscle and peritoneum was desensitized. They suggested that incisions close to the last rib required the blocking of 12th thoracic nerve. The animals developed a curvature of the spine towards the anaesthetized side and they showed inability to put full weight on the hind limbs of that side.

Lumb and Jones (1973) suggested that the sites in cattle for blocking the 13th thoracic, first and second lumbar spinal nerves in cattle at the point 5, 6.5 and 8 cm respectively from the dorsal midline. The needle was inserted at the anterior border of first, second and third lumbar transverse processes respectively. Similar sites were reported in sheep and goat, the sites being approximately 3 cm lateral to the midline.

Ohme and Prier (1974) discussed the Farquharsons method, "Cambridge method" and Magda's method of paravertebral anaesthesia in cattle and suggested that all the techniques

can be easily performed in sheep and goat. They observed a bow on the back of the animals subjected to paravertebral anaesthesia. They found that in distal paravertebral anaesthesia, the second lumbar spinal nerve could be blocked at the lateral edge of third lumbar transverse process, since the second lumbar spinal nerve crossed the third lumbar transverse process.

Thurmon et al. (1974) conducted surgical procedures like laparotomy, rumenotomy, spleenectomy and nephrectomy in goats under etorphin-trifluopromazine sedation supplemented by paravertebral lumbar anaesthesia.

Said et al. (1976) performed laparotomy and rumenotomy in buffaloes under Hickman's method of paravertebral anaesthesia.

Sloss and Dufty (1977) conducted 18 Caesarean operations in cattle under Farquharson's method of paravertebral anaesthesia. Analgesia was complete over all the layers of abdominal wall. Bowing of the back to the anaesthetized side, staggering gait and swaying of hind quarters were also observed. All the animals showed difficulty to lift and advance the hind limb of the anaesthetized side and the toe was dragged on the ground while walking.

Khatra and Tyagi (1980) in a comparative study, evaluated spinal and paralumbar blocks in buffalo calves using Novocaine - Suprarenin, and reported that paravertebral lumbar block anaesthetized the whole of flank. Time for onset of analgesia was 5.77 ± 0.72 min.and peak analgesia was attained by 10.82 ± 1.20 min. Duration of analgesia was 84.35 ± 6.72 min. and period of recovery was 18.35 ± 1.38 min.

Roe (1986) conducted dissection and radiological studies of the spinal nerves in cattle and suggested the skeletal landmarks to locate the site for blocking the spinal nerves viz., (1) caudal border of the transverse process rostrally, (2) lateral edge of the vertebral arch of respective vertebra medially and (3) rostral edge of mammillary process of adjacent posterior vertebra posteriorly. The site of insertion of the needle was 2 cm cranial and 2 cm lateral to the caudal border of the relevant spinal process. Analgesia developed in 2 to 3 min. One cow exhibited a degree of temporary ipsilateral paresis.

Short (1987) opined that Farquharson's method of paravertebral anaesthesia can be used in sheep and goat, the site being 2.5 to 3.0 cm lateral to the dorsal midline. The advantages of paravertebral anaesthesia were the small doses of anaesthetic agent, wide and uniform area of analgesia and muscle relaxation. Arching of back due to paralysis of

muscles, the risk of penetrating vital structures such as aorta, thoracic longitudinal vein and caudal venacava and paresis due to caudal migration of the anaesthetic to block the femoral nerve were the disadvantages of this method.

Taylor (1991) observed that the site for blocking 13th thoracic, first and second lumbar nerves in goat was over the anterior edge of the transverse process, approximately half way between the midline and the tip of the transverse process. It was observed that lignocaine at high doses produced convulsions, drowsiness and respiratory depression.

**Part III: Local anaesthetic agent - Bupivacaine hydrochloride**

Hall (1964) stated that the rapid systemic absorption of local anaesthetic agents produced CNS stimulation manifested as generalized clonic convulsions, tachycardia and increase in rate and depth of respiration, followed by a state of respiratory and vasomotor depression. He pointed out that the probability of primary cardiac failure and death in such cases was high.

Moore et al. (1970) in a clinical and laboratory study, found that bupivacaine was two to three times more potent and four times more toxic than mepivacaine and lignocaine. The systemic toxic manifestation of bupivacaine,

observed in human patients were convulsions, shivering, tremours, bradycardia, nausea and paraesthesia lasting for three weeks.

Albright (1979) reviewed six cases in which systemic toxicity developed following regional anaesthesia using bupivacaine in human patients with immediate onset of convulsions followed by cardiovascular collapse. Hypoxia due to seizures was found to contribute to these. He concluded that the central nervous system succumb to the toxicity first, than the cardiovascular and respiratory system.

Booth and McDonald (1982) stated that symptoms of toxicity to local anaesthetic developed from stimulation of the central nervous system and consisted of restlessness, muscular tremour or clonic convulsions followed by depression and respiratory failure.

Sage et al. (1983) observed that bupivacaine at the rate of 3.4 mg/kg body weight intravenously showed marked increase in heart rate and blood pressure along with convulsive seizures, which lasted for 6 min. Two dogs developed ventricular tachycardia in one minute and died due to ventricular fibrillation.

Thigpen et al. (1983) observed that in artifically induced hypoxic-acidotic states in sheep, intravenous

administration of bupivacaine at the rate of 2.1 mg/kg body weight produced significant increase in blood pressure and heart rate, cardiac arrhythmia, conduction changes and cardiovascular collapse.

Beeby and Jenkins (1984) stated that intravascular injection of bupivacaine in sheep, caused cardiac arrest unresponsive to resuscitative measures when there was acidosis.

Gillman et al. (1991) observed that bupivacaine produced variety of cardiac toxicities. In relatively low concentrations, it slows the conduction in various regions of heart and depressed the cardiac contractility.

# Materials and Methods

## MATERIALS AND METHODS

The study was conducted in 15 apparently healthy Alpine-Malabari crossbred male goats of 9 to 12 months of age, weighing 16 to 31.5 kg. All the animals were dewormed and kept under identical conditions of feeding and management. All the animals were kept under observation for 10 days prior to the experiment.

The study was conducted in three parts, viz.,

Part I : Dissection study on the distribution of spinal nerves in the abdominal region and locating the sites for blocking them.

Part II : Mapping the area desensitized by blocking the individual spinal nerves supplying the flank region at the sites located by dissection studies.

Part III : Anaesthesia of the flank region by blocking the spinal nerves.

Out of the 15 goats, three were used for the dissection study and the rest were used for nerve blocks, repeatedly at 10 days interval.

**Part I: Dissection study of the distribution of thoracic and lumbar spinal nerves in the abdominal region**

Dissection studies on the course and distribution of 10th, 11th, 12th and 13th thoracic and the first three lumbar spinal nerves were conducted in three goats. After embalming, dissection was carried out on either side, from the emergence of the spinal nerves to the final ramification. The observations were recorded in photographs and diagrams.

The purpose of this dissection study was to identify the spinal nerve(s) to be blocked for anaesthetizing the flank, and to identify suitable site(s) wherein perineural injection of local anaesthetic could easily be done.

**PART-II : Mapping the area desensitized by blocking each of the spinal nerves namely 10th, 11th, 12th and 13th thoracic and first, second and third lumbar spinal nerves**

Three goats were used for the study of blocking of each nerve.

Bupivacaine hydrochloride* 0.5 per cent solution, five millilitre was injected perineurally.

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* Sensorcaine - 0.5% and 0.25% solutions, Astra-IDL.

## 1. Tenth thoracic spinal nerve

Three trials were conducted to block the 10th thoracic spinal nerve on three different animals, on right or left sides.

### Site

The site for blocking 10th thoracic spinal nerve as found suitable during the dissection studies was determined by the following landmarks, namely, cranially the tubercle of the respective rib (10th), medially the lateral edge of arch of respective vertebra (10th) and posteriorly the rostral edge of mammillary process of adjacent posterior vertebra (11th). The point of insertion of the needle was 1.0 to 1.5 cm lateral to the dorsal midline (Fig.1).

### Procedure

An insensitive skin weal was produced at the site with one millilitre of 0.5 per cent bupivacaine solution using a 20 gauge hypodermic needle. After two minutes, a five centimetre long, 18 gauge needle with stillette was inserted vertically downward at the centre of the skin weal. When the tip of the needle touched the posterior border of the respective rib (10th), it was withdrawn slightly and redirected caudally and inserted further to a depth of 0.5 to 1.0 cm. The stillette

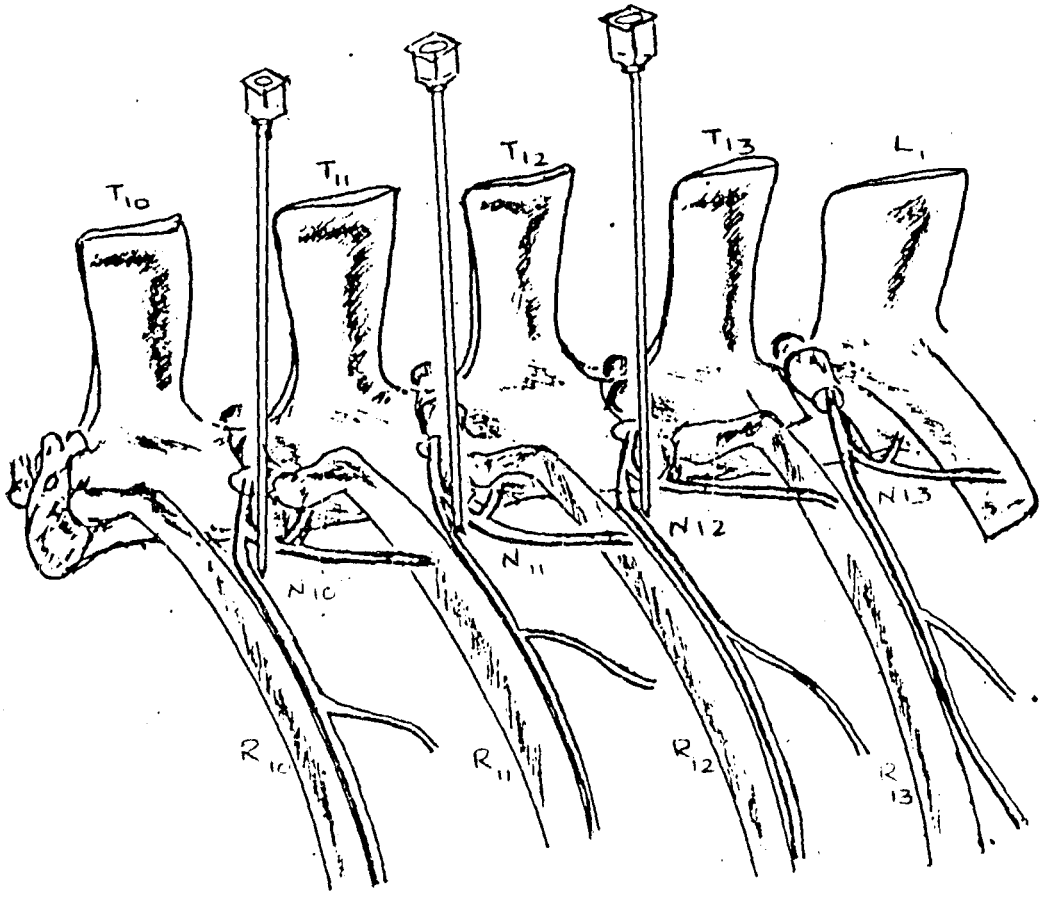
Fig.1. Diagram showing the site of administration of the local anaesthetic solution for blocking 10th, 11th and 12th thoracic spinal nerves at the site 1 (proximal site)

$T_{10-13}$ 10th to 13th thoracic vertebra

$L_1$ first lumbar verterba

$R_{10-13}$ 10th to 13th ribs

$N_{10-13}$ 10th to 13th thoracic spinal nerves


T10
T11
T12
T13
L1
N10
N11
N12
N13
R10
R11
R12
R13

was withdrawn and the syringe with five millilitre 0.5 per cent bupivacaine solution was attached to the needle. Two millilitre of the solution was deposited at this site for blocking the ventral primary branch of the spinal nerve. The needle was then gradually withdrawn and three millilitre of the solution was injected above the level of ribs at two or three points (fan like infiltration), for blocking the dorsal primary branch. The syringe was detached, stillette was reintroduced and the needle was withdrawn. While withdrawing the needle, the skin was kept pressed downwards to avoid its detachment.

After the onset of analgesia, the response to pin-pricks in the region innervated by the nerve was assessed and the area of analgesia was marked on the body of the animal. The area was then recorded diagramatically.

**2. Eleventh and twelfth thoracic spinal nerves**

The area innervated by 11th and 12th thoracic spinal nerves were mapped adopting similar procedure in three different animals on right or left side (Fig.1).

**3. Thirteenth thoracic spinal nerve**

Two sites appeared suitable for blocking 13th thoracic spinal nerve, from the dissection studies viz., Site 1 (proximal site) and Site 2 (distal site).

At each site, three trials were conducted to block the 13th thoracic spinal nerve on three different animals, on right or left side.

**Site 1 (Proximal site)**

The site for blocking the 13th thoracic spinal nerve was at a point, in front of the anterior border of the transverse process and in level with the anterior edge of mammillary process of the adjacent posterior lumbar vertebra (first), 1.0 to 1.5 cm lateral to the dorsal midline (Fig.2).

**Procedure**

After producing an insensitive skin weal at the site as done in the case of 10th thoracic spinal nerve, the needle was inserted vertically downward at the centre of the skin weal. When the tip of the needle touched the anterior border of the transverse process, it was withdrawn slightly and redirected anteriorly and inserted further to a depth of 0.5 to 1.0 cm to pierce the intertransverse ligament. Two millilitre of 0.5 per cent bupivacaine solution was injected at this site, for blocking the ventral primary branch. The needle was then gradually withdrawn and three millilitre of the solution was injected at two or three sites (fan like infiltration), immediately above the intertransverse ligament, for blocking the dorsal primary branch.

Fig.2. Diagram showing the site of administration of the local anaesthetic solution for blocking the 13th thoracic and first and second lumbar spinal nerves

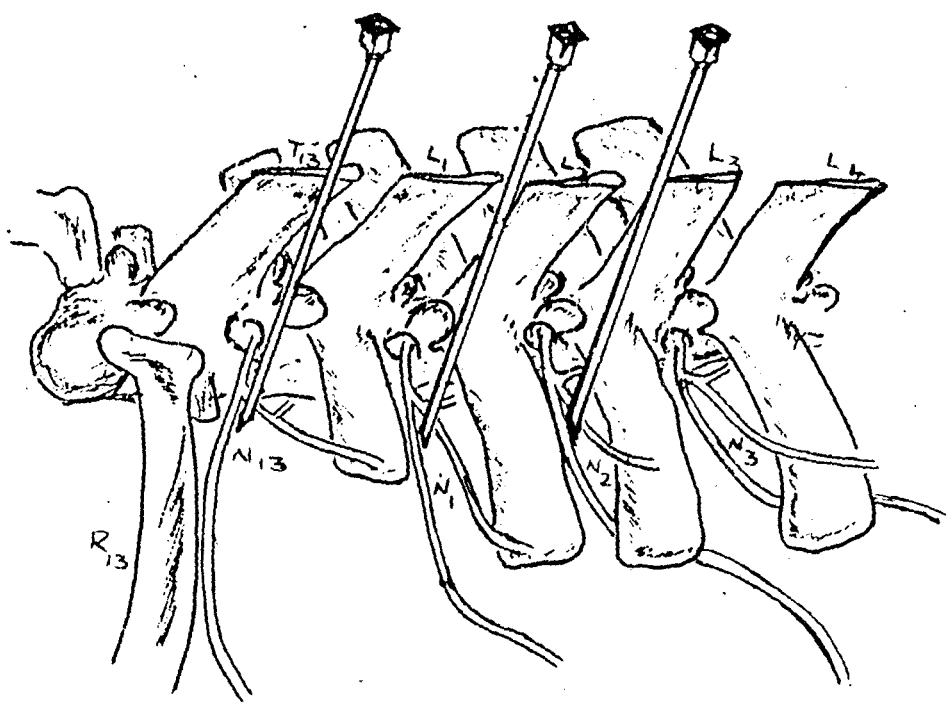
$T_{13}$ 13th thoracic vertebra

$L_{1-4}$ first to fourth lumbar vertebra

$R_{13}$ 13th rib

$N_{13}$ 13th thoracic spinal nerve

$N_{1-2}$ first to second lumbar spinal nerves


T13
L1
L2
L3
L4
N13
N1
N2
N3
R13

Mapping of the area of analgesia was done and it was marked on the body of the animal and in a diagram.

**Site 2 (Distal site)**

The site for blocking the 13th thoracic spinal nerve was just in front of the anterolateral edge of the transverse process of the adjacent posterior lumbar vertebra (first).

**Procedure**

A 2.5 cm long 20 gauge hypodermic needle was inserted horizontally just below the anterolateral edge of transverse process of adjacent posterior lumbar vertebra (first), to a depth of 1.0 cm. Two millilitre of 0.5 per cent bupivacaine solution was deposited at this site to block the ventral primary branch. The needle was partially withdrawn and redirected dorsally over the anterolateral edge of transverse process. Three millilitre of the solution was injected at two or three sites (fan like infiltration) to block the dorsal primary branch of the spinal nerve.

**4. First, second and third lumbar spinal nerves**

From the dissection studies two sites were found suitable for blocking the first, second and third lumbar spinal nerves viz. site 1 (proximal site) and site 2 (distal site).

**Site 1 (proximal site)**

Each of the nerves were blocked at the proximal site adopting similar procedure as done in the case of 13th thoracic nerve, on three different animals on right or left side and the area of analgesia was mapped (Fig.2).

**Site 2 (Distal site)**

The trial was conducted in three different animals on right or left sides.

The infiltration of the local anaesthetic solution was made immediately below and above the lateral edge of transverse process of adjacent posterior vertebra. The area of analgesia was mapped and recorded.

**PART III : Anaesthesia of flank**

From the results of mapping the area of analgesia of 10th thoracic to the third lumbar spinal nerves, it was found that blocking of 13th thoracic, first and second lumbar spinal nerves would bring about satisfactory analgesia of flank region and hence blocking of these three nerves was adopted for the present study.

Two sites were found suitable for blocking the 13th thoracic, first, second and third lumbar spinal nerves, during

the dissection study. Blocking at the distal site was not giving consistent results and hence the proximal site was selected for detailed study of anaesthesia.

Twelve goats were selected for this study. The animals were divided into two subgroups, viz., A and B, consisting of six animals each, serially numbered as $A_1$, $A_2$, $A_3$, $A_4$, $A_5$ and $A_6$ and $B_1$, $B_2$, $B_3$, $B_4$, $B_5$ and $B_6$.

**Preparation of the animal**

Food and water were withheld for 12 hours prior to the experiment. The area lateral to the dorsal midline from the 12th rib to the external angle of ilium to a width of 4 to 5 cm was clipped, shaved, scrubbed with five per cent Cetrimide* lotion, washed with water, mopped dry and painted with Tr. iodine. Sensitivity of the skin was tested with pin-pricks. The animals were controlled in standing position.

**Subgroup A**

Bupivacaine hydrochloride, 0.5 per cent solution, five millilitre was injected at each site to block the nerve. Paravertebral block was done on the left side in animals $A_1$, $A_2$ and $A_3$ and on the right side in animals $A_4$, $A_5$ and $A_6$.

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* Savlon lotion - Indian Explosives Ltd.

**Site**

The site chosen for blocking the 13th thoracic spinal nerve was at a point in front of the transverse process, in level with the anterior edge of mammillary process of the adjacent posterior vertebra and 1.0 to 1.5 cm lateral to the dorsal midline. For blocking first and second lumbar spinal nerves, similar landmarks were adopted.

**Procedure**

An insensitive skin weal was produced at the site by injecting one millilitre of the local anaesthetic solution subcutaneously using a 20 gauge hypodermic needle. After two minutes a five centimetre long 18 gauge needle with stillette was inserted vertically downwards at the centre of the skin weal. When the tip of the needle touched the anterior border of the transverse process of the adjacent posterior vertebra, the needle was withdrawn slightly, redirected anteriorly and inserted further to a depth of 0.5 to 1.0 cm to pierce the intertransverse ligament. The stillette was withdrawn and two millilitres of bupivacaine hydrochloride solution was injected at the site, for blocking the ventral primary branch. The needle was slightly withdrawn and three millilitre of the solution was injected at two or three sites (fan like infiltration) immediately above the intertransverse

ligament, for blocking the dorsal primary branch. After reintroducing the stillette the needle was withdrawn. While withdrawing the needle, the skin was kept pressed downwards to avoid its detachment.

After blocking the three nerves, the observations were recorded.

**Subgroup B**

Five millilitre of 0.25 per cent bupivacaine solution was injected at each site to block each of the nerves. Paravertebral block was done on left side in animals $B_1$, $B_2$ and $B_3$ and on right side in animals $B_4$, $B_5$ and $B_6$.

In this group, the sites for injection and the procedure were the same as in subgroup A. After administration of the local anaesthetic at the three sites, the observations were recorded.

**Items of observation**

After blocking the 13th thoracic, first and second lumbar spinal nerves, the following observations were recorded.

1. Time for onset of analgesia: It was calculated as the interval between the time of administration of the local anaesthetic and the loss of sensitivity to pin-pricks over the flank region.

2. Duration of analgesia: It was calculated as the period between the onset of analgesia and the return of sensitivity to pin-pricks.

3. Extent of analgesia: The extent of analgesia was assessed by pin-pricks and the area of analgesia was marked on the body of the animal. The area was then recorded diagramatically.

4. Clinical signs: C inical signs viz., rectal temperature, heart rate, rate of respiration and rate of rumen motility were recorded before administration of the local anaesthetic, at 30 min. intervals during analgesia and 30 min. after recovery from analgesia.

5. Laparotomy was performed on two animals from each of the subgroups, one on the left flank and the other on the right flank, to assess the degree of analgesia.

6. Other symptoms, if any, observed during analgesia.

Animals were kept under observation for two weeks to observe post-anaesthetic complications, if any.

**Statistical analysis**

The data were statistically analysed using students 't' test (Snedecor and Cochran, 1967).

# Results

# RESULTS

## PART I: Distribution of thoracic and lumbar spinal nerves in the abdominal region

Detailed dissections of both flank were carried out in three male goats, to study the distribution of the spinal nerves in the abdominal region.

