A CLINICAL EVALUATION OF ANAESTHESIA IN CATS USING KETAMINE HYDROCHLORIDE, ALONE AND IN COMBINATION WITH DIFFERENT PREANAESTHETICS

A thesis submitted to the Konkan Krishi Vidyapeeth, Dapoli (Agricultural University)
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MASTER OF VETERINARY SCIENCE

in

SURGERY

by

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CERTIFICATE

Certified that the thesis entitled " A CLINICAL EVALUATION OF ANAESTHESIA IN CATS USING KETAMINE HCl, ALONE AND IN COMBINATION WITH DIFFERENT PREANAESTHETICS " submitted by DR NITYA SAMBAMURTI GHOTGE in partial fulfilment of the requirements for the degree of MASTER OF VETERINARY SCIENCE in SURGERY which embodies the results of the record of bonafide research work carried out by her, under the guidance of University teacher DR M. B. MANTRI, is to our satisfaction.

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CONTENTS

INTRODUCTION

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Cats form a large percentage of patients in any small animal practice, by virtue of being the most popular pets after dogs. The unpredictable and somewhat fractious behaviour of the species tends to make them difficult to handle. Anaesthetic procedures maybe required not merely for surgical interventions but also for restraint during clinical examination.

A suitable anaesthetic is one which :

- o is non toxic
- o induces smooth and rapid anaesthesia
- o is easy to administer and of short duration
- o does not adversely affect the respiratory and cardiovascular systems
- o has adequate muscle relaxant and analgesic properties
- o ensures smooth and uneventful recovery
- o is easily available and economically viable.

Inhalant anaesthetics are not popular with most veterinary practitioners as the equipment needed for administering them is cumbersome, expensive and requires an anaesthetist constantly at hand. A few are explosive and therefore dangerous.

Among barbiturates, the short and ultra short acting ones have been used for general anaesthesia in cats. They have many disadvantages. As the route of administration is intravenous there is often diffuculty in injecting fractious cats and supplemental dosing becomes a problem. Additionally there is the risk of perivascular sloughing at the injection site. They have a depressant effect on the cardiovascular

systems, which makes constant monitoring essential, especially in the very old, the very young, the moribund and other high risk patients. As the recovery period with this group of drugs is prolonged, constant monitoring becomes essential.

Ketamine Hydrochloride, a derivative of phenylcyclidine hydrochloride, came into use as a human anaesthetic in 1966 (Domino et al.). Since then it has been used to induce anaesthesia in a number of species .This drug can be administered by any of the three routes, intravenous , intramuscular or subcutaneous.In cats it was found to be well tolerated with a wide margin of safety(Commons 1970).Beck et al. in 1971 found ketamine produced effects ranging from chemical restraint to cataleptoid surgical anaesthesia, depending on the dose injected.Due to its many advantages over other available drugs,ketamine rapidly gained popularity for use in cats (Ingerwerson et al. 1988).

Ketamine also has certain disadvantages as recorded by Beck et al.(1971), Reid and Frank (1972) and Stock (1973).

- o muscle relaxation may not be adequate for some surgical procedures
- o eyelids remain open and dessication of cornea may occur during prolonged procedures
- o myoclonic jerking and mild tonic convulsions may occur during recovery in some cases.

The use of a preanaesthetic in combination with Ketamine would help overcome some of these difficulties. Different premedications have been suggested by different authors . Atropine was used by Beck et al (1971), Eads (1972) and Glen (1973). They concluded that it not only reduces salivation but may infact potentiate the action of ketamine. Reid and Frank (1972) suggested the use of oxymorphone and triflupromazine. Diazepam as preanaesthetic was recommended for human beings by Dundee

and Wyant (1970) and for dogs by Szappamyos . .(1971). Xylazine has been tried by Amend et al. (1973),Schiamtke and Schmidtke (1974), Cullen and Jones (1977) and more recently by Allen et al. (1984) . While xylazine eliminates muscular tonicity, prolongs the duration of ketamine anaesthesia and provides sedation , it induces emesis in cats (Cullen and Jones1977) which is undesirable during surgery. Xylazine is not easily available in India and is expensive. Acepromazine ,another drug recommended as a preanaesthetic (Buyinsky and Christie 1977, Colby and Sanford 1982) is also not available for routine use in India .

The aim of this study is to clinically evaluate anaesthesia in cats using ketamine hydrochloride, alone in some cases and in combination with different preanaesthetics in others and thus try and determine the most suitable combination for regular, routine use by cat practitioners.

Evaluation is based on the following parameters

- o ease of administration
- o nature and duration of anaesthesia produced
- o effect on respiratory and cardiac function
- o effect on blood pH and blood gases
- o effect on body temperature
- o any adverse side effects produced

The four preanaesthetics used in the study are atropine sulphate , chlorpromazine HCl , triflupromazine and diazepam. All four drugs are easily available locally and approved for use in cats.