The study revealed that the branches of 10th, 11th, 12th and 13th thoracic and the first three lumbar spinal nerves ramified over the caudal thoracic and lumbar areas and the flank. These spinal nerves emerged through their respective intervertebral foraminae. The intervertebral foraminae were located between the arches of adjacent vertebrae, just anterior to and below the mammillary process, in level with the base of transverse processes. In addition to the spinal nerves, the lateral thoracic nerve from brachial plexus supplied the ventrolateral abdominal wall, anterior to umbilicus (Fig.3 to 8).

### Tenth thoracic spinal nerve

The 10th thoracic spinal nerve emerged through the intervertebral foramen located between the 10th and 11th thoracic vertebrae. The spinal nerve passed between the

multifidus dorsi and quadratus lumborum muscles and divided into dorsal and ventral primary branches.

The dorsal primary branch turned dorsally and released the dorsomedial branch and continued as the dorsolateral branch. The dorsomedial branch turned dorsally and ramified into the multifidus dorsi and longissimus dorsi muscles.

The dorsolateral branch continued caudolaterally between the longissimus dorsi and longissimus costarum muscles. It crossed the eleventh rib at the level of lateral edge of the transverse process of second lumbar vertebra. In the eleventh intercostal space, the nerve emerged at the lateral edge of the iliocostalis muscle and entered into the serratus dorsalis caudalis muscle. It finally penetrated through the thoraco-lumbar fascia, branched off into dorsal and ventral cutaneous branches and ramified into the cutaneous trunci muscles and the skin.

The ventral primary branch continued ventrally along the posterior border of the tenth rib, deeper to the internal intercostal muscle, between the pleura and muscle. In the upper third of the chest, in level with the lateral edge of the transverse process of second lumbar vertebra, the nerve divided into two branches viz., ventrolateral and ventromedial branches.

The ventrolateral branch ran caudoventrally, passed through the internal intercostal muscle and coursed between it and external intercostal muscles. At the caudoventral aspect of the intercostal space the nerve penetrated through the external intercostal muscle, crossed the eleventh rib, passed through the origin of obliquus abdominis externus muscle to end up as the cutaneous nerve, which ramified into the skin of the chest.

The ventromedial branch continued ventrally along the posterior border of the tenth rib and crossed the costal arch. It continued downwards over the external surface of the transverse abdominis muscle. The main trunk terminated between it and the rectus abdominis muscles, a hands breadth above the ventral midline. It was then divided into small branches which entered into the rectus abdominis muscle and came out through the aponeuroses of the lateral abdominal muscles and ramified as cutaneous branches, supplying the ventral abdomen.

For blocking the 10th thoracic spinal nerve, the suitable site appeared to be at its emergence through the intervertebral foramen. This site was located by adopting the following land marks, namely; cranially the tubercle of 10th rib, medially the lateral edge of arch of the 10th thoracic vertebra and posteriorly the mammillary process of 11th

Fig.3 Photograph showing the emergence and initial branching of 10th thoracic to third lumbar spinal nerve

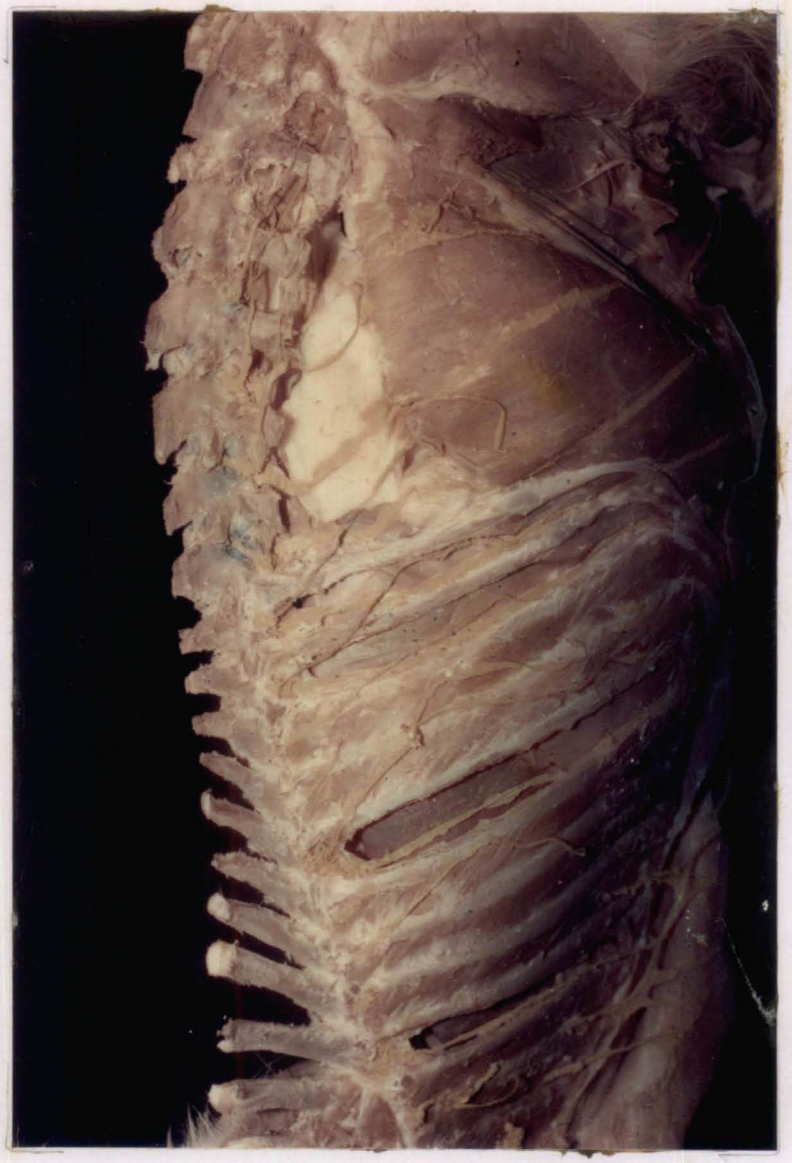


Fig.4 Diagram showing the emergence and initial branching of 10th thoracic to third lumbar spinal nerves

$T_{9-13}$ 9th to 13th thoracic vertebra

$L_{1-4}$ first to fourth lumbar vertebra

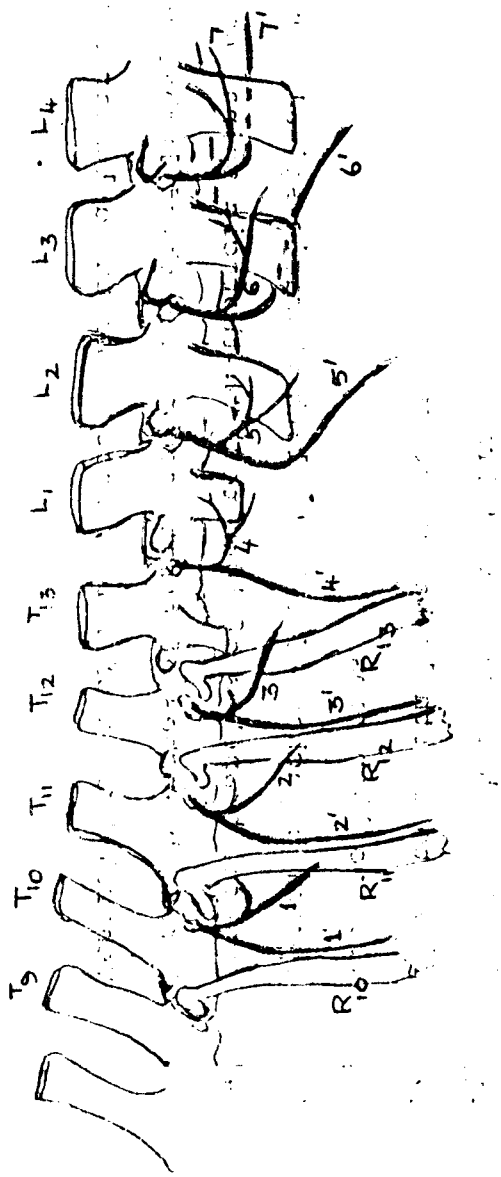
$R_{10-13}$ 10th to 13th ribs

1-4 Dorsal branches of 10th to 13th thoracic spinal nerves

1'-4' Ventral branches of 10th to 13th thoracic spinal nerves

5-7 Dorsal branches of first, second and third lumbar spinal nerves

5'-7' Ventral branch of first, second and third lumbar spinal nerves


T'
L4
6'
L3
L2
5'
L1
4
T13
4'
R-3
T12
3
3'
R-2
T11
2
2'
R-1
T10
1
1'
T9
R-0

thoracic vertebra. At this site the nerve was situated 1.0 cm lateral to the dorsal midline, immediately below the longissimus dorsi muscle 2.5 cm beneath the skin.

**Eleventh thoracic spinal nerve**

The 11th thoracic spinal nerve emerged through the intervertebral foramen that located between the 11th and 12th thoracic vertebrae. The initial course and branching of the nerves were similar to that of 10th thoracic spinal nerve.

The dorsolateral branch passed obliquely between the longissimus dorsi and longissimus costarum muscles, crossed the twelfth rib and in the twelfth intercostal space, came out at the lateral edge of the iliocostalis muscle. The nerve then entered into the serratus dorsalis caudalis muscle and emerged through the thoraco-lumbar fascia, divided into dorsal and ventral cutaneous branches. In its course it supplied the serratus dorsalis caudalis muscle, thoraco lumbar fascia and the cutaneous trunci muscle.

The ventral primary branch ran ventrally along the posterior border of the eleventh rib, deeper to the intercostal muscles. In the upper third of the abdominal wall, in level with the lateral edge of transverse process of second lumbar vertebra, it branched into the ventrolateral and ventromedial branches.

The ventrolateral branch penetrated through the internal intercostal muscle, coursed between it and the external intercostal muscle, crossed the twelfth rib and continued caudoventrally. It penetrated through the obliquus abdominis externus muscle at its origin and finally ramified into the skin.

The ventromedial branch continued ventrally over the surface of the transverse abdominis muscle and crossed the costal arch. The main trunk ended up between the transverse abdominis muscle and the rectus abdominis muscle, a hands breadth above the ventral midline. The nerve then divided into small branches, penetrated through the rectus abdominis muscle and the aponeuroses of the lateral abdominal muscles and ramified into the skin.

For blocking the 11th thoracic spinal nerve, suitable site appeared to be at its emergence through intervertebral foramen. This site was located by adopting the following landmarks, namely; cranially the tubercle of the 11th rib, medially the lateral edge of the arch of 11th thoracic vertebra and posteriorly the mammillary process of 12th thoracic vertebra. At this site the nerve was situated 1.0 cm lateral to the dorsal midline, immediately below the longissimus dorsi muscle, 2.5 cm beneath the skin.

**Twelfth thoracic spinal nerve**

The 12th thoracic spinal nerve emerged through the intervertebral foramen located between the 12th and 13th thoracic vertebrae. The initial course and branching of the nerve were similar to that of 10th thoracic spinal nerve.

The dorsolateral branch passed obliquely between the longissimus dorsi and longissimus costarum muscles and crossed the thirteenth rib in level with the lateral edge of second lumbar transverse process. At the level of the first lumbar vertebra, it emerged out at the lateral edge of the iliocostalis muscle, penetrated the serratus dorsalis caudalis muscle, and the thoraco-lumbar fascia to form the cutaneous innervation. The dorsolateral branch of the twelfth thoracic spinal nerve thus formed the innervation to the antero-dorsal angle of the paralumbar fossa, between the last rib and the transverse processes of first two lumbar vertebrae.

The ventral primary branch coursed ventrally along the posterior border of the twelfth rib, beneath the internal intercostal muscle. In the upper third of the abdominal wall in level with lateral edge of second lumbar transverse process it divided into ventrolateral and ventromedial branches.

The ventrolateral branch penetrated through the internal intercostal muscle and coursed between it and the

external intercostal muscle. It continued in a posteroventral direction where it perforated the obliquus abdominis externus muscle, continued for a short distance between it and the cutaneous trunci muscle, and ramified into the skin.

The ventromedial branch continued ventrally along the posterior border of the twelfth rib and crossed the costal arch. It continued ventrally over the surface of transverse abdominis muscle. Between it and the rectus abdominis muscle the nerve divided into fine branches. The branches pierced through the rectus abdominis muscle and the aponeuroses of the lateral abdominal muscles and ramified into the skin around the umbilicus.

For blocking the 12th thoracic spinal nerve a suitable site appeared to be at the emergence through the intervertebral foramen. This site was located by adopting the following landmarks, namely; cranially the tubercle of the 12th rib, medially the lateral edge of arch of the 12th thoracic vertebra and posteriorly the mammillary process of the 13th thoracic vertebra. At this site the nerve was situated 1.0 cm lateral to the dorsal midline, immediately below the longissimus dorsi muscle, 2.5 cm beneath the skin.

**Thirteenth thoracic spinal nerve**

The 13th thoracic spinal nerve emerged through the intervertebral foramen located between the 13th thoracic and first lumbar vertebrae. The initial course and branching of the nerve were similar to that of the 10th thoracic spinal nerve.

The dorsolateral branch of thirteenth thoracic spinal nerve passed obliquely between the longissimus dorsi muscle and the intertransversalis lumborum muscles, and turned caudally at the level of anterolateral angle of first lumbar transverse process. The nerve then perforated the lateral edge of the iliocostalis muscle, entered the serratus dorsalis caudalis muscle and penetrated through the muscle and the thoraco-lumbar fascia. It then branched off into dorsal and ventral cutaneous branches and ramified into the skin of anterior part of upper flank.

The ventral primary branch (costoabdominalis nerve) passed ventrally behind and parallel to the posterior border of the last rib, in front of the anterolateral edge of first lumbar transverse process, over the transverse abdominis muscle. In the upper third of the flank in level with lateral edge of second lumbar transverse process it was branched off into ventromedial and ventrolateral branches.

The ventrolateral branch continued downward and backward and penetrated the obliquus abdominis internus muscle and coursed between it and obliquus abdominis externus muscle. Then it passed through the obliquus abdominis externus and ramified into the skin of upper flank.

The ventromedial branch, at the level of costochondral junction of the last rib, turned caudoventrally and continued downwards to terminate under the rectus abdominis muscle, a hands breadth above the ventral midline. From there small branches continued downwards, penetrated the rectus abdominis muscle and the aponeuroses of the lateral abdominal muscles. They terminated as the cutaneous nerves which ramified on the ventral aspect of abdomen immediately posterior to the umbilicus and around the preputial orifice.

For blocking the 13th thoracic spinal nerve two sites appeared to be suitable, namely;

Site 1 (proximal site): At its emergence through the intervertebral foramen. This site was at a point in front of the anterior border of the first lumbar transverse process and in level with the anterior edge of mammillary process of first lumbar vertebra. At this site the nerve was situated 1.0 cm lateral to the dorsal midline immediately below the longissimus lumborum muscle, 2.5 to 3.0 cm beneath the skin.

Site 2 (distal site): The dorsal and ventral primary branches were accessable for perineural injection by inserting the needle horizontally, at right angles to the median plane, in front of the anterolateral angle of first lumbar transverse process and depositing the local anaesthetic solution at two points, one above and one below the level of transverse process, at a depth of 1.0 cm.

**First lumbar spinal nerve**

The first lumbar spinal nerve emerged through the intervertebral foramen located between the first and second lumbar vertebrae. The initial course and branching of the nerve were similar to that of the 10th thoracic spinal nerve.

The dorsolateral branch, after its initial oblique course in the intertransverse space, turned more caudally and crossed the lateral edge of the transverse process of second lumbar vertebra. It continued caudally below the iliocostalis muscle and emerged at the level of the transverse process of third lumbar vertebra. The nerve then penetrated the thoracolumbar fascia and divided into dorsal and ventral cutaneous branches. These branches moved posteroventrally and ramified as the cutaneous nerves to the middle third of the upper flank.

The ventral primary branch (iliohypogastric nerve) after the separation from its dorsal counterpart, coursed laterally under the intertransversalis lumborum muscle behind the caudal border of the transverse process of the first lumbar vertebra. At this portion, it released a small branch which traversed caudally, below the second lumbar transverse process and communicated with ventral branch of the second lumbar spinal nerve. The main trunk then passed caudoventrally, below the lateral edge of second lumbar transverse process, over the superficial surface of the transverse abdominis muscle. In the upper third of the flank, in level with external angle of ilium, it branched off into ventrolateral and ventromedial branches.

The ventrolateral branch moved posteriad and downward, penetrating through the obliquus abdominis internus muscle and coursed between it and the obliquus abdominis externus muscle, passed through the obliquus abdominis externus muscle and ramified into the skin of upper flank.

The ventromedial branch continued caudoventrally over the surface of transverse abdominis muscle and terminated under the rectus abdominis muscle as in the case of the 13th thoracic spinal nerve. It then ramified into small branches which penetrated the rectus abdominis muscle and the

aponeuroses of the lateral abdominal muscles to form the cutaneous innervation of the ventral abdominal wall.

For blocking the first lumbar spinal nerve, two sites were found suitable, namely;

Site 1 (proximal site): At the emergence of the nerve through the intervertebral foramen, at a point in front of the anterior border of the second lumbar transverse process and in level with the anterior edge of mammillary process of second lumbar vertebra. At this site the nerve was situated 1.0 cm lateral to the dorsal midline immediately below the longissimus lumborum muscle, 2.5 to 3.0 cm beneath the skin.

Site 2 (distal site): The dorsal and ventral primary branches crossed the second lumbar transverse process, approximately 1.0 cm from its lateral edge. The nerves were accessible for perineural injection by inserting the needle horizontally at right angles to median plane, above and below the lateral edge of the transverse process to a depth of 1.0 cm.

**Second lumbar spinal nerve**

The second lumbar spinal nerve emerged through the intervertebral foramen located between the second and third lumbar vertebrae. The initial course and branching of the nerve was similar to that of the 10th thoracic spinal nerve.

The dorsolateral branch passed obliquely in the intertransverse space and crossed the distal third of the transverse process of third lumbar vertebra. It emerged between the longissimus lumborum and the iliocostalis muscles at the level of transverse process of the fourth lumbar vertebra. The branch ran further backward and downward, penetrated the thoraco-lumbar fascia and ramified as the cutaneous nerves for the caudal part of upper flank.

The ventral primary branch (ilioinguinal nerve) initially passed laterally under the intertransversalis muscle, behind the caudal border of the transverse process of second lumbar vertebra. At this part it released a small branch which passed caudally, below the transverse process between the psoas muscles. The main trunk of the ventral primary branch turned caudoventrally and passed under the lateral edge of the transverse processes of third and fourth lumbar vertebra. It continued posteriorly and downward over the superficial surface of the transverse abdominis muscle, in the caudal third of the flank. It branched off into ventromedial and ventrolateral branches at the level of tuber coxae.

The ventrolateral branch passed caudoventrally, penetrating through the obliquus abdominis internus and coursed between it and the obliquus abdominis externus muscle. Then the nerve penetrated the obliquus abdominis externus

muscle and ran between it and cutaneous trunci muscle, releasing many fine branches to both these muscles. It finally ramified into the skin above the flap of flank.

The ventromedial branch continued downward and terminated between the rectus abdominis and the transverse abdominis muscles, a hands breadth above the ventral midline. Then it ramified into small branches which penetrated through the rectus abdominis muscle and the aponeuroses of the lateral abdominal muscles and formed cutaneous innervation just anterior to scrotum.

For blocking the second lumbar spinal nerve, two sites appeared to be suitable, namely;

Site 1 (proximal site): At the emergence of the nerve through the intervertebral foramen, at a point in front of the anterior border of third lumbar transverse process and in level with the mammillary process of third lumbar vertebra. At this site the nerve was situated 1.0 cm lateral to the dorsal midline, immediately below the longissimus lumborum muscle, 2.5 to 3.0 cm beneath the skin.

Site 2 (distal site): The dorsal and ventral primary branches crossed the third lumbar transverse process approximately 1.0 cm from its lateral edge. These nerves are accessible for perineural injection by inserting the needle horizontally at

right angles to the median plane, above and below the lateral edge of the transverse process to a depth of 1.0 cm.

**Third lumbar spinal nerve**

The third lumbar spinal nerve emerged through the intervertebral foramen located between the third and fourth lumbar vertebrae. The initial course and branching of the nerve were similar to that of the 10th thoracic spinal nerve.

The dorsolateral branch emerged between the longissimus lumborum and the iliocostalis muscles at the level of the tuber coxae. It ran caudally, above the fourth lumbar transverse process and penetrated through the thoraco-lumbar fascia. It provided cutaneous innervation to the posterodorsal angle of the paralumbar fossa.

The ventral primary branch of the third lumbar spinal nerve first ran ventrally and then passed caudad between the psoas muscles, crossing the lateral edge of fourth lumbar transverse process.

For blocking the third lumbar spinal nerve two sites were found suitable, namely;

Site 1 (proximal site): At the emergence of the nerve through the intervertebral foramen, at a point in front of the anterior border of the fourth lumbar transverse process and in

level with the mammillary process of the fourth lumbar vertebra. At this site the nerve was situated 1.0 cm lateral to the dorsal midline, immediately below the longissimus lumborum muscle 2.5 to 3.0 cm beneath the skin.

Site 2 (distal site): The dorsal and ventral primary branches crossed the fourth lumbar transverse process, approximately 1.0 cm from its lateral edge. The nerve was accessible for perineural injection by inserting the needle horizontally at right angles to median plane, above and below the lateral edge of transverse process at a depth of 1.0 cm.

**Fourth lumbar spinal nerve**

The fourth lumbar spinal nerve emerged through the intervertebral foramen located between the arches of fourth and fifth lumbar vertebrae. The initial course and branching of the nerve were similar to that of the 19th thoracic spinal nerve.

The dorsolateral branch coursed caudally and dorsally, through the longissimus lumborum muscle and penetrated through the thoracolumbar fascia, above the external angle of ilium, and close to the dorsal midline. It provided cutaneous innervation at the croup region.