PHARMACOLOGY OF KETAMINE HYDROCHLORIDE

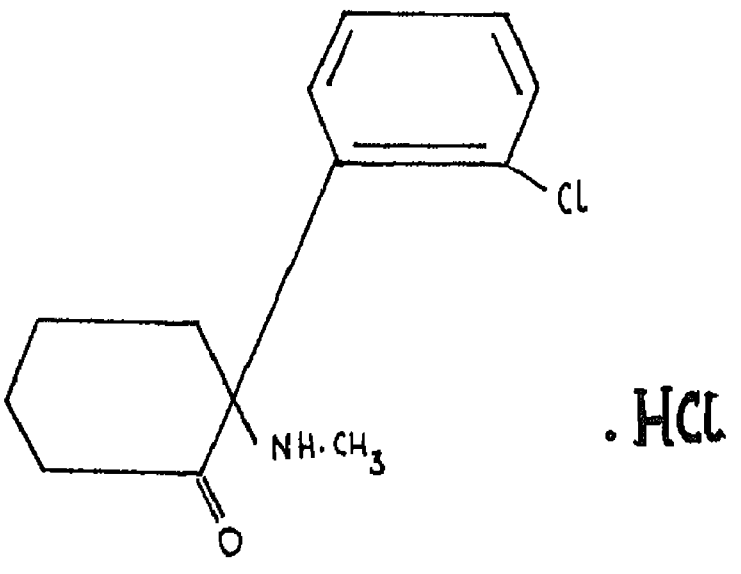
PHARMACOLOGY OF KETAMINE

Some arylcycloamines induce a state of sedation immobility and marked analgesia. Their action is believed to be on the cortex and limbic systems rather than on the reticular activating system of the brain stem. This form of anaesthesia is termed " dissociative anaesthesia " in human beings. Ketamine Hydrochloride belongs to this group of drugs.

Ketamine Hydrochloride was formed from Phencyclidine Hydrochloride by the reduction of its side chain . It is chemically designated ((2-0-chlorophenyl -)- 2 -(methylamino) cyclohexanone hydrochloride. It is otherwise also known as Ketalar, Ketaset, Vetalar or Ketmin.

Structure of

Ketamine HCl



The CNS effects of Ketamine as characterised by the EEG indicate that depression of the thalamaneo cortical system occurs in conjunction with activation of the limbic system (Corssen and Domino et al.1968) . Ketamine induces anaesthesia and amnesia by functional disruption (dissociation) of the

CNS through marked CNS stimulation or induction of a cataleptoid state . It induces stages I and II of anaesthesia but not stage III . Catalepsy is thought to occur due to a deficiency of dopamine function or an imbalance in cholinergic - dopaminergic function (Booth 1982). Ketamine is a relatively potent inhibitor of GABA binding in the CNS (Roberts .1978). It apparently blocks the neuronal transport processes of monoamino transmitters such as 5-hydroxytryptamine (serotonin),dopamine and norepinephrine (Smith . 1981).

The mechanism of cardio-vascular stimulation elicited by Ketamine is essentially unknown as well as controversial (Parker and Adams 1978). Ketamines lack of cardio-respiratory depression is virtually unequalled by any other general anaesthetic currently available (Lanning and Harmel 1975). Ketamine increases cardiac output, mean aortic pressure,pulmonary arterial pressure, central venous pressure and heart rate.It has a variable effect upon peripheral vascular resistance.Ketamine probably acts either directly by stimulating the central adrenergic centers or indirectly by inhibiting the neuronal uptake of catecholamines,especially norepinephrine. These cardiac stimulating properties in addition to its antiarrythmic action makes it a good induction agent for poor risk and hypovolaemic patients.However for maintenance, Ketamine may be a liability in subjects with severe coronary insufficiency since it elevates myocardial oxygen consumption. The effect of Ketamine upon ventilation is interesting as it is not a potent depressor of the ventilatory response to hypoxia unlike other anaesthetics (Lanning and Harmel 1975). Earlier Child et al. (1972) had found very large doses caused respiratory depression.

Absorption of Ketamine from the intramuscular site of administration is rapid (Waterman and Livingston 1983) . Peak plasma levels are reached after ten to

fifteen minutes and plasma levels thereafter decline exponentially, with a half life of thirty five minutes . Ketamine is rapidly distributed into all body tissues, primarily adipose tissue, liver, lung and brain.

Ketamine is metabolized in the liver (Livingstone and Waterman 1978a) initially to its n-de-methylated product norketamine which may then undergo further oxidation to form dehydronorketamine. Although metabolism is rapid, cats do not appear to metabolize the drug to form dehydronorketamine unlike rats and sheep. Ketamine is excreted in the bile and urine (Livingstone and Waterman 1978b). In cats it is mainly excreted by the kidneys in a virtually unchanged form.

Ketamine has a wide therapeutic index. In animals a Ketamine LD50/ED50 ratio five times that of pentobarbital has been demonstrated (Booth 1982).

Repeated administration does not seem to lead to development of any significant tolerance or complications (Bree et al. 1967).

REVIEW OF LITERATURE

REVIEW OF LITERATURE

McCarthy (1965) formed (2-O-chlorophenyl-)-2-(methylamino) cyclohexanone (Ketlar) from phencylidine hydrochloride by the reduction of its side reaction to make it a safe short acting drug for human beings.

Domino et al.(1965) reported the pharmacological effects of this drug on man.

The safety and tolerance of repeated anaesthesia with CI 581 (Ketamine HCl) in monkeys was reported by Bree et al. in 1967.