Fig.5. Photograph showing the distribution of the thoracic and lumbar spinal nerves and the lateral thoracic nerve

Fig.6. Diagram showing the distribution of thoracic and lumbar spinal nerves and the lateral thoracic nerve

| | |
|---|---|
| $T_{3-13}$ | third to 13th thoracic vertebrae |
| $L_{1-5}$ | first to fifth lumbar vertebra |
| $R_{3-13}$ | third to 13th ribs |
| a | intercostalis externus muscle |
| b | transverse abdominis muscle |
| b' | aponeurosis of transverse abdominis muscle |
| c | rectus abdominis muscle (cut and flapped) |
| d | pectoralis ascendens muscle |
| e | cutaneous trunci muscle (flapped) |
| 1-5 | Ventromedial branches of 5th to 13th thoracic spinal nerves |
| 1'-5' | Ventrolateral branches of 5th to 13th thoracic spinal nerves |
| 8-13 | cutaneous branches of ventrolateral branches of 3rd, 4th, 6th, 7th, 9th and 10th thoracic spinal nerves |
| 14 | lateral thoracic nerve |
| 14' | Ventromedial branches of 3rd, 4th, 5th and 6th thoracic spinal nerves communicating with lateral thoracic nerve |

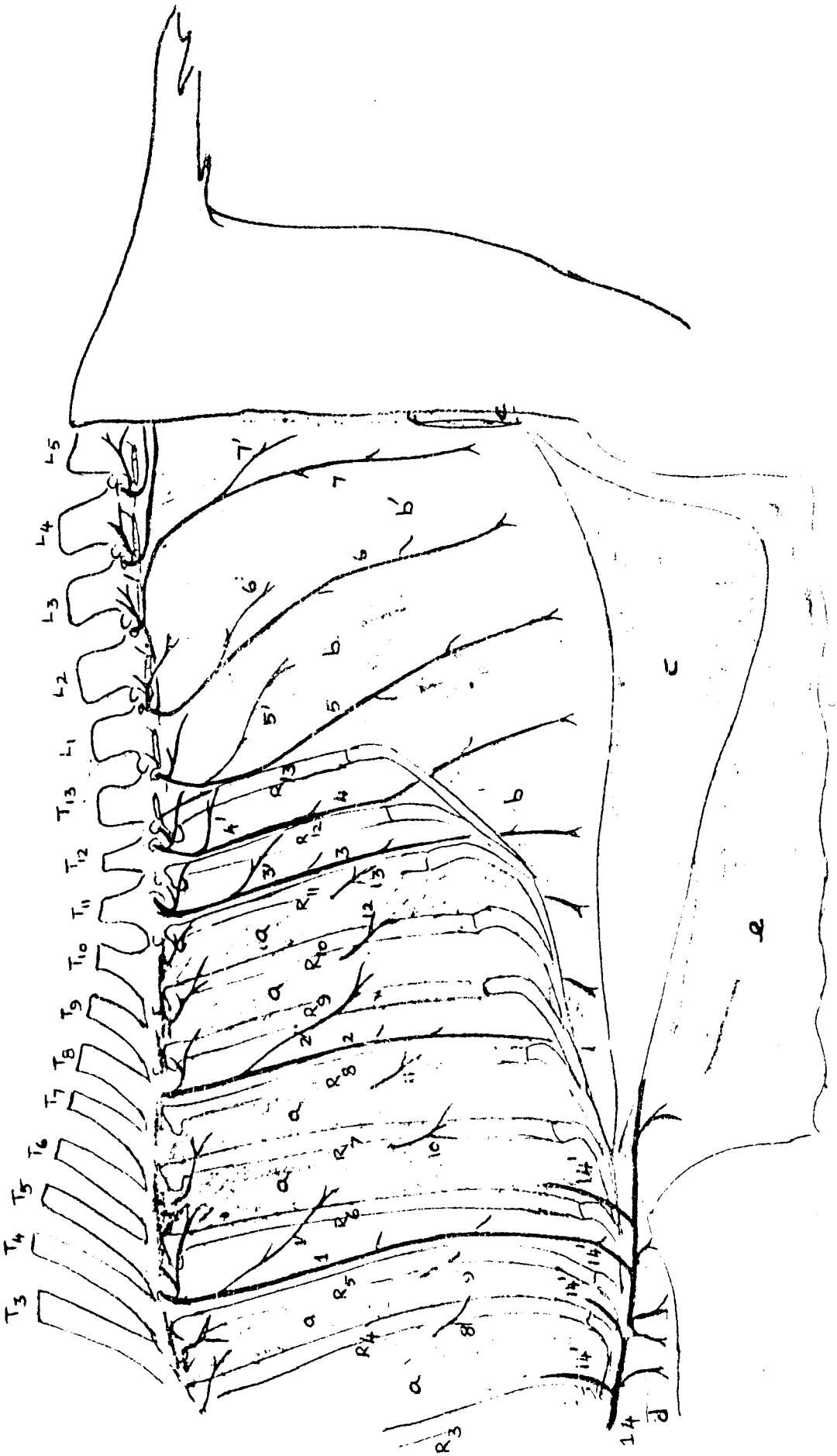
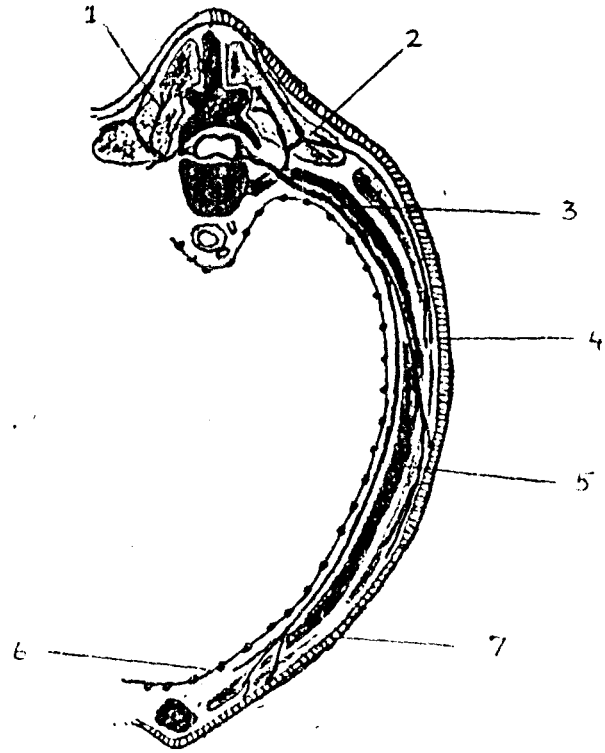

L5
L4
L3
L2
L1
T13
T12
T11
T10
T9
T8
T7
T6
T5
T4
T3
T'
7
b'
6
6'
b
5'
5
4'
4
3'
3
2'
2
1
a
c
d
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
8'
10
12
13
14
14'

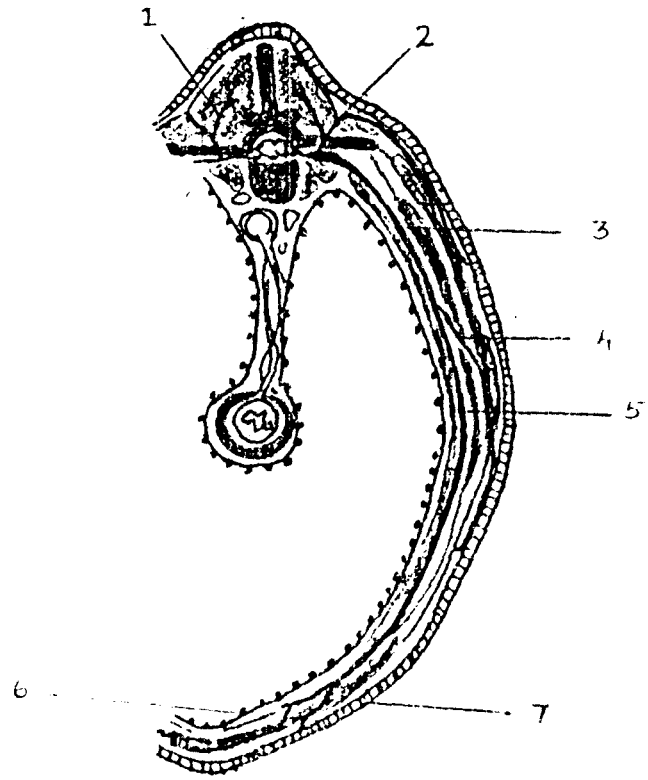
Fig.7. Diagram showing the distribution of thoracic spinal nerves (transverse section)

1. Dorsomedial branch
2. Dorsolateral branch
3. Ventral primary branch
4. Ventrolateral branch
5. Ventromedial branch
6. Pleura
7. Skin

Fig.8. Diagram showing the distribution of lumbar spinal nerves (transverse section)

1. Dorsomedial branch
2. Dorsolateral branch
3. Ventral primary branch
4. Ventrolateral branch
5. Ventromedial branch
6. Peritoneum
7. Skin


1
2
3
4
5
6
7


1
2
3
4
5
6
7

The ventral branch first passed ventrally and then ran caudad between the psoas muscles.

**Lateral thoracic branch of brachial plexus**

The lateral thoracic branch of the brachial plexus was also found to take part in the innervation of the ventrolateral abdominal wall, anterior to umbilicus. It originated from the posterior part of the brachial plexus and passed caudally under the pectoralis ascendans muscle. It ran caudally on the external surface of the lower part of the ribs under the skin of thorax and continued on the ventrolateral aspect of the anterior abdomen. It terminated just cranial to the umbilicus. Along its course, the lateral thoracic nerve received fibres from ventromedial branch of second, third, fourth and fifth thoracic spinal nerves. The branches of the nerve and its spinal nerve connections supplied the pectoral muscles, latissimus dorsi muscle, cutaneous muscles, fascia and skin on the ventrolateral part of the chest and the abdomen and the cranial preputial muscle.

## Part II. The area desensitized by blocking individual spinal nerves supplying the flank region

The area desensitized by blocking individual spinal nerves at two sites, viz. proximal and distal sites were as described below. Each nerve was blocked in three animals by

injecting 5 ml of 0.5% bupivacaine hydrochloride solution perineurally. The area desensitized were marked and presented as Fig.9 to 24. The measurements at the upper, middle and lower thirds are presented as Tables 1 and 2.

**Site 1 (Proximal site)**

**10th thoracic spinal nerve**

Uniform results were obtained in the three trials. The area of analgesia was more or less in the form of an S-shaped band. It commenced from the dorsal midline over the dorsal spines of 10th and 11th thoracic vertebrae, extending downwards and backwards to the level of tubercles of 10th and 11th ribs. The average width at this level was 3.2 cm. From there it deviated backwards to the level of posterior border of 11th and 12th ribs and it was 3.2 cm wide at this position. The area of analgesia then curved forward to the level of posterior border of 10th and 11th ribs and continued downwards. From the level of costal arch it extended downwards and backwards upto a distance of 8.7 cm lateral to the ventral midline. At this level it was 2.8 cm wide (Fig.9).

**11th thoracic spinal nerve**

The results obtained in the three trials were uniform. The area of analgesia was more or less in the form of an S-shaped band. It commenced from the dorsal midline over the dorsal spines of 11th and 12th thoracic vertebrae, extending downwards to the level of the tubercle of 11th and 12th ribs. The average width at this level was 5.5 cm. From there it deviated backward to the 11th and 12th intercostal spaces and it was 3.8 cm wide at this position. It then curved forward to the level of posterior border of 11th and 12th ribs and continued downward. From the level of the costal arch, it extended downward and backward upto a distance of 5.5 cm lateral to the ventral midline. At this level it was 3.3 cm wide (Fig.10).

**12th thoracic spinal nerve**

The results obtained in the three trials were uniform. The area of analgesia was more or less in the form of an S-shaped band. It commenced from the dorsal midline over the dorsal spines of 12th and 13th thoracic vertebrae, extending downwards to the level of the tubercles of 12th and 13th ribs. The average width of the area at this level was 4.9 cm. From there it deviated backward into the 12th intercostal space anteriorly and into the paralumbar fossa, to the level of

second lumbar transverse process posteriorly. It was 4.7 cm wide at this position. It then curved foreward to the level of posterior border of 12th and 13th ribs and continued downward and backward below the level of the costal arch, upto a distance of 10.0 cm lateral to the ventral midline. At this level it was 4.2 cm wide (Fig.11).

**13th thoracic spinal nerve**

The results obtained in the three trials were uniform. The area of analgesia commenced from the dorsal midline over the dorsal spines of 13th thoracic, first and second lumbar vertebrae, extending downwards to the level of tubercle of the last rib anteriorly and second lumbar transverse process posteriorly. The average width at this level was 5.5 cm. The area extended downwards along the posterior border of the last rib and it was 4.3 cm wide at the level of posterior angle of the costal arch. It became narrower and extended downward and backward upto a distance of 12.7 cm lateral to the ventral midline. At this level it was 3.7 cm wide (Fig.12).

**First lumbar spinal nerve**

The results obtained in the three trials were uniform. The area of analgesia was more or less in the form of an S-shaped band. It commenced from the dorsal midline over the dorsal spines of first, second and third lumbar vertebrae,

extending downwards to the level of first lumbar transverse process anteriorly and third lumbar transverse process posteriorly. The average width at this level was 6.5 cm. From there it deviated backwards upto the level of second lumbar transverse process anteriorly and fourth lumbar transverse process posteriorly. It was 6.3 cm wide at this position. It then curved foreward upto 3.5 cm behind the posterior angle of costal arch and continued downward and backward over the ventral flank, upto a distance of 9.5 cm lateral to the ventral midline. At this level it was 3.6 cm wide (Fig.13).

**Second lumbar spinal nerve**

The results obtained in the three trials were uniform. The area of analgesia commenced from the dorsal midline over the dorsal spines of fourth and fifth lumbar vertebrae, extending downwards to the level of transverse processes of the same vertebrae. The average width at this level was 6.5 cm. From there the area continued downward over the posterior third of the flank, in front of the external angle of ilium and pre-femoral lymph gland, with a slight backward curvature. It was 4.2 cm wide at the level of the pre-femoral lymph gland. The area extended upto a distance of 9.7 cm lateral to ventral midline. At this level it was 3.7 cm wide (Fig.14).

**Third lumbar spinal nerve**

The results obtained in the three trials were uniform. The area of analgesia commenced from the dorsal midline over the dorsal spines of fourth and fifth lumbar vertebrae, extending downwards to the level of transverse processes of the same vertebrae. The average width at this level was 6.0 cm. From there it continued downwards, upto the level of prefemoral lymph gland. At this level it was 6.0 cm wide (Fig.15).

**Site 2 (Distal site)**

**13th thoracic spinal nerve**

Animal No.1

The area of analgesia commenced from the dorsal midline, over the dorsal spines of the second, third and fourth lumbar vertebrae, extending downwards to the level of second lumbar transverse process anteriorly and fourth lumbar transverse process posteriorly. The width at this level was 7.0 cm. From there it curved slightly backward and then foreward, so that the anterior border reached upto 3.0 cm caudal to the posterior angle of costal arch. At this level, it was 9.0 cm wide. It then became narrower and extended backward and downward, upto 7.0 cm lateral to the ventral midline. At this level it was 3.0 cm wide (Fig.16).

**Animal No.2**

The area of analgesia commenced from the dorsal midline over the dorsal spines of the first, second and third lumbar vertebrae, extending downward to the level of first lumbar transverse process anteriorly and third lumbar transverse process posteriorly. The width at this level was 6.0 cm. It then curved forward, so that, anteriorly it reached upto the posterior border of the last rib and then extended downward along the posterior border of the last rib. It was 7.0 cm wide at the level of posterior angle of the costal arch. It extended backward and downward over the ventral flank, upto 5.0 cm lateral to the ventral midline. At this level it was 6.0 cm wide (Fig.17).

**Animal No.3**

The area of analgesia commenced from the dorsal midline over the dorsal spines of 13th thoracic, first, second, third and fourth lumbar vertebrae, extending downwards to the level of tubercle of the last rib anteriorly and fourth lumbar transverse process posteriorly. The width at this level was 9.0 cm. The area extended downward along the posterior border of the last rib and it was 6.0 cm wide at the level of posterior angle of the costal arch. It became narrower and extended downward and backward upto a distance of

level of first lumbar transverse process anteriorly and fifth lumbar transverse process posteriorly. The width at this level was 13.0 cm. It extended downward, 2.0 cm behind the posterior border of the last rib anteriorly and 2.0 cm in front of the prefemoral lymph gland posteriorly. It was 10.0 cm wide at this region. It extended downward upto a line below the level of posterior angle of the costal arch, 15.0 cm lateral to the ventral midline. At this level it was 8.0 cm wide (Fig.20).

**Animal No.3**

The area of analgesia commenced from the dorsal midline over the dorsal spines of 13th thoracic, first, second and third lumbar vertebrae, extending downwards to the level of tubercle of the last rib anteriorly and third lumbar transverse process posteriorly. The width at this level was 11.0 cm. It extended along the posterior border of the last rib and it was 10.0 cm wide at the level of posterior angle of the costal arch. Later, the anterior border deviated backwards and the area became narrower. It extended downward and backward upto 6.0 cm lateral to the ventral midline. At this level it was 4.0 cm wide (Fig.21).

**Second lumbar spinal nerve**

**Animal No.1**

The area of analgesia commenced from the dorsal midline over the dorsal spines of second, third and fourth lumbar vertebrae, extending downward to the level of third lumbar transverse process anteriorly and fifth lumbar transverse process posteriorly. The width at this level was 9.5 cm. It continued downward over the posterior part of the flank, 3.0 cm in front of external angle of ilium and prefemoral lymph gland with a slight backward curvature. It was 10.0 cm wide at the level of prefemoral lymph gland. The area extended downwards upto 13.0 cm lateral to the ventral midline. At this level it was 7.0 cm wide (Fig.22).

**Animal No.2**

The area of analgesia commenced from the dorsal midline over the dorsal spines of fourth and fifth lumbar vertebrae, extending downwards to the level of transverse processes of the same vertebrae. The width at this level was 5.0 cm. From there the area extended downward over the posterior third of the flank, 2.0 cm in front of the external angle of ilium and prefemoral lymph gland with a slight backward curvature. It was 5.0 cm wide at the level of prefemoral lymph gland. The area extended upto a distance of

Table 1. Width of the area of analgesia at the upper, middle and lower parts when the 10th thoracic to the third lumbar spinal nerves were individually blocked at the proximal site

| Spinal nerve | Animal number | Width (cm) at | | | Termination from ventral midline |
|---|---|---|---|---|---|
| | | upper | middle | lower | |
| 10th thoracic | 1 | 3.0 | 2.8 | 2.5 | 6.0 |
| | 2 | 3.0 | 2.8 | 2.5 | 9.0 |
| | 3 | 3.5 | 4.0 | 3.5 | 11.0 |
| | Mean | 3.2 | 3.2 | 2.8 | 8.7 |
| 11th thoracic | 1 | 5.5 | 4.5 | 3.6 | 5.5 |
| | 2 | 4.0 | 3.5 | 3.5 | 5.5 |
| | 3 | 7.0 | 3.5 | 2.8 | 5.4 |
| | Mean | 5.5 | 3.8 | 3.3 | 5.5 |
| 12th thoracic | 1 | 6.0 | 5.2 | 5.0 | 11.0 |
| | 2 | 4.0 | 4.5 | 3.0 | 12.0 |
| | 3 | 4.7 | 4.5 | 4.5 | 7.0 |
| | Mean | 4.9 | 4.7 | 4.2 | 10.0 |
| 13th thoracic | 1 | 6.0 | 4.6 | 3.6 | 14.0 |
| | 2 | 6.5 | 4.0 | 4.0 | 12.0 |
| | 3 | 4.0 | 4.3 | 3.5 | 12.0 |
| | Mean | 5.5 | 4.3 | 3.7 | 12.7 |

Contd.

Table 1 (Contd.)