It was first used in cats by Commons (1970).She found it produced an anaesthetic state , characterised by profound analgesia , normal reflexes , transient cardiac stimulation and minimum respiratory depression. It was found to be well tolerated by both sexes of various breeds , weights and ages. Subsequent to anaesthetic no nausea, vomiting or anorexia was reported.

Dosage of Ketamine

Commons (1970) reported the intramuscular dose varied from 5 mg/lb to 20 mg/lb (11 mg/kg-44.2mg/kg) depending on the depth of anaesthesia required.Beck, Coppock and Ott (1971) used intramuscular dosages varying from 5.3mg/kg to 56.7 mg/kg. Depending on the dosage given , the drug rapidly produced effects ranging from chemical restraint to cataleptoid surgical anaesthesia . No anaesthetic related deaths occured. Supplemental dose could be easily given with no side effect.Richards and Hinko (1971) recommended a unique dosage system. Full amounts of ketamine had to be repeated when supplemental doses had to be given and

in cases where the initial dose was low and so was the follow up dose.

Akusawa and Matsumara (1972) found a 20-30 mg/kg intramuscular dose optimum for cats. There were no side effects such as convulsions ,shock or vomiting reported with this dose.

Eads (1971) found the dosage of the drug determines the degree of anaesthesia and recovery time. The margin of safety was found to be wide over a broad dosage range. Anaesthetic periods could be extended by repeating one half the original dose.

Child et al. (1972) found ketamine active over a wide range of doses. Induction was slower after small doses while large doses caused respiratory and circulatory depression and protracted recovery period. The drug was found to have one of the highest therapeutic indexes amongst anaesthetic agents.

Beglinger and Lakatos (1974) found the drug suitable for short, simple surgical operations at a dose of 20 mg /kg intramuscularly.

Schmiatke and Schmidtke (1974) induced analgesia in cats using intramuscular dose of 20 mg ketamine combined with 8mg of Xylazine . They found it was not necessary to vary the doses according to the body weight.

Oeppert .(1974) induced surgical anaesthesia using xylazine and ketamine combined in various proportions. They found a dose of 10-20 mg/kg ketamine with 2 mg/kg xylazine an optimum dose. When only sedation was induced by this dose subsequent injection of half a dose was sufficient to induce surgical anaesthesia.

Amend (1974) recommended a combination of xylazine at the rate of 0.5 mg/0.45kg and ketamine at the dose rate of 7-10 mg/0.45 kg for safe anaesthesia.

Derbal (1977) injected a mixture of ketamine at the dose rate of 8-10

mg/kg droperidol at the rate of 1 mg/kg and phenoperidine at the rate of 0.2 mg/kg, intramuscularly to produce anaesthesia sufficient for surgical intervention in cats.

Heller (1977) tried a combination of 0.5 mg/kg acepromazine and 20mg/kg ketamine I/M and found it to be a safe, satisfactory anaesthetic.

Arnbjerg (1979) found very high doses of ketamine (100 mg/kg) injected intramuscularly in cats to be safe. All cats given this dose recovered from anaesthesia albeit after twenty four hours.

Induction, Duration and Recovery

Commons (1970) observed that after an I/M injection of ketamine the animal smoothly and rapidly became recumbent, within one to eight minutes , without struggling. While it took only ninety minutes for the animal to stand unassisted , complete recovery took an average of five hours. External stimuli during recovery sometimes resulted in clonic and tonic convulsions. These apparently were the only side effects.

Beck et al. (1971) reported that induction time , depth and duration of anaesthesia and recovery time were all dose dependant. Induction time following an I/M administration of 22 mg/kg was approximately three minutes, becoming less as dosage increased. Dosage less than 22 mg/kg produced merely a state of chemical restraint while dosages from 22-44 mg/kg produced surgical cataleptoid anaesthesia lasting from 20-40 minutes. Recovery, to an essentially normal state , occured within seven and a half hours. Five percent of the patients were found to have myoclonic convulsions during recovery. This was not thought to be dose related and could be reduced by eliminating external stimuli during recovery.

Lo and Cumming (1971) and Reid and Frank (1972) found diazepam when used

as preanaesthetic to ketamine increased sleeping time and prevented ketamine induced convulsions.

Akusawa and Matsumara (1972) and Beglinger and Lakatos (1973) noted that anaesthesia began quietly four to five minutes after an I/M injection of dose 20-40 mg/kg bwt. Duration of anaesthesia was for 15-20 minutes and recovery was without any excitement.

Stock (1973) maintained that while ketamine induced rapid and reliable immobilisation after I/M administration at the rate of 20 mg/kg, recovery periods were long , often seven hours and a number of patients suffered convulsions and clonic spasms.

Massey (1973) observed that following an I/M injection of ketamine, surgery could commence after five minutes. While recovery was prolonged and often accompanied by excitement , the cat was usually able to maintain a sitting position after two hours.

Amend et al. (1973) premedicated cats with xylazine prior to ketamine anaesthesia and found the duration of anaesthesia was prolonged. Xylazine also produced sedation to assure quick recovery.

Schmiatke and Schmidtke (1974) using the same combination induced anaesthesia adequate for most operations within seven to twelve minutes.

Hatch and Ruch (1974) were able to reduce the duration of ketamine anaesthesia by injecting a mixture of amphetamine at the rate of 1 mg/kg bwt. and yohimbine at the rate of 0.125 mg/kg. The drugs did not however reduce ambulation time.

Faulk (1978) found surgical anaesthesia was attained within ten minutes in cats given a combination of xylazine and ketamine. Most cats however vomited six minutes after the first injection and starvation was found necessary. Average sleeping time was hundred and eighteen minutes.

Derbal (1978) using a mixture of ketamine , droperidol and phenoperidine

found consciousness was regained quietly and progressively after surgical anaesthesia had been attained.

Jones (1979) observed that as the drug ketamine was excreted unchanged in the urine , any renal impairment would lead to delayed recovery.

Sanford and Colby (1982) attempted induction of anaesthesia in felines using combinations of xylazine and acepromazine with ketamine. They found that onset of surgical anaesthesia was always faster when drug combination was injected together. Emesis occured frequently when xylazine was used, but was less when xylazine and ketamine were injected together. Surgical plane of anaesthesia lasted longer with ketamine xylazine combination.

Hatch et al. (1983) were able to safely and rapidly antagonise ketamine anaesthesia with a combination of 4-aminopyridine and yohimbine. The mixture promoted rapid arousal with few adverse side effects.

Samy and Othman (1985) noted that ketamine at a dose rate of 33 mg/kg injected subcutaneously induced a state of sternal recumbency persisting for 45-65 minutes which was inadequate for surgery, however a combination of xylazine at the rate of 2.2 mg/kg and ketamine at the rate of 20 mg/kg injected subcutaneously gave safe dependable anaesthesia for about one and a half hours.

Pageat (1986) reported recurrent photophobia, anxiety, hallucinatory behaviour in many cats anaesthetised with ketamine. Predisposing factors were inadequate preanaesthetic medication and allowing the animal to be taken away before complete recovery from anaesthesia.

Ingerwersson et al. (1986) found the ketamine/acepromazine combination produced a good surgical plane of anaesthesia that lasted approximately 30-45 minutes.

Effect of Ketamine on Temperature

Beck et al. (1971) observed that ketamine, when used for surgical anaesthesia , caused a drop in temperature which varied from 0-3.6 C (6.4 F) with an average drop of 1.6 C.

Buyinsky and Christie (1977) and Adsul (1979) reported that ketamine had no significant effect on body temperature.

Effect on Blood Gas Analysis

Beck et al.(1971) found no marked change in blood gas or homeo-stasis.

Glen (1973) reported slight metabolic acidosis after studies on blood gas following ketamine anaesthesia. He attributed this to increased levels of circulating catecholamines.

Buyinsky and Christie (1977) noted that fifteen minutes after injection of ketamine there was a significant fall in arterial pH and PO2 and a significant increase in arterial carbon dioxide tension.

Arnbjerg (1979) observed that the PO2 fell from 97-90 mm Hg five minutes after administration of ketamine xylazine combination but rose again to 96 mm Hg after thirty minutes.

Sanford and Colby (1982) found that a combination of Xylazine / Ketamine produced greater effects by lowering PO2 , raising PCo2 and lowering pH than one of Ketamine / Acepromazine.

Allen et al. (1986) noted blood values remained stable following administration of a xylazine / ketamine combination intramuscularly.

Ingerwersson et al. (1988) found PaCO2 and pH demonstrated significant alteration in the first thirty minutes of anaesthesia induced by a ketamine / acepromazine combination.

Effect on Heart Rate and Respiratory Rate

Commons (1970) reported that for all practical purposes respiratory rate, heart rate and pulse remained unchanged after ketamine anaesthesia.

Beck et al. (1971) noted transient cardiovascular stimulation , increase in cardiac output and slight increase in mean systolic pressure. The effect on respiration was found to be minimal with little or no change in total peripheral resistance.

Beglinger and Lakatos (1972) conducted trials on cats and found it increased heart rate and induced occasional extra systoles. Due to these reasons it was contra-indicated for cats suspected to have circulatory disorders.

Child et al. (1972) found a distinct variation in effects when ketamine was administered at different dosages. Ketamine, injected intravenously seemed to cause a 125-135% increase in blood pressure.Heart rate too increased but not significantly. High doses of ketamine (64 mg/kg) induced profound circulatory and respiratory depression. Ketamine at 32 mg/kg also reduced respiratory rates significantly . However, at lower doses ketamine had little effect on the heart or respiration and was seen at times to induce transient cardiac and respiratory stimulation.

Glen (1973) evaluated the effect of ketamine alone and in combination with atropine. The combination with atropine seemed to cause an initial increase in pulse rate which later assumed the same levels as in those where ketamine alone had been given. Respiratory rates were found to be low but with efficient elimination of carbon dioxide .

Oeppert (1974) recorded a decrease in respiratory frequency , volume and increase in blood pressure and a decrease in pulse rate using a xylazine ketamine combination.

Buyinsky and Christie (1978) testing the safety of a commercial

preparation , containing ketamine , centrine and promazine (keta set) found the drug combination to have no significant effect on mean aortic pressure or heart rate. Fifteen minutes after administration there was a sharp fall in respiratory frequency which later attained normal levels.