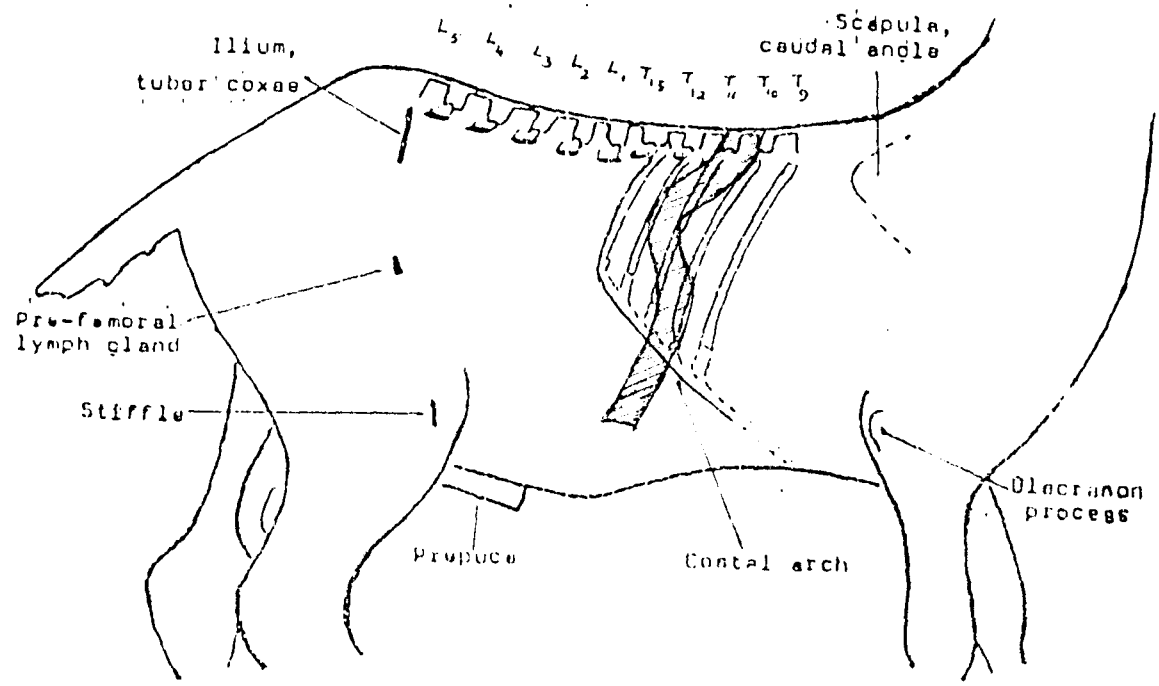
| Spinal nerve | Animal number | Width (cm) at | | | Termination from ventral midline |
|---|---|---|---|---|---|
| | | upper | middle | lower | |
| First lumbar | 1 | 6.0 | 6.5 | 5.0 | 7.5 |
| | 2 | 4.5 | 6.4 | 3.0 | 8.5 |
| | 3 | 9.0 | 6.0 | 3.0 | 13.0 |
| | Mean | 6.5 | 6.3 | 3.6 | 9.6 |
| Second lumbar | 1 | 8.0 | 6.5 | 5.0 | 7.0 |
| | 2 | 4.5 | 6.0 | 5.5 | 4.0 |
| | 3 | 7.0 | 5.0 | 8.0 | 8.0 |
| | Mean | 6.5 | 5.8 | 6.2 | 6.3 |
| Third lumbar | 1 | 8.0 | - | 7.0 | - |
| | 2 | 5.0 | - | 5.0 | - |
| | 3 | 5.0 | - | 6.0 | - |
| | Mean | 6.0 | - | 6.0 | - |

Table 2. Width of the area of analgesia at the upper, middle and lower parts when the 13th thoracic to the third lumbar spinal nerves were individually blocked at the distal site

| Spinal nerve | Animal number | Width (cm) at | | | Termination from ventral midline |
|---|---|---|---|---|---|
| | | upper | middle | lower | |
| 13th thoracic | 1 | 7.0 | 9.0 | 3.0 | 7.0 |
| | 2 | 6.0 | 7.0 | 6.0 | 5.0 |
| | 3 | 9.0 | 6.0 | 5.0 | 12.0 |
| First lumbar | 1 | 13.0 | 9.0 | 4.0 | 0.0 |
| | 2 | 13.0 | 10.0 | 8.0 | 15.0 |
| | 3 | 11.0 | 10.0 | 4.0 | 6.0 |
| Second lumbar | 1 | 9.5 | 10.0 | 7.0 | 13.0 |
| | 2 | 5.0 | 5.0 | 3.0 | 17.0 |
| | 3 | 5.0 | 3.0 | 5.0 | 12.0 |
| Third lumbar | 1 | 6.0 | - | 6.0 | - |
| | 2 | 6.1 | - | 5.8 | - |
| | 3 | 6.5 | - | 7.1 | - |
| Mean | | 6.2 | - | 6.3 | - |

Fig.9. Diagram showing the area of analgesia mapped after blocking the 10t. thoracic spinal nerve at the site 1 (proximal site)

Fig.10. Diagram showing the area of analgesia mapped after blocking the 11th thoracic spinal nerve at the site 1 (proximal site)


Ilium,
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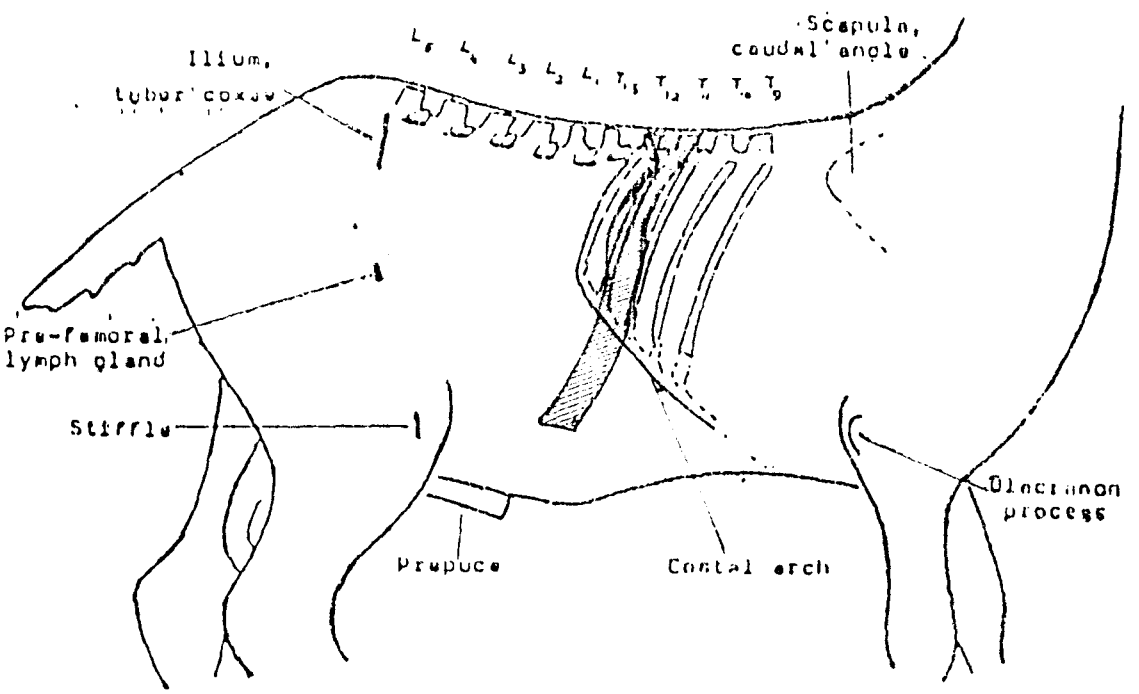
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch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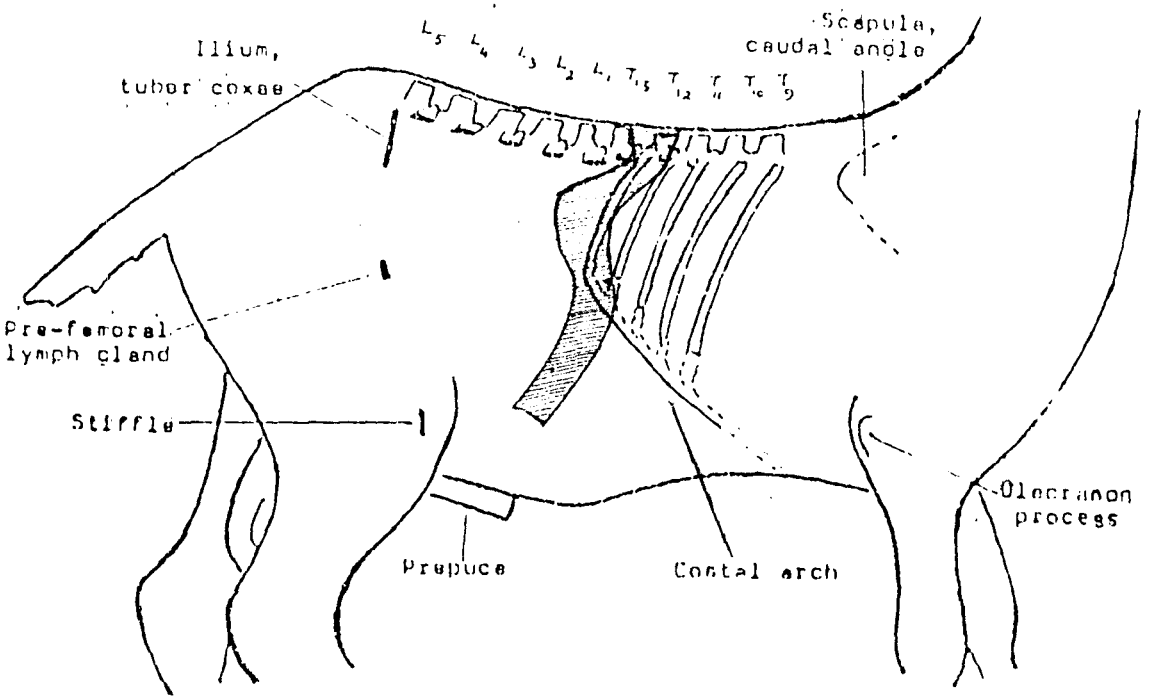
tubor coxae
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch

Fig.11. Diagram showing the area of analgesia mapped after blocking the 12th thoracic spinal nerve at the site 1 (proximal site)

Fig.12. Diagram showing the area of analgesia mapped after blocking the 13th thoracic spinal nerve at the site 1 (proximal site)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Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch

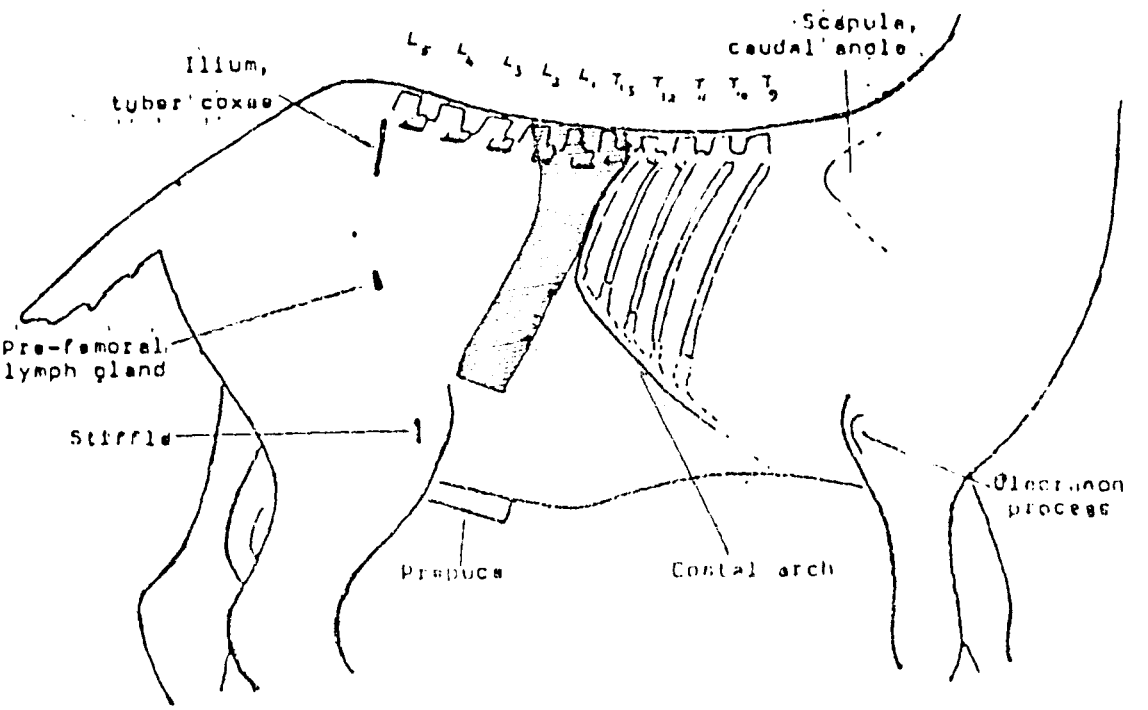
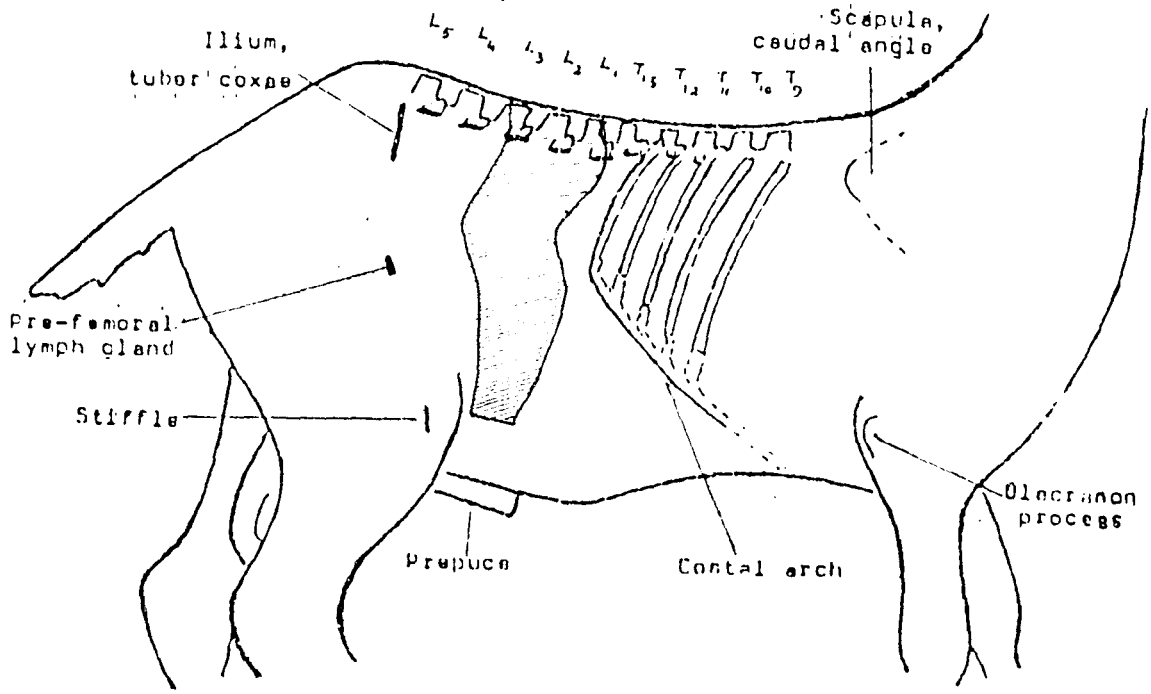

Ilium,
tuber coxae
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch

Fig.13. Diagram showing the area of analgesia mapped after blocking the first lumbar spinal nerve at the site 1 (proximal site)

Fig.14. Diagram showing the area of analgesia mapped after blocking the second lumbar spinal nerve at the site 1 (proximal site)


Ilium,
tuber coxae
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Contal arch

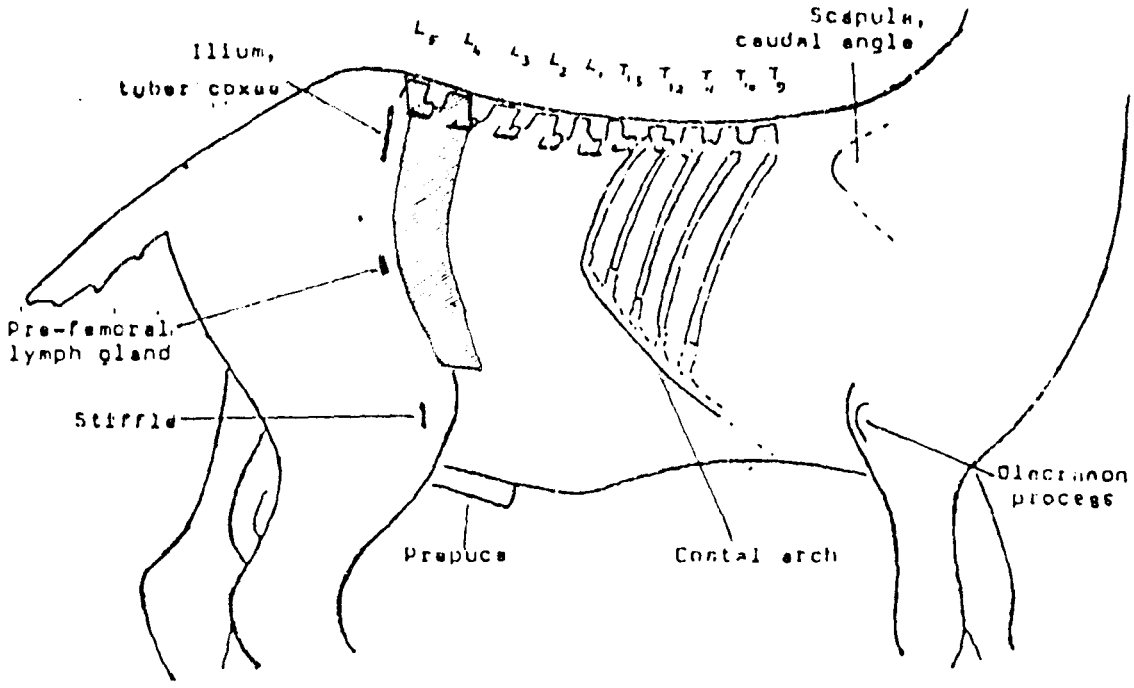
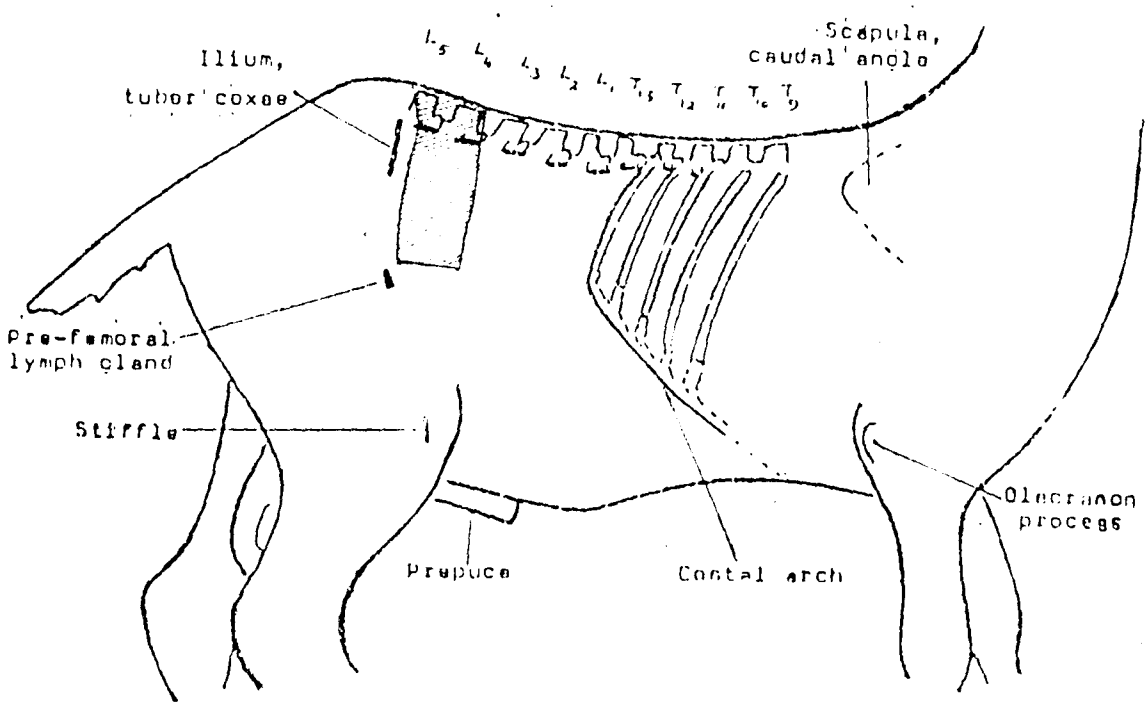

Ilium,
tuber coxae
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Contal arch

Fig.15. Diagram showing the area of analgesia mapped after blocking the third lumbar spinal nerve at the site 1 (proximal site)

Fig.16. Diagram showing the area of analgesia mapped after blocking the 13th thoracic spinal nerve at site 2 (distal site) in Animal No.1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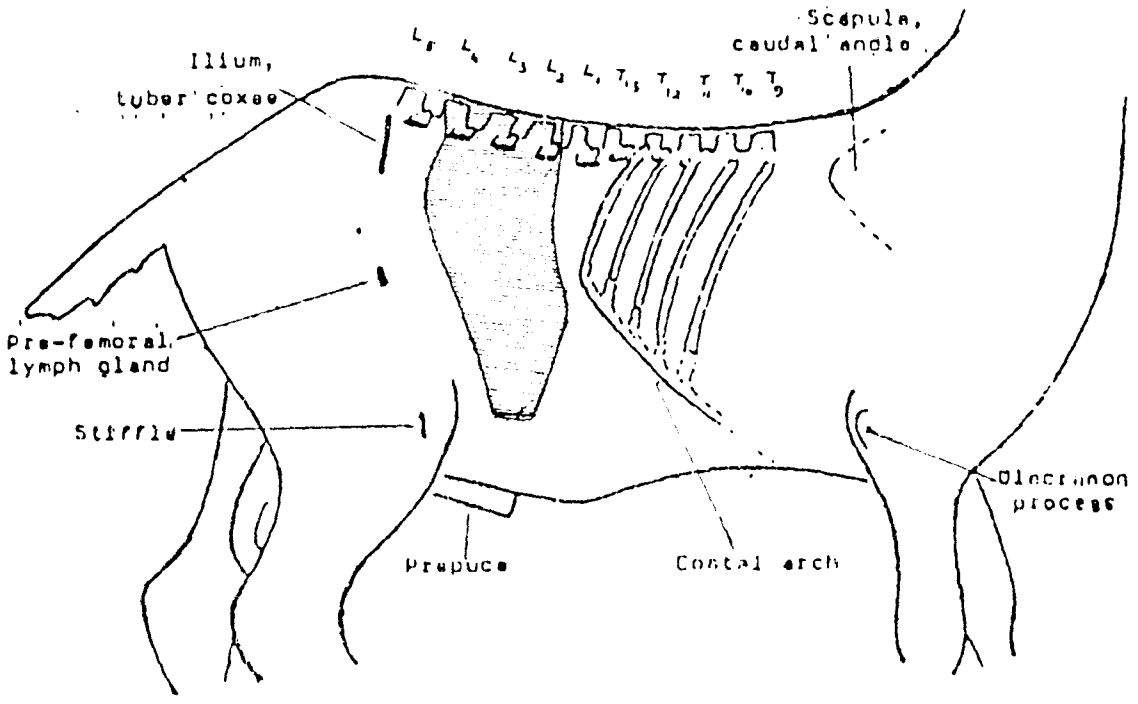
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch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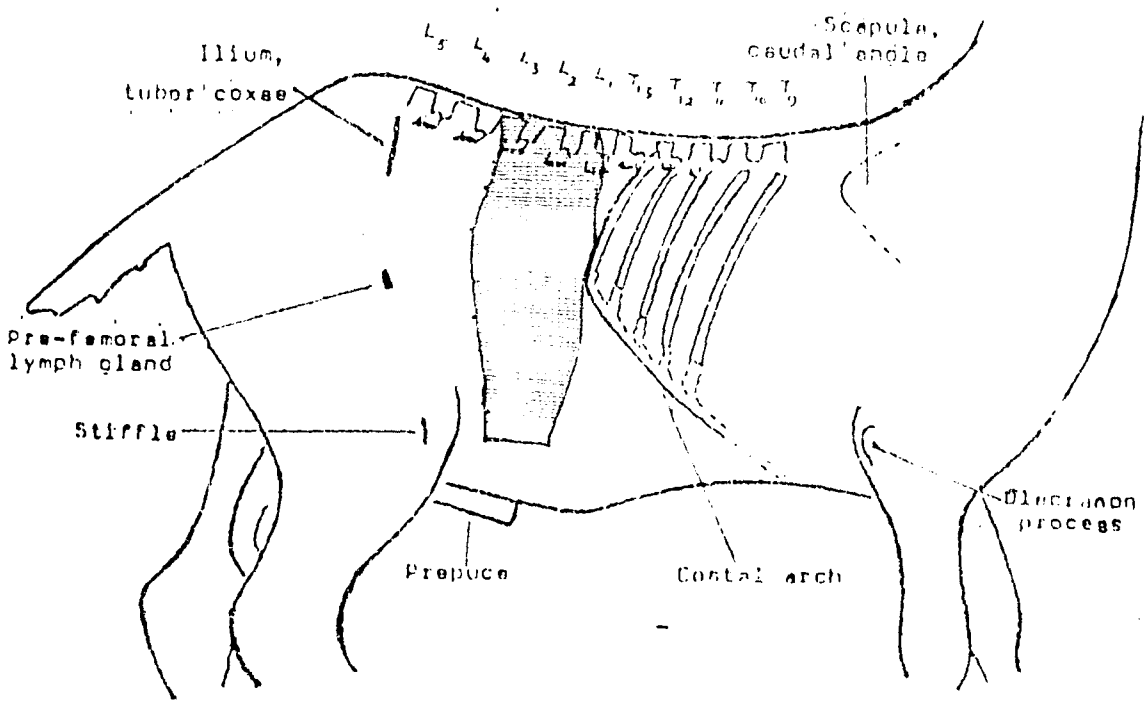
tuber coxae
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch

Fig.17. Diagram showing the area of analgesia mapped after blocking the 13th thoracic spinal nerve at site 2 (distal site) in Animal No.2

Fig.18. Diagram showing the area of analgesia mapped after blocking the 13th thoracic spinal nerve at site 2 (distal site) in Animal No.3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Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch

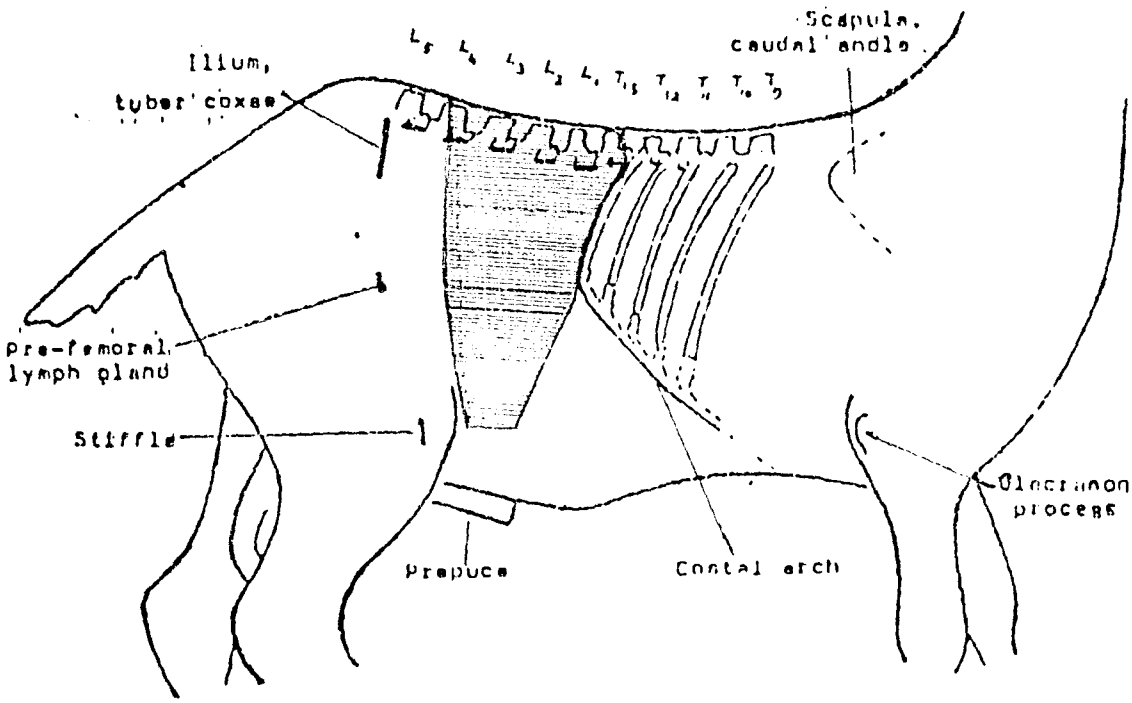
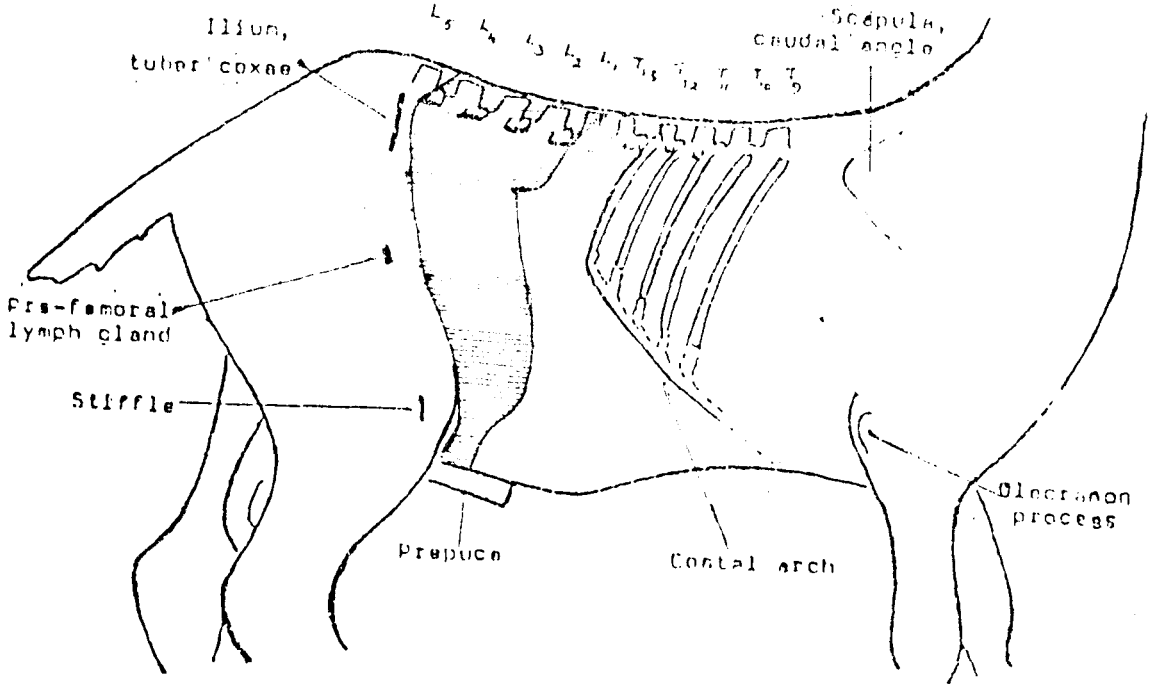

Ilium,
tuber coxae
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch

Fig.19. Diagram showing the area of analgesia mapped after blocking the first lumbar spinal nerve at site 2 (distal site) in Animal No.1

Fig.20. Diagram showing the area of analgesia mapped after blocking the first lumbar spinal nerve at site 2 (distal site) in Animal No.2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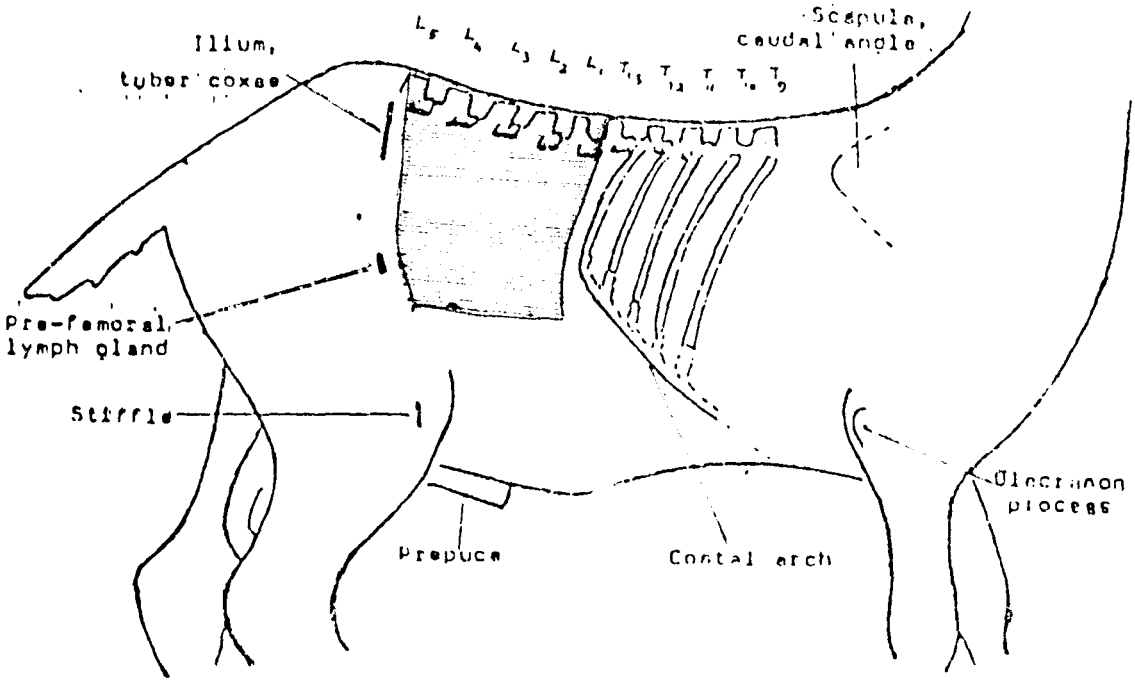
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Prepuce
Costal arch
Olecranon
process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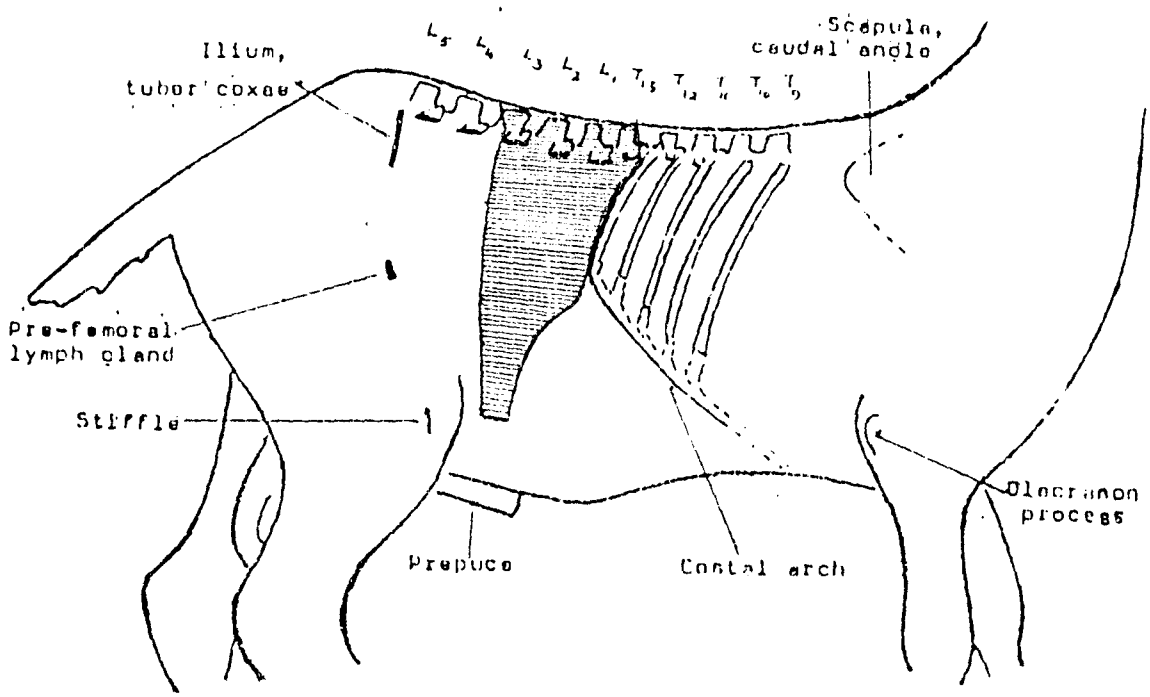
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Prepuce
Costal arch
Olecranon
process

Fig.21. Diagram showing the area of analgesia mapped after blocking the first lumbar spinal nerve at site 2 (distal site) in Animal No.3

Fig.22. Diagram showing the area of analgesia mapped after blocking the second lumbar spinal nerve at site 2 (distal site) in Animal No.1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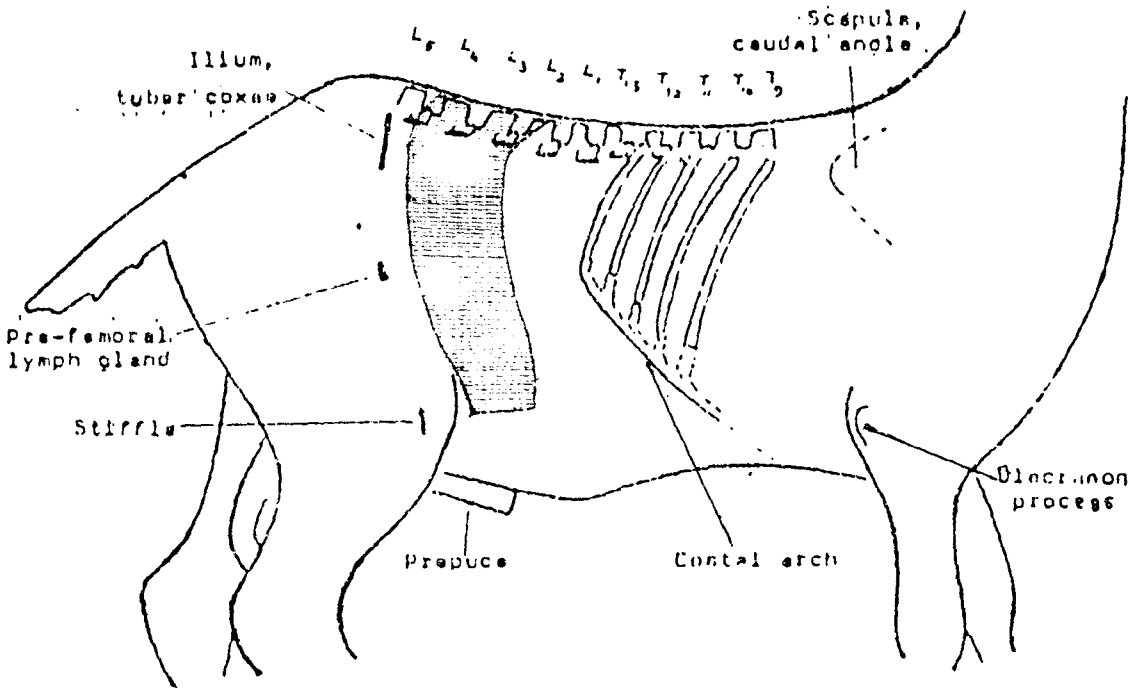
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch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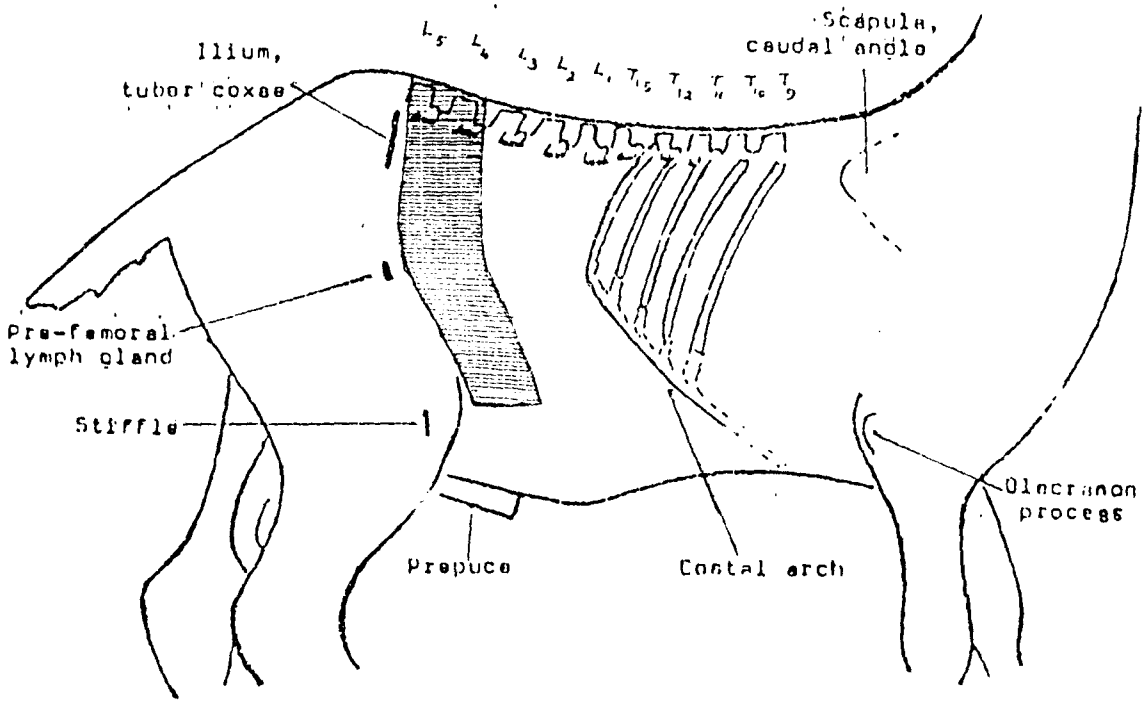
tuber coxae
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch

Fig.23. Diagram showing the area of analgesia mapped after blocking the second lumbar spinal nerve at site 2 (distal site) in Animal No.2 and 3

Fig.24. Diagram showing the area of analgesia mapped after blocking the third lumbar spinal nerve at site 2 (distal site) in Animal No.3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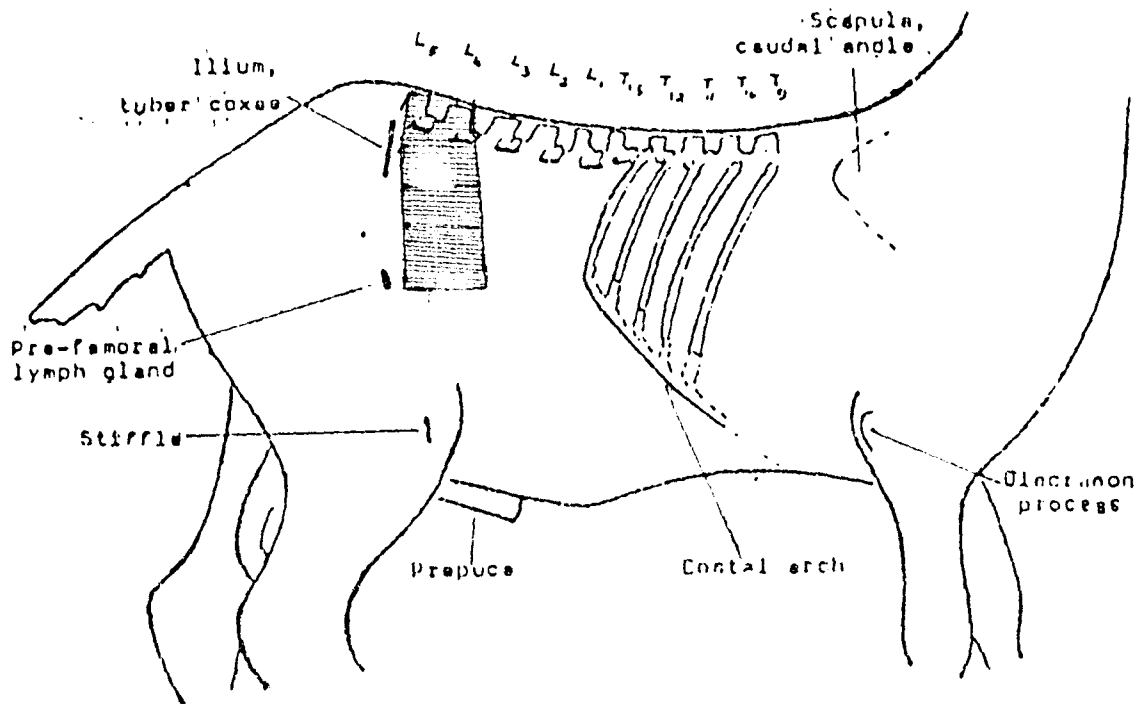
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch


Ilium,
tuber coxae
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch

17.0 cm lateral to the ventral midline. At this level it was 3.0 cm wide (Fig.23).

**Animal No.3**

The area of analgesia was similar to that observed in Animal No.2 (Fig.23).

**Third lumbar spinal nerve**

The results obtained in the three trials were uniform. The area of analgesia commenced from the dorsal midline over the dorsal spines of fourth and fifth lumbar vertebrae, extending downward to the level of transverse processes of the same vertebrae. The width at this level was 6.2 cm. From there the area of analgesia continued downwards upto the level of prefemoral lymph gland. At this level it was 6.3 cm wide (Fig.24).

**PART III. Anaesthesia of the flank**

The observations made after blocking the 13th thoracic, first and second lumbar spinal nerves simultaneously in sub group A and B were as follows:

## SUB GROUP A

### 1. Time for onset of analgesia

The time for onset of analgesia was 2.83 ± 0.87 minutes (Table 3).