Derbal (1978) similarly recorded respiratory depression in cats with a combination of ketamine , droperidol and phenoperidine . This depression was easily countered by nalorphine.

Arnbjerg (1979) found some cats injected with ketamine xylazine showed a depressed respiratory frequency (30-60 sec. periods) followed by a rapid respiratory rate over 10-20 minute. No cyanosis was observed. Pulse frequency was found to rise from 120-170. Overdoses of ketamine (100 mg/kg) induced no cardiac arrythmias . He concluded xylazine prevented tachycardia sometimes induced by low doses of ketamine.

Jones (1979) compared ketamine to other injectable anaesthetic agents in the cat and found normal doses caused hypertension and tachycardia while high doses produced respiratory depression.

Lee et al. and Clement (1981) noted that cats anaesthetised with ketamine after premedication with diazepam showed no respiratory depression.

Sanford and Colby (1982) found the ketamine xylazine combination depressed heart and respiratory rates for longer periods than a ketamine acepromazine combination.

Allen et al.(1986) observed alteration in heart rate and significant cardiovascular depression following ketamine xylazine anaesthesia in the cat.

Pokorski et al. (1987) observed ketamine administered intravenously at the dose rate of 2 mg/ml per kg caused apneustic respiratory depression in cats.

Ingerwerson et al. (1988) studied the cardio pulmonary effects of a ketamine acepromazine combination and found heart rates and respiratory

rates were not significantly altered, although there was an initial decline in respiratory rates during the first thirty minutes of anaesthesia .

Effects on Reflexes and Muscle Relaxation

The pharmacological action of ketamine being entirely different from conventional anaesthetic agents , the anaesthetic state it produces does not fit into the conventional classification of stages of anaesthesia. In contrast to other anaesthetics, particularly inhalation agents ketamine does not dull protective reflexes, such as coughing and swallowing. It does not produce appreciable skeletal muscle relaxation and infact even slightly increaseds skeletal muscle tone. While some of these deviations from the normal (anaesthetic) are difficult to accept persistence of muscle tone hinders surgery . The effect of ketamine HCl on different body reflexes and muscle tone has been studied by a number of workers.

Commons (1970) found that after an intramuscular injection of ketamine eyelids remain open and mydriasis occurs. Repeated flicking of the tongue maybe observed. Laryngeal and pharyngeal reflexes remain normal. Swallowing reflex was always present. Skeletal muscle tone remained and the pedal and palpebral reflexes were easily stimulated during the anaesthetic state.

Beck et al. (1971) found that with an intravenous dose of 3-5 mg/kg in cats the eyes remained open and the pupils were dilated. Licking of lips, profuse salivation and slow movements of head were observed. Rigidity and extension of fore limbs was seen. Opisthotonus was seen with higher doses. Pedal and ear reflexes were not abolished and the photic and corneal reflexes also persisted.

Lo and Cumming (1971) and Reid and Frank (1972) found diazapam produced slightly increased muscle relaxation.

Eads (1972) recommended the use of a bland ophthalmic ointment during prolonged procedures where ketamine was used so as to prevent dessication of the cornea, as the eyes always remained open.

Reid and Frank (1972) used oxymorphone 165 mg/kg and triflupromazine 1.1 mg/kg to overcome the disadvantages of hypertonus and poor muscle relaxation. They felt that the results of anaesthesia were better when pre anaesthetics were injected 15 minutes prior to ketamine.

Glen (1973) recommended the use of atropine to overcome the disadvantages of excessive salivation which could be dangerous in animals with obstructive respiratory disease.

Amend (1973) premedicated cats with xylazine to eliminate muscular tonicity during ketamine anaesthesia and found it suitable. Supplemental doses of ketamine were preferred to prolong analgesic periods as opposed to xylazine which induced respiratory depression in overdoses.

Ketamine when used with nitrous oxide and skeletal muscle relaxants provides adequate anaesthesia for intra-abdominal and thoracic surgery (Vaughan and Stephen 1974).

When ketamine is used as a monoanaesthetic, pharyngeal and laryngeal reflexes remain active (Lanning and Harmel 1975). Preservation of these reflexes, however, leads to bronchospasm and coughing secondary to secretions or manipulations in the oropharynx. These complications may make ketamine an unsuitable drug for use in endoscopy or oropharyngeal surgery.

Arnbjerg (1979) investigating into overdoses of ketamine found 100 mg/kg of the drug induced salivation and abolished the ear reflex for 5-30 minutes. Absence of pedal reflex and first signs of recovery occured at 10-45 minutes and 90-120 minutes respectively. Muscle tonus in legs and tail remained as did corneal and laryngeal reflexes

Jones(1979) maintained the condition produced by ketamine is not one of

a traditional anaesthetic but one of clinical unresponsiveness. Eyes remain open and there is poor muscle relaxation which makes premedication necessary for routine surgical procedures. He too recommends atropine to overcome effects of excessive salivation.

Sanford and Colby (1982) found acepromazine a suitable preanaesthetic to abolish muscle tonicity induced by ketamine.

Contraindications to the use of Ketamine

- As ketamine is excreted virtually unchanged by the kidneys Gaskell (1978) recommended that it should not be used for anaesthetising cats with renal dysfunction or urethral obstruction.
- Dodman (1979) felt ketamine was unsuitable as the sole agent for caesarean sections.
- Due to poor muscle relaxation, without suitable premedication, ketamine cannot be used for abdominal and orthopaedic surgery (Jones 1979) .
- Contraindicated in head injuries as it increases cerebro-spinal fluid pressure (Booth 1982) .
- Cannot be used in animals with epileptic seizures(Booth 1982).
- Post surgical haemorrhage needs to be controlled as aerterial hypertension increases after ketamine (Evans 1972)

MATERIAL AND METHODS

MATERIAL AND METHODS

This study was conducted at the Bai Sakarbai Dinshaw Petit Hospital for Animals, Parel, Bombay.All observations were made on clinical cases of cats brought to the surgery ward for various conditions.A total of one hundred and thirtynine cats were anaesthetised during the period of study.

The different indications for which the animals had to be anaesthetised were mainly surgical interventions such as panhysterectomies, ovario hysterectomies on pyometra cases, castrations, caesarean sections, cystotomies , amputation of limbs , wound suturing and ophthalmic surgery,Other interventions included extraction of teeth, wiring of broken jaws,setting of fractures,catheterization and removal of foreign bodies from the pharynx.

SURGICAL INTERVENTION	TOTAL	K	KA	KL	KS	KD
Castration	17	3	3	5	2	4
Cystotomy	3	-	-	-	3	-
Pan hysterectomy	67	6	5	7	46	3
Pyometra (ovario-hysterectomy)	3	-	-	-	3	-
Caesarean section	2	-	-	-	2	-
Amputation of limb	5	-	-	1	3	1
Wound suturing	7	1	1	2	3	-
Ophthalmic Surgery	10	4	2	1	3	-
Catheterization	6	1	-	2	3	-
Rectal prolapse	3	1	-	-	2	-
Fracture setting	7	1	-	2	4	-
Hernia repair	2	-	-	1	1	-
Removal of growths	5	1	1	1	2	-
Wiring of jaw	1	-	-	-	1	-
Removal of foreign body from pharynx	1	-	-	-	1	-
Grand total	139	18	12	22	79	8

K-Ketamine HCl (Ketlar)	50mg/ml	Parke Davis and Co. Bombay.
KA-K+Atropine sulphate	0.65mg/ml	Intra-Labs, Patna.
KL-K+Chlorpromazine HCl (Largactil)	25mg/ml	May & Baker Ltd. Bombay.
KS-K+Triflupromazine (Siquil)	10mg/ml	Sarabhai, Ahmedabad.
KD-K+Diazepam (Calmpose)	5mg/ml	May & Baker Ltd. Bombay.

Since the entire study was conducted on clinical cases, it was impossible to study all the parameters in every case.Six cats from each of the five groups (K,KA,KL,KS,KD) were selected at random for statistical analysis.This analysis was conducted on induction, duration and recovery periods,body temperature, blood gas values, heart and respiratory rates.

A pilot study was conducted on a number of cases prior to the actual study to see the effects of ketamine administered alone at different doses. On the basis of these trials and the work of Beck et al.(1971) and Akusawa and Matsumara (1972) a dose of 25mg/kg bwt. was selected for the actual study.

Preanaesthetic Procedure

All the cats were weighed using a spring balance and the dose of drug to be administered was calculated.Rectal temperature , heart rates and respiratory rates were recorded.Blood was then collected anaerobically in heparinized syringes* for blood gas analysis from the femoral vein.**

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* Heparine Sodium (Beparine) 1000 I.U. units/ml Biological E. Ltd. Hyderabad.

** Arterial samples are difficult to collect in clinical cases.To obtain such samples the animal would first have to be anaesthetised to expose a superficial artery.

Anaesthetic Procedure

The calculated dose of ketamine HCl , alone or in combination with one of the four pre-anaesthetics ,was injected intramuscularly in the thigh. The following dose schedule was adopted;

Ketamine 25 mg/kg bwt.

Atropine 0.1 mg/kg bwt.

Chlorpromazine HCl 2.5 mg/kg bwt.

Triflupromazine 3.0 mg/kg bwt.

Diazepam 0.5 mg/kg bwt.

Assessment of Anaesthesia

The time taken for the animal to become recumbent following injection of anaesthetic was noted . This was taken to be the induction period and it generally coincided with the onset of a state of sedation and immobility The corneal,palpebral, pupillary, pedal,ear, laryngeal,pharyngeal and swallowing reflexes were assessed. The presence of any adverse side effects such as excessive lachrymation , salivation or shivering, were also noted. The indicated surgical intervention was then performed. Muscle relaxation,visceral relaxation and analgesia suitable for surgery were assessed during the operation. Based on these observations,suitability of a particular combination for different interventions was judged.

The total time during which the animal remained recumbent and immobile was taken as the duration of anaesthesia ,and this was noted.The time at which the animal began to regain righting reflex,mobility and

made attempts to raise its head was taken as onset of period of recovery.Recovery period was the time the animal took to maintain a sitting posture unassisted.The kind of recovery,smooth and uneventful or traumatic with rough emergence, was also observed.