### 2. Duration of analgesia

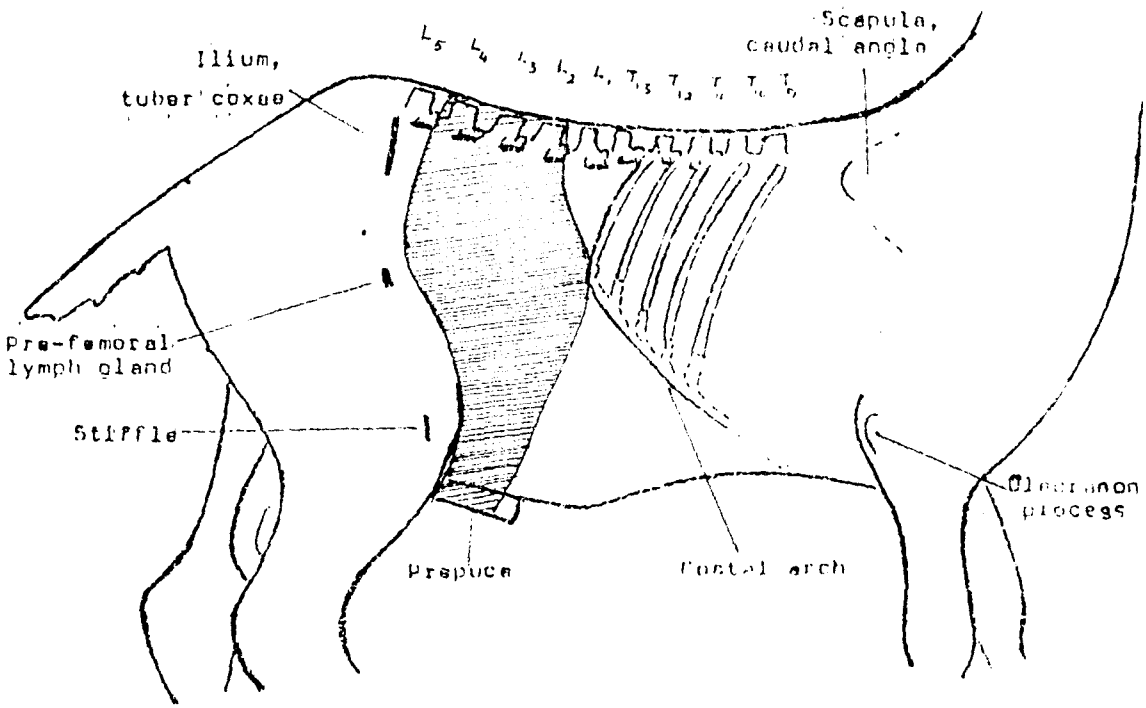
The duration of analgesia was 215.83 ± 14.97 minutes (Table 3).

### 3. Extent of analgesia

The results obtained in the six trials were uniform.

The area of analgesia commenced from the dorsal midline, over the dorsal spines of second, third and fourth lumbar vertebrae and it was 10.17 ± 1.01 cm wide. It extended downwards to the posterior angle of the costal arch anteriorly and prefemoral lymph gland, posteriorly. The width at this region was of 13.5 ± 0.62 cm. Then it became narrower and extended backward and downward upto the ventral midline, behind the preputial orifice anteriorly and the base of scrotum posteriorly. It was 8.67 ± 0.72 cm wide at this level (Table 4).

A triangular area, bounded by the posterior border of the last rib anteriorly, line joining the dorsal spines of


Scapula,
caudal angle
Ilium,
tuber coxae
Pre-femoral
lymph gland
Stifle
Olecranon
process
Prepuce
Costal arch

13th thoracic and second lumbar vertebrae superiorly and the line joining the dorsal spine of second lumbar vertebra and the posterior angle of the costal arch posteriorly was not desensitized. Similarly, the area bounded by a line joining the dorsal spine of fourth lumbar vertebra and the prefemoral lymph gland anteriorly, the dorsal spine of fifth lumbar vertebra superiorly and the external angle of ilium posteriorly was not desensitized. The preputial orifice and the skin around it were also not desensitized (Fig.25).

**4. Clinical signs**

The clinical signs viz., rectal temperature, heart rate, rate of respiration and rate of rumen motility were observed before administration of the local anaesthetic, at 30 min. intervals during anaesthesia and 30 min. after recovery from analgesia.

**A. Rectal temperature**

In the animals of this sub group, the rectal temperature (°F) was 102.13 ± 0.27 before administration of the local anaesthetic. It was 102.37 ± 0.24 at the onset of analgesia, 102.13 ± 0.20 at 30 min., 102.13 ± 0.20 at 60 min., 102.27 ± 0.20 at 90 min., 102.43 ± 0.18 at 120 min., 102.53 ± 0.17 at 150 min., 102.70 ± 0.21 at 180 min., 102.80 ± 0.19 at 210 min., 102.96 ± 0.26 at 240 min., 103.04 ± 0.22 at 270 min.

and 103.16 ± 0.29 at 300 min. after onset of analgesia and 103.3 ± 0.26 at 30 min. after recovery from analgesia (Table 5). The variations in the rectal temperature were within normal range.

**B. Heart rate**

In animals of this sub group, the heart rate (per minute) was 86.50 ± 6.43 before administration of the local anaesthetic. It was 78.50 ± 8.65 at the onset of analgesia, 78.83 ± 9.26 at 30 min., 82.0 ± 9.31 at 60 min., 85.83 ± 9.15 at 90 min., 87.67 ± 9.71 at 120 min., 88.0 ± 10.53 at 150 min., 86.83 ± 9.59 at 180 min., 86.50 ± 9.34 at 210 min., 80.80 ± 7.37 at 240 min., 78.20 ± 7.85 at 270 min. and 77.0 ± 7.67 at 300 min. after onset of analgesia and 85.67 ± 9.97 at 30 min. after recovery from analgesia (Table 6). There was slight increase in the heart rate throughout the experiment but the variations were within normal range.

**C. Rate of respiration**

In animals of this sub group, the rate of respiration (per minute) was 22.83 ± 1.21 before administration of the local anaesthetic. It was 21.26 ± 1.52 at the onset of analgesia, 22.67 ± 1.58 at 30 min., 22.33 ± 2.04 at 60 min., 21.17 ± 0.95 at 90 min., 20.0 ± 0.58 at 120 min., 19.50 ± 0.76 at 150 min., 20.33 ± 0.67 at 180 min., 19.83 ± 0.54 at

210 min. 21.4 ± 0.51 at 240 min., 20.8 ± 0.73 at 270 min. and 20.8 ± 0.73 at 300 min. after onset of analgesia and 21.0 ± 0.57 at 30 min. after recovery from analgesia (Table 7). The variations observed in rate of respiration were within normal range.

**D. Rate of rumen motility**

In the animals of this sub group rumen motility (per minute) was 2.30 ± 0.22 before administration of the local anaesthetic. It was 1.50 ± 0.34 at onset of analgesia, 1.67 ± 0.33 at 30 min., 1.67 ± 0.21 at 60 min., 1.67 ± 0.21 at 90 min., 1.83 ± 0.25 at 120 min., 2.0 ± 0.26 at 150 min., 1.83 ± 0.31 at 180 min., 1.67 ± 0.10 at 210 min., 1.80 ± 0.20 at 240 min., 1.80 ± 0.20 at 270 min. and 1.80 ± 0.20 at 300 min. after onset of analgesia and 1.67 ± 0.21 at 30 min. after recovery from analgesia (Table 8). The variations in the rate of rumen motility were within normal range.

**5. Laparotomy**

Laparotomy was performed in animal number $A_3$ on the left side and in animal number $A_5$ on the right side to assess the degree of analgesia. In both the animals, the analgesia was satisfactory and complete over the skin, subcutaneous tissue, abdominal muscles and peritoneum. Relaxation of the abdominal muscles was observed in both the animals.

6. Other symptoms observed during analgesia

(a) At the onset of analgesia, all the animals of this subgroup had shown varying degree of scoliosis at the lumbar region, towards the side of nerve blocks. The scoliosis reduced gradually and disappeared when the anaesthetic effect vained off .

(b) Bulging of the anaesthetized flank was observed which disappeared when the anaesthetic effect vained off. Palpation of visceral organs was found to be easier on paravertebral blocking .

(c) All the animals of this subgroup had shown difficulty in bearing weight on the hind limb on the side of nerve blocking. While standing this limb was kept abducted and extended backward with the toe touching the ground. When the animals were made to walk, they showed difficulty in advancing the hind limb on the anaesthetized side and occasionaly knuckling was also noticed. These symptoms disappeared gradually as the anaesthetic effect passed off.

(d) Animal number $A_6$ developed symptoms of systemic reactions, 3 minute after the paravertebral block. They became unsteady in gait, assumed sternal recumbency, immediately followed by lateral recumbency. Dilatation of the pupil, champing of jaws and frothy salivation were also present.

Severe clonic convulsions of the muscles of neck and limbs with paddling movement of the limbs were also noticed. After 10 minutes, the bouts became less frequent, however paddling movements of the limb persisted. By 21 minutes, the convulsions disappeared and the animal was assisted to sternal recumbency. In another 10 minutes, it could stand up and walk with unsteady gait. It was excited and restless. All the symptoms gradually disappeared by about 2½ hours, but the animal appeared to be dull.

**Post anaesthetic observation**

The animals were apparently normal during the period of observation. The healing of laparotomy wound was uneventful.

SUBGROUP B

**1. Time for onset of analgesia**

The time for onset of analgesia was 2.67 ± 0.21 min. (Table 9).

**2. Duration of analgesia**

The duration of analgesia was 105.67 ± 31.13 min. (Table 9).

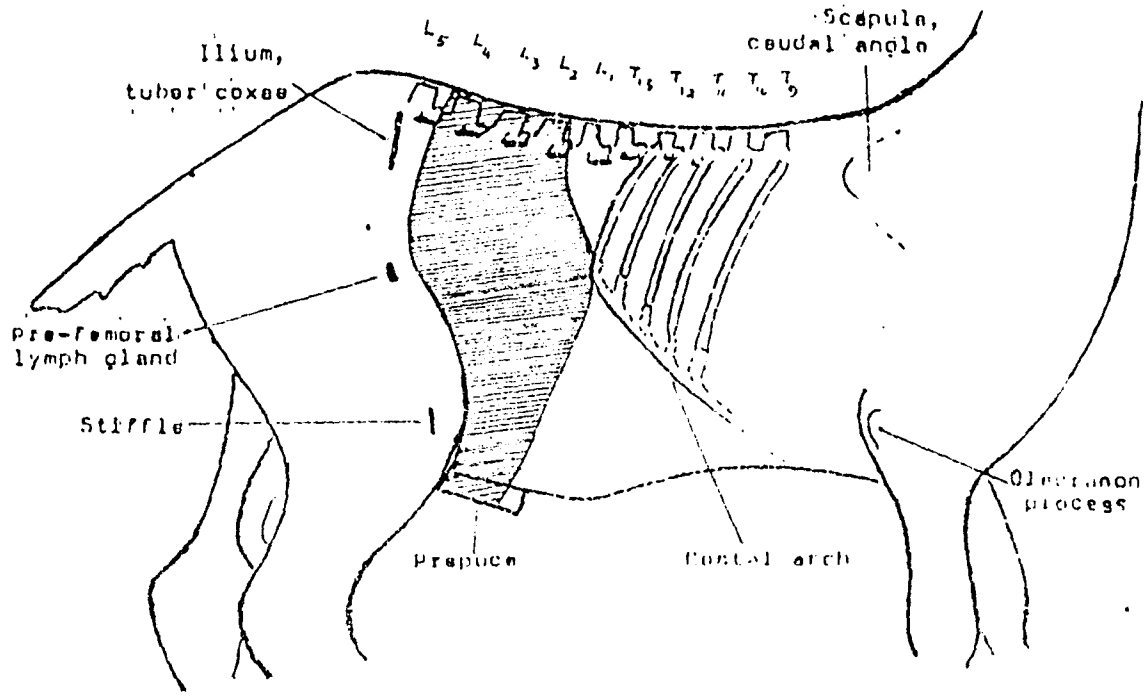
### 3. Extent of analgesia

The results obtained in the six trials were uniform.

The area of analgesia commenced from the dorsal midline over the dorsal spines of second, third and fourth lumbar vertebrae and it was 7.3 ± 0.88 cm wide. It extended downwards to the posterior angle of the costal arch anteriorly and prefemoral lymph gland posteriorly. The width at this region was 12.0 ± 0.34. Then it became narrower and extended backward and downward upto the ventral midline, behind the preputial orifice anteriorly and in front of the base of scrotum posteriorly. It was 6.20 ± 0.70 cm wide at this level (Table 10).

A triangular area bounded by the posterior border of the last rib anteriorly, line joining the dorsal spines of 13th thoracic,second lumbar vertebrae superiorly and the line joining the dorsal spine of second lumbar vertebra and posterior angle of the costal arch, posteriorly was not desensitized. Similarly, the area bounded by a line joining the dorsal spine of fourth lumbar vertebrae and prefemoral lymph gland anteriorly, the dorsal spine of fifth lumbar vertebra superiorly and the external angle of ilium posteriorly was not desensitized. The preputial orifice and the skin around it were also not desensitized (Fig.26).

Fig.26. Diagram showing the area of analgesia mapped after blocking the 13th thoracic, first and second lumbar spinal nerves simultaneously at site 1 (proximal site) using 0.25% bupivacaine hydrochloride solution


Ilium,
tuber coxae
Scapula,
caudal angle
Pre-femoral
lymph gland
Stifle
Prepuce
Olecranon
process

## 4. Clinical signs

The clinical signs viz., rectal temperature, heart rate, rate of respiration and rate of rumen motility were observed before administration of the local anaesthetic, at 30 min. intervals during anaesthesia and 30 min. after recovery from analgesia.

### A. Rectal temperature

In the animals of this subgroup the rectal temperature (°F) was 102.43 ± 0.17 before administration of the local anaesthetic. It was 102.43 ± 0.12 at onset of analgesia, 102.43 ± 0.17 at 30 min., 102.5 ± 0.15 at 60 min., 102.40 ± 0.19 at 90 min., 102.46 ± 0.21 at 120 min., 102.60 ± 0.25 at 150 min., 102.80 ± 0.35 at 180 min., 102.88 ± 0.44 at 210 min., 102.40 ± 5.78 at 240 min. and 102.3 ± 1.60 at 270 min. after onset of analgesia and 103.0 ± 0.41 at 30 min. after recovery from analgesia (Table 11). The variations in rectal temperature were within normal range.

### B. Heart rate

In animals of this subgroup, the heart rate (per minute) was 97.83 ± 7.81 before administration of the local anaesthetic. It was 94.50 ± 10.85 at the onset of analgesia, 91.33 ± 7.92 at 30 min., 91.17 ± 8.76 at 60 min., 91.17 ± 8.84

at 90 min., 92.30 ± 8.63 at 120 min., 89.83 ± 8.0 at 150 min., 89.66 ± 6.95 at 180 min., 85.20 ± 7.08 at 210 min., 82.50 ± 10.43 at 240 min. and 81.0 ± 9.87 at 270 min. after onset of analgesia and 88.66 ± 7.65 at 30 min. after recovery from analgesia (Table 12). The variations in the heart rate were within normal range.

**4. Rate of respiration**

In animals of this subgroup, the rate of respiration (per minute) was 24.0 ± 1.21 before administration of local anaesthetic. It was 23.67 ± 0.92 at the onset of analgesia, 23.16 ± 0.70 at 30 min., 22.50 ± 3.49 at 60 min., 22.83 ± 0.75 at 90 min., 22.17 ± 2.99 at 120 min., 22.23 ± 0.92 at 150 min., 20.16 ± 1.33 at 180 min., 21.60 ± 2.83 at 210 min., 20.3 ± 2.67 at 240 min. and 18.67 ± 2.05 at 270 min. after onset of analgesia and 23.17 ± 1.05 at 30 min. after recovery from analgesia (Table 13). The variations observed in the rate of respiration were within normal range.

**D. Rate of rumen motility**

In the animals of this subgroup rumen motility (per minute) was 2.16 ± 0.17 before administration of the local anaesthetic. It was 1.75 ± 0.36 at the onset of analgesia, 1.58 ± 0.27 at 30 min., 1.58 ± 0.27 at 60 min., 1.58 ± 0.27 at 90 min., 1.58 ± 0.27 at 120 min., 1.66 ± 0.21 at 150 min.,

1.83 ± 0.31 at 180 min., 1.80 ± 0.20 at 210 min., 1.50 ± 0.28 at 240 min. and 1.30 ± 0.23 at 270 min. after onset of analgesia and 1.83 ± 0.17 at 30 min. after recovery from analgesia (Table 14). The variations in the rate of rumen motility were within normal range.

**5. Laparotomy**

Laparotomy was performed in Animal number $B_3$ on the left side and in Animal number $B_6$ on the right side to assess the degree of analgesia. In both the animals, the analgesia was satisfactory and complete over the skin, subcutaneous tissue, abdominal muscles and peritoneum. Relaxation of the abdominal muscles was observed in both the animals.

**6. Other symptoms observed during analgesia**

(a) At the onset of analgesia, all the animals of this sub group had shown varying degree of scoliosis at the lumbar region towards the side of nerve blocks. The scoliosis reduced gradually and disappeared when the anaesthetic effect vained off.

(b) Bulging of the anaesthetized flank was observed, which disappeared when the anaesthetic effect vained off. Palpation of visceral organs was found to be easier on paravertebral blocking.

(c) All the animals of this subgroup had shown difficulty in bearing weight on the hind limbs on the side of nerve blocking. While standing, this limb was kept abducted and extended backward with the toe touching the ground. When the animals were made to walk, they showed difficulty in advancing the hind limb on the anaesthetized side and occasionaly knuckling was also noticed. These symptoms disappeared gradually as the anaesthetic effect passed off.

**Post anaesthetic observation**

The animals were apparently normal during the period of observation. The healing of laparotomy wound was uneventful.

Table 3. Time for onset and duration of analgesia in subgroup A

| Animal Number | Side | Time for onset of analgesia (min.) | Duration of analgesia (min.) |
|---|---|---|---|
| 1. | Left | 1 | 229 |
| 2. | Left | 5 | 244 |
| 3. | Left | 1 | 205 |
| 4. | Right | 2 | 226 |
| 5. | Right | 6 | 244 |
| 6. | Right | 2 | 147 |
| Mean | | 2.83 | 215.83 |
| ± SE | | 0.87 | 14.97 |
| Range | | 6-1 | 244-147 |

Table 4. Width of area of analgesia at upper, middle and lower parts in subgroup A

| Animal Number | Width (cm) at | | |
|---|---|---|---|
| | upper | middle | lower |
| 1. | 11.0 | 14.0 | 6.0 |
| 2. | 11.0 | 16.0 | 10.0 |
| 3. | 12.0 | 12.0 | 10.0 |
| 4. | 11.0 | 14.0 | 10.0 |
| 5. | 6.0 | 12.0 | 9.0 |
| 6. | 10.0 | 13.0 | 7.0 |
| Mean | 10.17 | 13.50 | 8.67 |
| $\pm$ SE | 1.01 | 0.62 | 0.72 |
| Range | 6-12 | 12-16 | 6-10 |

Table 5. Rectal temperature before, during and after analgesia in subgroup A (°F)

| Animal Number | Before analgesia | During analgesia | | | | | | | | | | | | | 30 min. after recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 | 360 | |
| 1. | 102.2 | 103.0 | 102.4 | 102.4 | 102.2 | 102.4 | 102.6 | 102.8 | 102.8 | 102.8 | 102.8 | 102.8 | | | 102.8 |
| 2. | 101.4 | 101.4 | 101.4 | 101.4 | 101.4 | 101.6 | 101.8 | 101.8 | 102.0 | 102.0 | 102.0 | 102.2 | 102.4 | 102.6 | 102.6 |
| 3. | 102.8 | 102.4 | 102.4 | 102.4 | 102.6 | 102.8 | 102.8 | 103.0 | 103.0 | 103.2 | 103.4 | 103.6 | 103.6 | 103.6 | 103.6 |
| 4. | 103.0 | 103.0 | 102.8 | 102.8 | 102.8 | 102.8 | 102.6 | 103.0 | 103.2 | 103.4 | 103.4 | 103.4 | 104.0 | 104.0 | 104.0 |
| 5. | 101.6 | 102.2 | 102.0 | 102.0 | 102.2 | 102.6 | 103.0 | 103.2 | 103.2 | 103.4 | 103.6 | 103.8 | | | 104.0 |
| 6. | 101.8 | 102.2 | 101.8 | 101.8 | 102.4 | 102.4 | 102.4 | 102.4 | 102.6 | | | | | | 102.8 |
| Mean | 102.13 | 102.37 | 102.13 | 102.13 | 102.27 | 102.43 | 102.53 | 102.70 | 102.80 | 102.96 | 103.04 | 103.16 | 103.33 | 103.40 | 103.30 |
| ± SE | 0.27 | 0.24 | 0.20 | 0.20 | 0.20 | 0.18 | 0.17 | 0.21 | 0.19 | 0.26 | 0.22 | 0.29 | | | 0.26 |
| Range | 101.4-103.0 | 101.4-103.0 | 101.4-102.8 | 101.4-102.8 | 101.4-102.8 | 101.6-102.8 | 101.8-103.0 | 101.8-103.2 | 102.0-103.2 | 102.0-103.4 | 102.0-103.6 | 102.0-103.8 | 102.4-104.0 | 102.6-104.0 | 102.6-104.0 |

Table 6. Heart rate before, during and after analgesia in subgroup A (per min.)

| Animal Number | Before analgesia | During analgesia | | | | | | | | | | | | 30 min. after recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 | 360 | |
| 1. | 87 | 80 | 81 | 79 | 87 | 87 | 84 | 84 | 85 | 87 | 88 | 86 | | | 88 |
| 2. | 64 | 48 | 54 | 58 | 60 | 64 | 64 | 63 | 63 | 64 | 63 | 64 | 65 | 66 | 66 |
| 3. | 82 | 64 | 65 | 72 | 74 | 76 | 76 | 78 | 76 | 77 | 64 | 64 | 68 | 68 | 64 |
| 4. | 89 | 67 | 67 | 68 | 69 | 67 | 68 | 70 | 69 | 70 | 72 | 68 | 68 | 76 | 68 |
| 5. | 113 | 84 | 88 | 93 | 113 | 109 | 104 | 98 | 102 | 106 | 104 | 103 | | | 104 |
| 6. | 84 | 110 | 118 | 122 | 112 | 123 | 132 | 128 | 124 | | | | | | 124 |
| Mean | 86.50 | 75.50 | 78.83 | 82.00 | 85.83 | 87.67 | 88.00 | 86.83 | 86.50 | 80.80 | 78.20 | 77.00 | 67.00 | 70.00 | 85.67 |
| ± SE | 6.43 | 8.65 | 9.26 | 9.31 | 9.15 | 9.71 | 10.53 | 9.59 | 9.34 | 7.37 | 7.85 | 7.67 | 1.00 | | 9.97 |
| Range | 113-64 | 110-48 | 118-54 | 122-58 | 113-60 | 123-64 | 132-64 | 128-63 | 124-63 | 106-64 | 104-63 | 103-64 | 68-65 | 76-66 | 124-64 |