Respiratory rate , heart rate and rectal temperature were noted 15 mins. and 60 mins after administering of anaesthetic. Blood for analysis was collected anaerobically from the femoral vein,in heparinized syringes, 15 mins. after anaesthesia.

Blood Gas Analysis

An attempt was made to monitor pH and PvCO2 values in blood. Syringes were flushed in a solution of heparin. The femoral vein was raised and blood was anaerobically collected from this vein.Any gas bubbles remaining in the syringe were immediately removed and the syringes were sealed with rubber stoppers and stored on ice.These samples were then transported on ice for analysis on an IL 1306 Blood Gas Analyser.

This machine quantitatively measures PCO2 (partial pressure of carbon dioxide), PO2 (partial pressure of oxygen) and pH of whole blood which is fed into the machine.

Venous blood samples are generally satisfactory for determining pH and PCO2 values but are unsuitable for PO2 values (Jung 1966 and Brobst 1984)

Statistical Analysis

Group differences for induction period, duration period and recovery period were studied by analysis of variance for one way classification. Heart and respiratory rates,rectal temperature,blood pH and blood gas were studied by analysis of variance for two way classification where

between group and between stage means were compared.Means were compared using Critical Difference Test , as per Snedecor and Cochran (1968).All statistical analyses were carried out on Micro -2200 model of Hindustan Computers Ltd.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

Dosage

Group K (Ketamine HCl 25 mg/kg)

This dose of ketamine, when injected intramuscularly, produced a state of immobility and sedation which was sufficient for performing minor surgery such as castrations and for interventions such as catheterization. This state was however unsuitable for performing any major surgical intervention, such as a panhysterectomy. This observation tallies with those of Commons (1970), Massey (1973), Beglinger and Lakatos (1974) and Jones (1979). Half the original amount of ketamine used as a supplemental dose was sufficient to prolong the duration of anaesthesia. This is in accordance with the observations of Eads (1971). Supplemental dosing created no problems. As recorded by Akusawa and Matsumara (1972), no side reactions, such as convulsions, shock or vomiting occurred with this dose.

Group KA (Ketamine HCl 25 mg with Atropine 0.1 mg/kg)

This dose combination when injected intramuscularly produced anaesthesia sufficient for all minor procedures. One cat out of twelve that received this combination, suffered convulsions during surgery. Two convulsions of thirty seconds duration, two minutes apart were noted before triflupromazine (3 mg/kg) was injected to sedate the animal.

In those animals where sufficient depth of anaesthesia was not attained, supplemental dosing using half the amount of ketamine

originally used, was resorted to. Supplemental doses created no adverse effects. None of the animals exhibited shock or vomiting during anaesthesia.

Group KL (Ketamine HCl 25 mg/kg with Chlorpromazine 2.5 mg/kg)

This dose combination was found sufficient to produce anaesthesia required for surgical intervention. In the occasional case, where the depth of anaesthesia was insufficient, supplemental dosing using half the original amount of ketamine produced the desired depth of anaesthesia. No adverse effects such as vomiting or shock were encountered with this combination.

Group KS (Ketamine HCl 25 mg/kg with Triflupromazine 3 mg/kg)

This dose combination produced a suitable anaesthetic state in most cases, which was found conducive to surgery. In a few cases this dose did not produce the required depth of anaesthesia for major procedures, but this was easily remedied by injecting half the original dose of ketamine. No adverse effects such as convulsions, shock or vomiting were seen even when used on toxaemic and uraemic cases ; this disagrees with Gaskell (1978).

Group KD (Ketamine HCl 25 mg/kg with Diazepam 0.5 mg/kg)

While this dose produced very rapid immobility and recumbency, sufficient depth of anaesthesia facilitating surgery did not prevail in most cases. Respiration was shallow and irregular with this dose and supplemental dosing was not advisable. Excessive lachrymation and salivation also occurred following this dose which was undesirable.

Induction

Induction period was taken as the average time the animal took to

become recumbent and attain a state of sedation and immobility after being injected by the drug.Surgery could commence immediately after this period was complete.

Induction of anaesthesia following an intramuscular injection of ketamine was smooth and rapid in all cases.Many animals vocalized during the time of injection and for a short period thereafter.The anaesthetic effect began with the animal crouching and weaving its head from side to side. The hind limbs were the first to be rendered immobile,followed by the forelimbs and lastly the head.Shortly after, the righting reflex was lost and the animal became recumbent.Neither struggling or excitement were observed during induction nor did any of the animals exhibit symptoms of vomiting.These observations compare favourably with those of Commons (1970) and Beck et al. (1971).

The mean induction period following an injection of ketamine (25mg/kg) given intramuscularly was 12.66 mins. (Table 1).This was much longer than the induction periods recorded by most authors (Beck et al. 1971 - 3 mins.,Akusawa and Matsumara 1972 - 4-5 mins., Beglinger and Lakatos 1973 and Massey 1973 - 5mins.) but tallies with the observations of Schmiatke and Schmidtke (1974) who recorded an induction period of 12 mins.