Table 7. Rate of respiration before, during and after analgesia in subgroup A (per min.)

| Animal Number | Before analgesia | During analgesia | | | | | | | | | | | | 30 min. after recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 | 360 | |
| 1. | 21 | 24 | 24 | 21 | 23 | 19 | 18 | 19 | 18 | 21 | 21 | 22 | | | 22 |
| 2. | 22 | 16 | 18 | 18 | 19 | 20 | 21 | 22 | 22 | 23 | 21 | 22 | 22 | 21 | 22 |
| 3. | 34 | 26 | 27 | 22 | 21 | 21 | 22 | 21 | 21 | 22 | 22 | 18 | 20 | 20 | 21 |
| 4. | 17 | 19 | 18 | 17 | 18 | 18 | 17 | 18 | 18 | 20 | 18 | 21 | 21 | 21 | 19 |
| 5. | 21 | 21 | 23 | 24 | 22 | 20 | 19 | 22 | 20 | 21 | 22 | 21 | | | 22 |
| 6. | 19 | 24 | 26 | 32 | 24 | 22 | 20 | 20 | 20 | | | | | | 20 |
| Mean | 22.83 | 21.66 | 22.67 | 22.33 | 21.17 | 20.00 | 19.50 | 20.33 | 19.83 | 21.40 | 20.80 | 20.80 | 21.00 | 20.60 | 21.00 |
| ± SE | 1.21 | 1.52 | 1.58 | 2.04 | 0.95 | 0.58 | 0.76 | 0.67 | 0.54 | 0.51 | 0.73 | 0.73 | | | 0.57 |
| Range | 34-17 | 26-16 | 27-18 | 32-17 | 24-18 | 22-18 | 22-17 | 22-18 | 22-18 | 23-20 | 22-18 | 22-18 | 22-20 | 20-21 | 22-19 |

Table 8. Rate of rumen motility before, during and after analgesia in subgroup A (per min.)

| Animal Number | Before analgesia | During analgesia | | | | | | | | | | | | | 30 min. after recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 | 360 | |
| 1. | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | | | 2 |
| 2. | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3. | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 4. | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 5. | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | | | 2 |
| 6. | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | 1 |
| Mean | 2.30 | 1.50 | 1.67 | 1.67 | 1.67 | 1.83 | 2.00 | 1.83 | 1.67 | 1.80 | 1.80 | 1.80 | 1.67 | 1.67 | 1.67 |
| ± SE | 0.22 | 0.34 | 0.33 | 0.21 | 0.21 | 0.25 | 0.26 | 0.31 | 0.10 | 0.20 | 0.20 | 0.20 | | | 0.21 |
| Range | 3-2 | 3-1 | 3-1 | 2-1 | 2-1 | 3-1 | 3-1 | 3-1 | 2-1 | 2-1 | 2-1 | 2-1 | 2-1 | 2-1 | 2-1 |

Table 9. Time for onset and duration of analgesia in subgroup B

| Animal Number | Side | Time for onset of analgesia (min.) | Duration of analgesia (min.) |
|---|---|---|---|
| 1. | Left | 3 | 121 |
| 2. | Left | 3 | 88 |
| 3. | Left | 2 | 163 |
| 4. | Right | 2 | 73 |
| 5. | Right | 3 | 66 |
| 6. | Right | 3 | 193 |
| Mean | | 2.67 | 105.67 |
| ± SE | | 0.21 | 31.13 |
| Range | | 3-2 | 193-66 |

Table 10. Width of area of analgesia at upper, middle and lower parts in subgroup B

| Animal Number | Width (cm) at | | |
|---|---|---|---|
| | upper | middle | lower |
| 1. | 5.0 | 11.0 | 4.0 |
| 2. | 6.0 | 12.0 | 8.0 |
| 3. | 7.0 | 12.0 | 5.0 |
| 4. | 10.0 | 13.0 | 7.0 |
| 5. | 6.0 | 11.0 | 8.0 |
| 6. | 10.0 | 13.0 | 8.0 |
| Mean | 7.30 | 12.00 | 6.60 |
| ± SE | 0.34 | 0.34 | 0.70 |
| Range | 5-10 | 11-13 | 4-8 |

Table 11. Rectal temperature before, during and after analgesia in subgroup B (°F)

| Animal Number | Before analgesia | During analgesia | | | | | | | | | | | | 30 min. after recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 | 360 | |
| 1. | 102.4 | 102.2 | 102.4 | 102.6 | 102.6 | 102.4 | 102.6 | 102.6 | 102.6 | 102.6 | | | | | 102.8 |
| 2. | 103.2 | 102.6 | 102.4 | 102.4 | 102.6 | 102.6 | 103.4 | 104.2 | 104.4 | | | | | | 104.4 |
| 3. | 102.2 | 102.2 | 102.2 | 102.2 | 102.0 | 102.2 | 102.4 | 102.6 | 103.2 | 103.4 | 103.4 | | | | 103.6 |
| 4. | 102.6 | 103.0 | 103.2 | 103.2 | 103.4 | 103.4 | 103.4 | 103.4 | | | | | | | 103.4 |
| 5. | 102.2 | 102.2 | 102.0 | 102.2 | 102.2 | 102.2 | 102.0 | 102.0 | 102.2 | 101.8 | 101.8 | 101.8 | | | 101.8 |
| 6. | 102.0 | 102.4 | 102.4 | 102.4 | 101.8 | 102.0 | 102.0 | 102.0 | 102.0 | 101.8 | 101.8 | | | | 102.0 |
| Mean | 102.43 | 102.43 | 102.43 | 102.50 | 102.40 | 102.46 | 102.60 | 102.80 | 102.88 | 102.40 | 102.30 | | | | 103.0 |
| ± SE | 0.17 | 0.12 | 0.17 | 0.15 | 0.19 | 0.21 | 0.25 | 0.35 | 0.44 | 5.78 | 1.60 | | | | 0.41 |
| Range | 103.2-102.0 | 103.0-102.4 | 103.2-102.0 | 103.2-102.2 | 103.4-101.8 | 103.4-102.0 | 103.4-102.0 | 104.2-102.0 | 104.4-102.0 | 103.4-101.8 | 103.4-101.8 | | | | 104.4-101.8 |

Table 12. Heart rate before, during and after analgesia in subgroup B (per min.)

| Animal Number | Before analgesia | During analgesia | | | | | | | | | | | | 30 min. after recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 | 360 | |
| 1. | 94 | 87 | 87 | 83 | 86 | 86 | 84 | 81 | 86 | 84 | | | | | 84 |
| 2. | 92 | 84 | 91 | 86 | 85 | 88 | 84 | 88 | 89 | | | | | | 86 |
| 3. | 106 | 108 | 112 | 112 | 112 | 118 | 116 | 109 | 109 | 111 | 108 | | | | 110 |
| 4. | 132 | 142 | 116 | 123 | 121 | 118 | 112 | 112 | | | | | | | 112 |
| 5. | 79 | 72 | 72 | 74 | 72 | 76 | 73 | 72 | 68 | 63 | 63 | 65 | | | 66 |
| 6. | 84 | 74 | 70 | 69 | 71 | 68 | 70 | 76 | 74 | 72 | 72 | | | | 74 |
| Mean | 97.83 | 94.50 | 91.33 | 91.11 | 91.17 | 92.30 | 89.83 | 89.66 | 85.20 | 82.50 | 81.00 | 65.00 | | | 88.66 |
| ± SE | 7.81 | 10.89 | 7.92 | 8.76 | 8.44 | 8.63 | 8.00 | 6.95 | 7.08 | 10.43 | 9.87 | | | | 7.65 |
| Range | 132-79 | 142-72 | 116-70 | 123-69 | 121-71 | 118-60 | 116-70 | 112-72 | 109-68 | 111-63 | 108-63 | | | | 112-66 |

Table 13. Rate of respiration before, during and after analgesia in subgroup B(per min.)

| Animal Number | Before analgesia | During analgesia | | | | | | | | | | | | | 30 min. after recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 | 360 | |
| 1. | 20 | 24 | 21 | 24 | 22 | 24 | 22 | 18 | 22 | 24 | | | | | 24 |
| 2. | 28 | 24 | 24 | 21 | 22 | 24 | 23 | 22 | 24 | | | | | | 26 |
| 3. | 25 | 23 | 21 | 22 | 22 | 21 | 23 | 18 | 22 | 21 | 18 | | | | 22 |
| 4. | 21 | 27 | 24 | 28 | 26 | 26 | 24 | 24 | | | | | | | 26 |
| 5. | 25 | 24 | 25 | 23 | 24 | 25 | 24 | 21 | 23 | 17 | 17 | 18 | | | 19 |
| 6. | 25 | 20 | 24 | 17 | 21 | 18 | 18 | 18 | 17 | 19 | 21 | | | | 22 |
| Mean | 24.00 | 23.67 | 23.16 | 22.50 | 22.33 | 22.17 | 22.33 | 20.16 | 21.60 | 20.30 | 18.67 | | | | 23.17 |
| ± SE | 1.21 | 0.92 | 0.70 | 3.49 | 0.75 | 2.99 | 0.92 | 1.33 | 2.83 | 2.67 | 2.05 | | | | 1.05 |
| Range | 28-20 | 27-27 | 25-21 | 28-17 | 26-21 | 26-18 | 24-18 | 24-18 | 24-17 | 24-17 | 21-17 | | | | 26-19 |

Table 14. Rate of rumen motility before, during and after analgesia in subgroup B (per min.)

| Animal Number | Before analgesia | During analgesia | | | | | | | | | | | | | 30 min. after recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 | 360 | |
| 1. | 2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1 | 1 | 2 | 2 | | | | | 2 |
| 2. | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | | | | | | 2 |
| 3. | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | | | | 2 |
| 4. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | | | | | 2 |
| 5. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | | | 2 |
| 6. | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | 1 |
| Mean | 2.16 | 1.75 | 1.58 | 1.58 | 1.58 | 1.58 | 1.66 | 1.83 | 1.80 | 1.50 | 1.30 | | | | 1.83 |
| ± SE | 0.17 | 0.36 | 0.27 | 0.27 | 0.27 | 0.27 | 0.21 | 0.31 | 0.20 | 0.28 | 0.23 | | | | 0.17 |
| Range | 2-3 | 3-0.5 | 2-0.5 | 2-0.5 | 2-0.5 | 2-0.5 | 2-1 | 2-1 | 2-1 | 2-1 | 2-1 | | | | 2-1 |

# Discussion

# DISCUSSION

## Part I: Distribution of spinal nerves in the flank region

The origin, course and distribution of tenth, eleventh, twelfth, and thirteenth thoracic, and the first, second and third lumbar spinal nerves were studied by dissection in three male goats.

The tenth, eleventh, twelfth and thirteenth thoracic and the lumbar spinal nerves emerged through the corresponding intervertebral foramina located between the arches of the vertebrae, in level with the base of the transverse processes. The spinal nerves passed between the multifidus dorsi and quadratus lumborum muscles and divided into dorsal and ventral primary branches. The dorsal primary branches turned dorsally and released a dorsomedial branch and continued as the dorsolateral branch. The dorsomedial branch supplied the longissimus dorsi et lumborum and multifidus dorsi muscles.

The dorsolateral branches of the thoracic spinal nerves coursed caudolaterally between the longissimus dorsi and longissimus costarum muscles and emerged out at the lateral edge of the dorsal muscles, in the intercostal space

immediately behind. It then passed through the serratus dorsalis caudalis muscle and the thoracolumbar fascia and finally formed the cutaneous supply to the upper third of chest.

The dorsolateral branches of the first and second lumbar spinal nerves coursed posteriorly between the longissimus dorsi and intertransversalis lumborum muscles, above the lateral edge of the transverse process immediately posterior to them. They emerged at the lateral aspect of iliocostalis muscle, continued caudoventrally, penetrated through thoracolumbar fascia and formed the cutaneous supply to the upper third of flank. These observations are similar to the observations of Arnold and Kitchel (1957) in cattle.

The dorsolateral branch of the third lumbar spinal nerve supplied the skin of posterodorsal angle of the flank just in front of the external angle of ilium. This observation is similar to the observation of Wright (1952) Arnold and Kitchell (loc. cit.) Hall (1971) and Ohme and Prier (1974) in bovine.

The dorsolateral branches of the fourth lumbar spinal nerve penetrated through the dorsal muscles above the external angle of ilium, closer to the median plane and ended up as the

cutaneous innervation to the croup region, as observed in cattle by Arnold and Kitchell (loc. cit.).

The ventral primary branches of tenth, eleventh and twelfth thoracic spinal nerves coursed ventrally along the posterior border of the corresponding ribs between the pleura and internal intercostal muscle. This is in agreement with the observations of Westhues and Fritsch (1964) in cattle. But Arnold and Kitchell (loc. cit.) observed that in bovine the ventral branches of thoracic spinal nerves moved ventrally between the internal and external intercostal muscles.

In the upper third of the chest, at the level of lateral edge of the transverse process of second lumbar vertebra, the ventral primary branches of the thoracic spinal nerves released a ventrolateral branch and continued downward as the ventromedial branch. The ventrolateral branch passed through the internal intercostal muscle and continued between it and the external intercostal muscle. It then penetrated the latter, ran caudoventrally through the serratus dorsalis caudalis muscle, and the origin of the obliquus abdominis externus muscle, finally terminating as the cutaneous supply to the middle part of the skin over the last three ribs.

The ventromedial branch of these thoracic spinal nerves continued ventrally along the posterior border of their

corresponding rib, crossed the costal arch and continued ventrally over the surface of transverse abdominis muscle. They terminated as fine branches, a hands breadth above the ventral mid-line. These fine branches passed through the rectus abdominis muscle and aponeuroses of external and internal oblique muscles of the abdomen and formed the cutaneous supply to the ventral abdominal wall, anterior to the umbilicus. This is in agreement with the observations in cattle (Westhues and Fritsch, loc. cit. and Arnold and Kitchell , loc. cit.). In dogs, Baily et al. (1984) reported that the ventromedial branches of eleventh thoracic to third lumbar spinal nerves do not have the ventral cutaneous branches.

The ventral primary branch of thirteenth thoracic spinal nerve (costoabdominalis nerve) traversed ventrally behind and parallel to the posterior border of the last rib, over the surface of transverse abdominis muscle. At the level of the last costochondral junction it turned caudally and coursed caudoventrally.

The ventral primary branches of the first lumbar spinal nerve (iliohypogastric nerve) and the second (ilioinguinal nerve) lumbar spinal nerve coursed caudolaterally under the intertransversales muscles. At the level of lateral edge of the lumbar transverse processes, the

nerves passed caudoventrally over the surface of transverse abdominis muscle in the middle and caudal thirds of the flank respectively.

In the upper third of the flank, in level with the external angle of ilium, the ventral primary branches of the thirteenth thoracic, first and second lumbar spinal nerves divided into the ventrolateral and ventromedial branches. The ventrolateral branches moved caudoventrally, penetrating through the obliquus abdominis internus muscle and coursed between it and the obliquus abdominis externus muscles. It penetrated through the latter and finally formed the cutanous supply to the middle part of the flank.

The ventromedial branches continued posteriorly and downward over the surface of transverse abdominis muscle. A hands breadth lateral to the ventral midline, they ramified into fine branches, between the transverse abdominis and rectus abdominis muscles. The fine branches penetrated through the rectus abdominis muscle and aponeuroses of oblique muscles of abdomen and innervated the skin of ventral abdomen from umbilicus to base of the scrotum. Similar observations were reported by Farquharson (1940), Wright (loc. cit.), Arnold and Kitchell (loc. cit.), Westhues and Fritsch (loc. cit.), Hall (loc. cit.), Ohme and Prier (loc. cit.) and Getty (1977).

The ventral primary branch of first lumbar spinal nerve gave away a branch traversing posteriorly below the transverse process of second lumbar vertebra to join the ventral primary branch of second lumbar spinal nerve, on either side. Getty (1977) observed that in goats the ventral branches of first and second lumbar spinal nerves communicated with each other unilaterally. Ventral primary branch of second lumbar spinal nerve gave away a small branch which passed caudally below the transverse process of the lumbar vertebrae behind and between the psoas muscles. Westhues and Fritsch (loc. cit.) observed that the ventral branch of second lumbar nerve in cattle gave off fibres to external spermatic nerve, near the intervertebral foramen.

The ventral primary branches of third and fourth lumbar spinal nerves were found coursing caudally between the psoas muscles. This is similar to the observations of Arnold and Kitchell (loc. cit.) and Westhues and Fritsch (loc. cit.) in cattle.

The lateral thoracic nerve which originated from the posterior bundle of brachial plexus was found coursing posteriorly on the external surface of ventral third of the ribs. In its course it anastomosed with ventromedial branches of second, third, fourth and fifth thoracic spinal nerves. It formed a part of the innervation of the anterior preputial

muscles, the preputial orifice, the skin and the cutaneous muscles of ventral abdominal wall, along with the ventromedial branches of tenth, eleventh, twelfth and thirteenth thoracic spinal nerves. This is in agreement with the observations of Larson and Kitchell (1958), Nascimento and Godinho (1973) and Getty (loc. cit.) in bulls and ram, Prasad and Sinha (1991) in buffaloes and Prakash and Kumar (1983) in sheep.

The nerve supply to the flank was found to be by the thirteenth thoracic, first and second lumbar spinal nerves. They travelled caudoventrally from the site of their emergence through the intervertebral foramina. So the area of innervation of these nerves lies at the levels of two to three vertebrae behind the site of their emergence. They innervated the skin, subcutaneous tissue, muscles and peritoneum. This is in agreement with the observations of Westhues and Fritsch (loc. cit.) in cattle.

The nerve supply to the abdominal wall anterior to umbilicus was found to be by the tenth, eleventh and twelfth thoracic spinal nerve.

The site suitable for perineural injection to block tenth, eleventh and twelfth thoracic spinal nerves was found to be at their emergence through the intervertebral foramen. The site was located between the tubercle of the respective

rib cranially, the lateral edge of arch of respective vertebra medially and the rostral edge of mammillary process of adjacent posterior vertebra posteriorly. The point of insertion of the needle was 1.0 to 1.5 cm lateral to the dorsal midline.

For perineural injection to block thirteenth thoracic, first second and third lumbar spinal nerves, two sites appeared to be suitable.

Site 1 (Proximal site): The site was in front of the anterior border of the transverse process, and in level with the anterior edge of mammillary process of adjacent posterior lumbar vertebra, 1.0 to 1.5 cm lateral to the dorsal midline.

Farquharson (loc. cit.) recommended the site on a transverse line drawn over the posterior aspect of the dorsal spine of the vertebra, 2½ inches lateral to the dorsal midline. Link and Smith (1956), Jennings (1961), Frank (1964), Khatra and Tyagi (1972b) and Short (1987) adopted the same landmarks. Neal (1957) adopted a site, 6.0 cm lateral to the centre point of dorsal spine of the corresponding vertebra, behind the posterior edge of transverse process. A site in front of the anterior edge of the transverse process of adjacent posterior vertebra was recommended by Formston (1945). Similar methods were suggested by Westheus and

Fritsch (loc. cit.) Lumb and Jones (1973), Taylor (1991) and also by Hall (loc. cit.) in Cambridge method. Roe (1986) suggested the posterior border of transverse process of the corresponding vertebra anteriorly, lateral edge of vertebral arch medially and rostral edge of the mammillary process of adjacent posterior vertebra caudally as the landmarks.

Site 2 (Distal site): The site for blocking the 13th thoracic spinal nerve was just in front of the anterolateral edge of the transverse process of first lumbar vertebra, at a depth of 1.0 cm with the needle inserted horizontally. The site for blocking first, second and third lumbar spinal nerves was at the lateral edge of transverse process of adjacent posterior lumbar vertebra, at a depth of 1.0 cm, with the needle inserted horizontally. Similar site was suggested by Magda (1945), where the lateral edge of the transverse process of fourth lumbar vertebra was the site of approach to block the second lumbar spinal nerve. But in the present study it was observed that the second lumbar spinal nerve crosses the third lumbar transverse process and not the fourth. This is also in agreement with the suggestions of Ohme and Prier (loc. cit.). Westhues and Fritsch (loc. cit.) suggested the sites for blocking $T_{13}$, $L_1$ and $L_2$ spinal nerves, between the last rib and tip of first lumbar transverse processes between tips

of transverse processes of $L_1$ and $L_2$, and $L_2$ and $L_3$ respectively.

**Part II: The area desensitized by blocking the individual spinal nerve supplying the flank region**

**Site 1 (Proximal site)**

When 10th, 11th, 12th and 13th thoracic, first, second and third lumbar spinal nerves were blocked separately by administration of local anaesthetic at site 1, the area extended caudoventrally, from the dorsal midline, to varying distances, lateral to the ventral midline. The area desensitized on blocking each of these spinal nerves were in accordance with the distribution of the nerves as found in the dissection studies. A posterior displacement of the area of analgesia, upto 2-3 vertebrae, from the site of emergence of the nerves were observed as stated by Westhues and Fritsch (loc. cit.).

Desensitization upto the ventral midline was not observed on blocking individual spinal nerves, eventhough the distribution of the nerve fibres extended upto the ventral midline. This was probably due to the overlapping of the distribution of fibres from the adjacent spinal nerves. The nerve supply to the ventrolateral abdominal wall, anterior to the umbilicus by lateral thoracic nerve from the brachial

plexus may also account for this effect. Larson and Kitchell (loc. cit.), Getty (loc. cit.), in bull and ram, Prasad and Sinha (1981) in buffaloes and Prakash and Kumar (loc. cit.) in sheep had stated that the lateral thoracic nerve supplied the ventrolateral abdominal wall.

The area of analgesia on blocking the 10th, 11th and 12th thoracic spinal nerves were similar. It was more or less in the form of an S-shaped band from the dorsal midline, extending downwards and backwards to the level of tubercle of the ribs. It then deviated backwards and downwards, curved forward and continued downwards. They crossed the costal arch, extended to varying distances, lateral to the ventral midline. The results were consistent in the three trials.

The posterior curvature in the upper third may be due to the distribution of the cutaneous fibres of the dorsolateral branch of the spinal nerves in the posterior direction as seen in the dissection studies.

The area of analgesia on blocking the 13th thoracic spinal nerve extended caudoventrally in the anterior third of the flank, behind the last rib and below the level of transverse process of first and second lumbar vertebrae. It became narrower and extended downwards and backwards upto a level lateral to the ventral midline.

The area of analgesia on blocking the first lumbar spinal nerve was more or less in the form of an S-shaped band. Commencing from the dorsal midline, it extended caudoventrally in the mid-flank region, ending between the level of stifle and the ventral midline. The results were consistent in the three trials.

The area of analgesia on blocking the second lumbar spinal nerve commenced from the dorsal midline, extending downwards over the posterior third of the flank, in front of the external angle of ilium and prefemoral lymph gland. It was wide above and narrow below and extended upto a level lateral to the ventral midline. The results were consistent in the three trials.

The area of analgesia on blocking the third lumbar spinal nerve commenced from the dorsal midline, extending downwards over the posterior third of the flank, in front of the external angle of ilium, ending at the level of prefemoral lymph gland. The results were consistent in the three trials.

The results of the present study are in agreement with the observations of Arnold and Kitchell (loc. cit.), Westheus and Fritsch (loc. cit.) and Hall (loc. cit.) in cattle and Baily et al. (loc. cit.) in dogs.

**Site 2 (Distal site)**

The 13th thoracic, first, second and third lumbar spinal nerve were individually blocked in three animals at the distal site.

On blocking the 13th thoracic spinal nerve, the area of analgesia showed wide range of variations. It commenced from the dorsal midline and extended below the level of stifle joint, lateral to the ventral midline. In animal numbers 1 and 2 it extended from the dorsal spines of first to third lumbar vertebrae whereas in animal number 3 it extended from 13th thoracic to fourth lumbar vertebrae. In the mid-region the width was more in animal number 1. At the lower portion, the width was more in animal number 2.

On blocking the first lumbar spinal nerve, at the distal site, the area of analgesia showed wide range of variation. It commenced from dorsal midline over the dorsal spines of second to fifth lumbar vertebrae in animal numbers 1 and 2, whereas from 13th thoracic to third lumbar vertebrae in animal number 3. The area extended upto the ventral midline in animal number 1, upto the midflank region in animal number 2 and below the level of stifle in animal number 3. The width at the midregion was more in animal number 2.

On blocking the second lumbar spinal nerve at the distal site, the area of analgesia showed wide range of variations. It commenced from the dorsal midline over the dorsal spines of second to fourth lumbar vertebrae in animal number 1 and over dorsal spines of fourth and fifth lumbar vertebrae in animal number 2 and 3. The width at the midregions was more in animal number 1 than in animal numbers 2 and 3.

While blocking the third lumbar spinal nerve, the area of analgesia commenced from the dorsal midline. Over the dorsal spines of fourth and fifth lumbar vertebrae and extended to a level just below the prefemoral lymph gland. The results were consistent in the three trials.

Since the blocking of the individual spinal nerves at the distal site had not given uniform results, further trials were not undertaken to block these nerves at the distal site.

**Part III: Anaesthesia of flank**

In the present study, the 13th thoracic, first and second lumbar spinal nerves were blocked by perineural administration of five millilitres of bupivacaine hydrochloride solution at the proximal site. The effect of 0.5 per cent and 0.25 per cent solutions were studied in subgroup A and B respectively.

**1. Time for onset of analgesia**

The time for onset of analgesia was 2.83 ± 0.87 min. and 2.67 ± 0.21 min. in subgroups A and B respectively. There was no significant difference in the time for onset of analgesia. According to Hall (loc. cit.) the time for onset of anaesthesia was 10 minutes when two per cent Lignocaine solution was used in cattle and 5 minutes when one per cent lignocaime was used in sheep and goat for paravertebral anaesthesia. Khatra and Tyagi (1980) reported that the time for onset of analgesia was 5.77 ± 0.72 min. in buffalo calves when Novocaine - suprarenin was used. Roe (loc. cit.) observed the onset of analgesia in two minutes when two per cent lignocaine was used for paravertebral anaesthesia in cattle.

2. Duration of analgesia

The duration of analgesia was 215.83 ± 14.97 min. in subgroup A and 105.87 ± 31.30 min. in subgroup B. In the present study, the duration of analgesia was significantly prolonged when higher concentration of bupivacaine hydrochloride solution was used. Link and Smith (1956) had reported that in cattle the duration of anaesthesia was 312 min. with cyclane, 258 min. with xylocaine, 287 min. with pyribenzamine and 120 min. with procaine. According to Hall

(loc. cit.) it was 90 min. in cattle when two per cent lignocaine was used and 60 min. in sheep and goat when one per cent lignocaine was used. According to Khatra and Tyagi (loc. cit.) it was 84.35 ± 6.72 min. in buffalo calves when Novacaine-Suprarenin was used.

### 3. Extent of analgesia

In the present study satisfactory analgesia of the flank was achieved in both the subgroups. Dorsally it commenced from the dorsal midline and extended over the flank in a caudoventral direction. Its anterior border was landmarked by the anterolateral corner of the transverse process of second lumbar vertebra, costochondral junction of the last rib and it extended upto a point behind the preputial orifice on the ventral midline. Posterior border was marked by the posterolateral angle of transverse process of fourth lumbar vertebra, the external angle of ilium, prefemoral lymph gland, flap of flank and the base of the scrotum on the ventral midline. Ventrally the area of analgesia was limited by the ventral midline.

In the paralumbar fossa, the following areas were not desensitized:

A. A triangular area formed between the posterior border of the last rib and the lateral edge of transverse process of first lumbar vertebra.

From the dissection studies it was seen that this region was innervated also by the cutaneous fibres of dorsolateral branch of the 12th thoracic spinal nerve. On blocking the 12th thoracic spinal nerve, this area was also desensitized. Hence blocking of the 12th thoracic spinal nerve will be necessary for surgical interventions of this area. This is in agreement with the observations of Wright (loc cit) and Westheus and Fritsch (loc. cit.), in cattle and Khatra and Tyagi (1972a) in buffalo calves.

B. A triangular area formed between the external angle of ilium and lateral edge of transverse process of fifth lumbar vertebra.

From the dissection studies, it was seen that this area was innervated also by the cutaneous fibres of dorsolateral branch of the third lumbar spinal nerve. This is in agreement with the observations of Farquharson (loc. cit.), Arnold and Kitchell (loc. cit.), Ohme and Prier (loc. cit) and Westheus and Fritsch (loc. cit). On blocking the third lumbar spinal nerve, this area was also desensitized. Hence blocking

of the third lumbar nerve will be necessary for surgical interventions of this area.

C. The preputial orifice and the skin around it

The preputial orifice and the skin around it, receive innervation from 10th to 13th thoracic spinal nerves, genitofemoral nerve and the lateral thoracic nerve as observed by Nascimento and Gordinho (loc. cit) in bovines, Larson and Kitchell (loc. cit.) and Getty (loc. cit.) in bull and ram, Prakash and Sinha (1981) and Prakash and Kumar (1981) in buffaloes. Since these nerves were not blocked during the present study, desensitization of preputial orifice and the skin around it was not achieved.

**4. Clinical signs**

**A. Rectal temperature**

A gradual rise in rectal temperature was seen in all the animals of both the subgroups, but were within the normal range.

**B. Heart rate**

A slight increase in heart rate was seen in all the animals of both the sub-groups but were within the normal range.

**C. Rate of respiration**

A slight variation was observed in rate of respiration of all the animals of both the sub-groups but were within the normal range.

**D. Rumen motility**

A slight reduction in the rate of rumen motility was observed in all the animals of both sub-groups, but were within the normal range.

**5. Laparotomy**

Laparotomy was performed in two animals from each sub-group. Anaesthetic effect was found to be satisfactory in these animals. Nociceptive reflexes were not present while incising and suturing the skin, muscles and peritoneum. This is in agreement with the observations of Farquharson (loc. cit.), Wright (loc. cit.), Messervey et al. (1956), Jennings (1961), Frank (loc. cit.), Hall (loc. cit.), Sloss and Dufty (1977) and Short (loc. cit.).

**6. Other observations during the Anaesthesia**

All the animals had shown varying degree of scoliosis at the lumbar region, towards the side of nerve blocks. This may be due to the loss of tone of the spinal muscles

innervated by the dorsomedial branches of the spinal nerves. The curvature disappeared as the anaesthetic effect vained away. This is in agreement with the observations in cattle (Farquharson (loc. cit.), Wright (loc. cit.), Cakala (loc. cit.), Frank (loc. cit.), Gabel (1964), Westheus and Fritsch (loc. cit.), Hall (loc. cit.), Ohme and Prier (loc. cit.), Sloss and Dufty (loc. cit.) and Short (loc. cit.)) and in buffalo calves (Khatra and Tyagi (loc. cit.)).

In all the animals, bulging of the anaesthetized flank was observed, which disappeared when the anaesthetic effect vained away. Palpation of visceral organs became easier. This may be due to the relaxation of the abdominal muscles.

All the animals had shown difficulty in bearing weight on the hind limb on the side of nerve blocking. The limb was kept extended and abducted with the toe touching the ground. During progression, the animals had shown difficulty in advancing that limb and knuckling was also seen occasionally. These symptoms disappeared gradually as the anaesthetic effect vained away. Similar observations were made in buffalo calves (Khatra and Tyagi (loc. cit.)) and in cattle (Sloss and Dufty (loc. cit.) and Short (loc. cit.)). According to Ohme and Prier (loc. cit.), Short (loc. cit) and Roe (loc. cit.) this may be due to the backward spread of the local anaesthetic

solution and blocking of the third lumbar spinal nerve which contribute in the formation of femoral and obturator nerve.

Animal number $A_6$ had shown symptoms of systemic toxicity. It was characterized by initial excitement, recumbency, severe clonic convulsions of muscles of the neck and limbs, paddling movements of the limbs, dilatation of pupil, champing of jaws and frothy salivation, followed by a phase of depression. In human beings the systemic toxicity of bupivacaine was manifested as convulsions, shivering, tremours, bradycardia, nausea and paraesthesia as reported by Moore et al. (1970) and Albright (1979). In dog, Sage (1983) had reported that, administration of bupivacaine at the rate of 3.4 mg/kg body weight resulted in increase in heart rate and blood pressure, convulsive episodes lasting for 6 min., ventricular fibrillation and death. In hypoxic-acidotic sheep Thigpen et al. (1983) had reported similar symptoms when bupivacaine was administered at the rate of 2.1 mg/kg body weight intravenously. Beeby and Jenkins (1984) had also made similar observations in sheep. According to Hall (1964), Booth and McDonald (1982) and Taylor (loc. cit.) systemic absorption of local anaesthetic agent in higher quantities produced cortical stimulation characterized by restlessness, excitation, muscle tremours and clonic convulsions followed by a state of depression. According to Gillman (1991)

bupivacaine produces cardiac toxicity and depressed the contractibility of the heart. The risk of puncturing aorta and thoracic longitudinal vein on the left side and posterior vena cava on the right side, while performing proximal paravertebral anaesthesia had been reported by Cakala (loc. cit.) and Short (loc. cit.). The reactions observed in Animal number $A_6$ might have been due to the systemic absorption of bupivacaine solution.

# Summary

## SUMMARY

The study was conducted in 15 apparently healthy Alpine-Malabari crossbred male goats of 9 to 12 months of age. Three goats were embalmed and used for dissection studies and the remaining 12 goats were used for nerve blocking trials, repeatedly at 10 days interval. The study was conducted in three parts.

**Part I: Distribution of thoracic and lumbar spinal nerves in the abdominal region**

The origin, course and distribution of the 10th thoracic to the third lumbar spinal nerves were studied on both flank. The spinal nerves emerged through the intervertebral foramina, and divided into dorsal and ventral primary branches. The dorsal primary branch released the dorsomedial branch and continued as the dorsolateral branch. The former ramified into the multifidus dorsi and longissimus dorsi muscles and the latter ramified into the cutaneous trunci muscle and skin of the upper third of the body wall. The dorsolateral branch of the 10th, 11th and 12th thoracic spinal nerves supplied the serratus dorsalis caudalis muscles and the thoracolumbar fascia in their course.

The ventral primary branch of the 10th, 11th and 12th thoracic spinal nerves gave away a ventrolateral branch which supplied the intercostal muscles, the origin of obliquus abdominis externus muscle and provided cutaneous innervation to the middle third of chest wall. The ventromedial branch terminated as fine branches between the transverse abdominis and rectus abdominis muscles, penetrated through the rectus abdominis muscle and the aponeuroses and supplied the skin on the ventral third of the chest wall.

The ventral primary branches of the 13th thoracic, first and second lumbar spinal nerves coursed below the intertransversalis muscles, released ventrolateral branch and continued as the ventromedial branch. The former supplied the oblique muscles of abdomen and ramified into the skin and cutaneous muscles in the middle third of the flank. The latter terminated as fine branches, penetrated through the rectus abdominis muscle and the aponeuroses and formed the cutaneous innervation to the ventral abdominal wall.

The ventral primary branch of the first and second lumbar spinal nerves have communicating branch, which traversed below the second lumbar transverse process. The ventral primary branch of the second lumbar spinal nerve gave away a small branch which ran caudad, below the lumbar transverse processes.

The ventral primary branch of the third lumbar spinal nerve coursed back, below the lumbar transverse processes, between the psoas muscles.

The lateral thoracic nerve of the brachial plexus supplied muscles on the ventral part of chest and abdomen and the cranial preputial muscle.

One site (proximal site) was found suitable for blocking the 10th, 11th and 12th thoracic spinal nerves, while, two sites, proximal and distal, were found suitable for 13th thoracic, first, second and third lumbar spinal nerves.

**Part II: The area sesensitized by blocking individual spinal nerves supplying the flank region**

The 10th thoracic to the third lumbar spinal nerves were blocked individually in three different animals using 0.5 per cent bupivacaine hydrochloride solution and the area of analgesia was mapped.

The 10th, 11th and 12th thoracic spinal nerves were blocked at the proximal site. The area of analgesia was similar, with S-shape, commencing from the dorsal midline to a point between the costal arch and the ventral midline.

The 13th thoracic, first, second and third lumbar spinal nerves were blocked at two sites, viz. Proximal site:

The area of analgesia for the 13th thoracic, first and second lumbar spinal nerves commenced from the dorsal midline, and terminated lateral to the ventral midline.

The area of analgesia of the third lumbar spinal nerve extended over the caudodorsal part of the flank.

Distal site: The results of the study for each of the spinal nerves were inconsistent.

Based on this study, it was concluded that, for anaesthetizing the flank, the 13th thoracic, first and second lumbar spinal nerves are to be blocked simultaneously, at the proximal site.

**Part III: Anaesthesia of the flank**

The 13th thoracic, first and second lumbar spinal nerves were blocked simultaneously at the proximal site, in two groups (A and B) of six goats each using 0.5 per cent and 0.25 per cent solutions of bupivacaine hydrochloride respectively.

The time for onset of analgesia was 2.83 $\pm$ 0.87 min. in subgroup A and 2.67 $\pm$ 0.21 min. in subgroup B.

The duration of analgesia was 215.83 $\pm$ 14.97 min. and 105.67 $\pm$ 31.13 min. in subgroups A and B respectively.

The extent of analgesia obtained in all the trials in both of the subgroups were similar. It extended over the entire flank from dorsal midline to the ventral midline, except: (a) a triangular area at the anterodorsal angle of flank (b) the posteriodorsal corner of the flank, in front of the external angle of ilium and (c) the preputial orifice and the skin around it.

The rectal temperature, heart rate, rate of respiration, and the rate of rumen motility did not show significant variation throughout the experiment in both the subgroups.

Laparotomy was conducted in two animals from each subgroup. Analgesia was satisfactory over the skin, muscles and peritoneum and muscle relaxation was adequate.

In addition, the following symptoms were observed

a. Scoliosis at the lumbar region towards the side of nerve block

b. bulging of the anaesthetized flank and

c. difficulty in bearing weight on the hind limb on the side of nerve block, with knuckling on progression.

One animal (No. $A_6$) developed symptoms of toxicity viz., lateral recumbency, dialatation of pupil, champing of jaw, frothy salivation, severe clonic convulsions of neck and limb muscles and paddling movements. The animal had a spontaneous recovery.

The following conclusions were drawn from the study

1. The flank in goat is innervated by the dorsal and ventral branches of 13th thoracic, first and second lumbar spinal nerves.

2. For inducing analgesia of all layers of abdominal wall, all the three nerves have to be blocked simultaneously.

3. The nerves can be blocked at two sites, viz., the proximal and distal sites. The proximal site was found to be more accurate for locating the nerve.

4. Blocking all the three nerves simultaneously, produce surgical analgesia and muscle relaxation of the flank satisfactory for rumenotomy/laparotomy.

5. Both the 0.5per cent and 0.25 per cent solutions of bupivacaine hydrochloride produce adequate duration of analgesia.

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# PARAVERTEBRAL ANAESTHESIA IN GOATS USING BUPIVACAINE HYDROCHLORIDE

By

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## ABSTRACT OF A THESIS

Submitted in partial fulfilment of the
requirement for the degree

## Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
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COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy, Thrissur

**1994**

## ABSTRACT

The study was conducted in 15 apparently healthy Alpine-Malabari crossbred male goats of 9 to 12 months of age. Three goats were embalmed and used for dissection studies and the remaining 12 goats were used for nerve blocking trials, repeatedly at 10 days interval. The study was conducted in three parts.

**Part I: Distribution of thoracic and lumbar spinal nerves in the abdominal region**

The origin, course and distribution of the 10th thoracic to the third lumbar spinal nerves were studied on both flank. The spinal nerves emerged through the intervertebral foramina, and divided into dorsal and ventral primary branches. The dorsal primary branch released the dorsomedial branch and continued as the dorsolateral branch. The former ramified into the multifidus dorsi and longissimus dorsi muscles and the latter ramified into the cutaneous trunci muscle and skin of the upper third of the body wall. The dorsolateral branch of the 10th, 11th and 12th thoracic spinal nerves supplied the serratus dorsalis caudalis muscles and the thoracolumbar fascia in their course.

The ventral primary branch of the 10th, 11th and 12th thoracic spinal nerves gave away a ventrolateral branch which supplied the intercostal muscles, the origin of obliquus abdominis externus muscle and provided cutaneous innervation to the middle third of chest wall. The ventromedial branch terminated as fine branches between the transverse abdominis and rectus abdominis muscles, penetrated through the rectus abdominis muscle and the aponeuroses and supplied the skin on the ventral third of the chest wall.

The ventral primary branches of the 13th thoracic, first and second lumbar spinal nerves coursed below the intertransversalis muscles, released ventrolateral branch and continued as the ventromedial branch. The former supplied the oblique muscles of abdomen and ramified into the skin and cutaneous muscles in the middle third of the flank. The latter terminated as fine branches, penetrated through the rectus abdominis muscle and the aponeuroses and formed the cutaneous innervation to the ventral abdominal wall.

The ventral primary branch of the first and second lumbar spinal nerves have communicating branch, which traversed below the second lumbar transverse process. The ventral primary branch of the second lumbar spinal nerve gave away a small branch which ran caudad, below the lumbar transverse processes.

The ventral primary branch of the third lumbar spinal nerve coursed back, below the lumbar transverse processes, between the psoas muscles.

The lateral thoracic nerve of the brachial plexus supplied muscles on the ventral part of chest and abdomen and the cranial preputial muscle.

One site (proximal site) was found suitable for blocking the 10th, 11th and 12th thoracic spinal nerves, while, two sites, proximal and distal, were found suitable for 13th thoracic, first, second and third lumbar spinal nerves.

**Part II: The area desensitized by blocking individual spinal nerves supplying the flank region**

The 10th thoracic to the third lumbar spinal nerves were blocked individually in three different animals using 0.5 per cent bupivacaine hydrochloride solution and the area of analgesia was mapped.

The 10th, 11th and 12th thoracic spinal nerves were blocked at the proximal site. The area of analgesia was similar, with S-shape, commencing from the dorsal midline to a point between the costal arch and the ventral midline.

The 13th thoracic, first, second and third lumbar spinal nerves were blocked at two sites, viz., Proximal site:

The area of analgesia for the 13th thoracic, first and second lumbar spinal nerves commenced from the dorsal midline, and terminated lateral to the ventral midline.

The area of analgesia of the third lumbar spinal nerve extended over the caudodorsal part of the flank.

Distal site: The results of the study for each of the spinal nerves were inconsistent.

Based on this study, it was concluded that, for anaesthetizing the flank, the 13th thoracic, first and second lumbar spinal nerves are to be blocked simultaneously, at the proximal site.

**Part III: Anaesthesia of the flank**

The 13th thoracic, first and second lumbar spinal nerves were blocked simultaneously at the proximal site, in two groups (A and B) of six goats each using 0.5 per cent and 0.25 per cent solutions of bupivacaine hydrochloride respectively.

The time for onset of analgesia was 2.83 $\pm$ 0.87 min. in subgroup A and 2.67 $\pm$ 0.21 min. in subgroup B.

The duration of analgesia was 215.83 $\pm$ 14.97 min. and 105.67 $\pm$ 31.13 min. in subgroups A and B respectively.

The extent of analgesia obtained in all the trials in both of the subgroups were similar. It extended over the entire flank from dorsal midline to the ventral midline, except: (a) a triangular area at the anterodorsal angle of flank (b) the posteriodorsal corner of the flank, in front of the external angle of ilium and (c) the preputial orifice and the skin around it.

The rectal temperature, heart rate, rate of respiration, and the rate of rumen motility did not show significant variation throughout the experiment in both the subgroups.

Laparotomy was conducted in two animals from each subgroup. Analgesia was satisfactory over the skin, muscles and peritoneum and muscle relaxation was adequate.

In addition, the following symptoms were observed

a. Scoliosis at the lumbar region towards the side of nerve block

b. bulging of the anaesthetized flank and

c. difficulty in bearing weight on the hind limb on the side of nerve block, with knuckling on progression.

One animal (No. $A_6$) developed symptoms of toxicity viz., lateral recumbency, dialatation of pupil, champing of jaw, frothy salivation, severe clonic convulsions of neck and limb muscles and paddling movements. The animal had a spontaneous recovery.