Induction periods were found to be shorter when preanaesthetics were used in combination with ketamine (Table 1). Group differences were studied by analysis of variance for one way classification and group means were compared by critical difference tests.All the four groups (KA, KL, KS and KD) recorded highly significant decreases in mean induction periods.Group KA recorded a mean induction period of 6.6 mins., Group KL 5.34 mins., Group KS 7.4 mins and Group KD recorded

(Table - I)

Analysis of Variance for Induction Period

Source of Variation	Degree of Freedom	Mean Squares
Between Groups	4	90.18 **
Error	27	2.52

Comparison of Means

Between Groups

1	K	12.66 ±0.84	2(*), 3(**), 4(*), 5(**)
2	KA	6.66 ±0.76	3(**), 5(**)
3	KL	5.33 ±0.47	4(**), 5(**)
4	KS	7.42 ±0.58	5(**)
5	KD	2.625 ±0.47	

N S - Non Significant
* - $p < 0.05$
** - $p < 0.01$

Note :- Number on Mean value indicates Group or Stage which differs significantly from the Mean.

the shortest at 2.625 mins.Anaesthesia,however was induced in an identical manner in all the five groups and was smooth and rapid in all cases.

Duration

This was the entire period following the induction period when the animal remained recumbent,immobile and sedated. This was the period during which actual surgery was performed.Purposeful movements made by the animal were considered an indication of lightening of anaesthesia and onset of the recovery period.Duration of anaesthesia could be extended by supplemental dosing.The mean anaesthetic period using ketamine alone was 46.67 mins. (Table 2) . This was longer than the periods recorded by Beck et al. (1971) and Akusawa and Matsumara (1972)

The four anaesthetic combinations produced considerable variation on the anaesthetic period (Table 2).The average duration of Group KA was 36.6 mins.This was not significantly different from Group K.

The anaesthetic period was the longest in Group KL with an average of 51 mins. This was significantly different from Groups KA and KD.

Group KS recorded a mean time of 45.38 mins.and Group KD recorded the shortest anaesthetic period with a mean of only 28.88 mins.This difference was highly significant as compared to Groups K and KL and significantly different from Group KS

Recovery

The time at which the animal regained mobility, righting reflex and

(Table - 2)

Analysis of Variance for Duration of Anaesthesia

Source of Variation	Degree of Freedom	Mean Squares
Between Groups	4	548.46 **
Error	27	127.74

Comparison of Means

Between Groups

1	K	46.66 ±6.28	5(**)
2	KA	36.66 ±5.2	3(**)
3	KL	51 ±4.69	5(**)
4	KS	45.33 ±4.16	5(**)
5	KD	28.87 ±2.12	

N S - Non Significant
* - $p < 0.05$
** - $p < 0.01$

Note :- Number on Mean value indicates Group or Stage which differs significantly from the Mean.

made attempts to raise its head was taken as beginning of the recovery period.The total time taken by the animal to maintain a sitting position unassisted was the period of recovery.

Recovery from ketamine induced anaesthesia was essentially a reversal of the induction process.It was initially charecterized by the animal making attempts to raise its head and move its forelimbs.Following this ,the animal invariably assumed sternal recumbency.The hind limbs were the last to regain mobility.Complete recovery when the animal was restored to a normal state took very long and extended well over seven hours in most cases.This compares favourably with the observations of Commons (1970), Beck et al. (1971),Massey (1973) and Stock (1973).

Recovery in Group K took an average of 134.16 mins. (2 hours 14 mins.).This tallies with the observations of Massey (1973).One cat out of the eighteen (5.55%) of Group K suffered a traumatic recovery accompanied by convulsions.All the others recorded a smooth, uneventful recovery.This agrees with the observations of Beck et al. (1971).

The use of premedicants in combination with ketamine prolonged recovery periods (Table 3).

Group KA recorded an average of 214 mins. This was significantly different from Group K. Recovery was smooth in all cases.

The recovery period of Group KL was 230 mins.This was also significantly different from Group K.One cat out of the twenty two (4.54%) of this group experienced rough emergence and violent convulsions which led to surgical sutures giving way.

Group KS differed highly significantly from Group K.Average recovery periods increased to 270 mins.Recovery however was smooth and

(Table - 3)

Analysis of Variance for Recovery Period

Source of Variation	Degree of Freedom	Mean Squares
Between Groups	4	15316.73 **
Error	27	3752.35

Comparison of Means

Between Groups

1	K	134.16 ±10.52	2(*), 3(*), 4(**)
2	KA	214.16 ±22.74	
3	KL	230 ±18.21	
4	KS	270 ±47.74	5(*)
5	KD	190.625±8.57	

N S - Non Significant
* - $p < 0.05$
** - $p < 0.01$

Note :- Number on Mean value indicates Group or Stage which differs significantly from the Mean.

uneventful in all the cases.Triflupromazine produced a state of sedation which seemed to ensure smooth recovery.This tallies with the observations of Reid and Frank (1972).

Group KD recorded an average of 190 mins. which was not considered significantly different from Group K.Recovery although smooth in all the cases of this group, was not much different from when ketamine alone was used.These observations agree with those of Lo and Cumming (1971) and Reid and Frank (1972).

Effect on Body Temperature

The effect of the different drug combinations is graphically represented (Graph I)

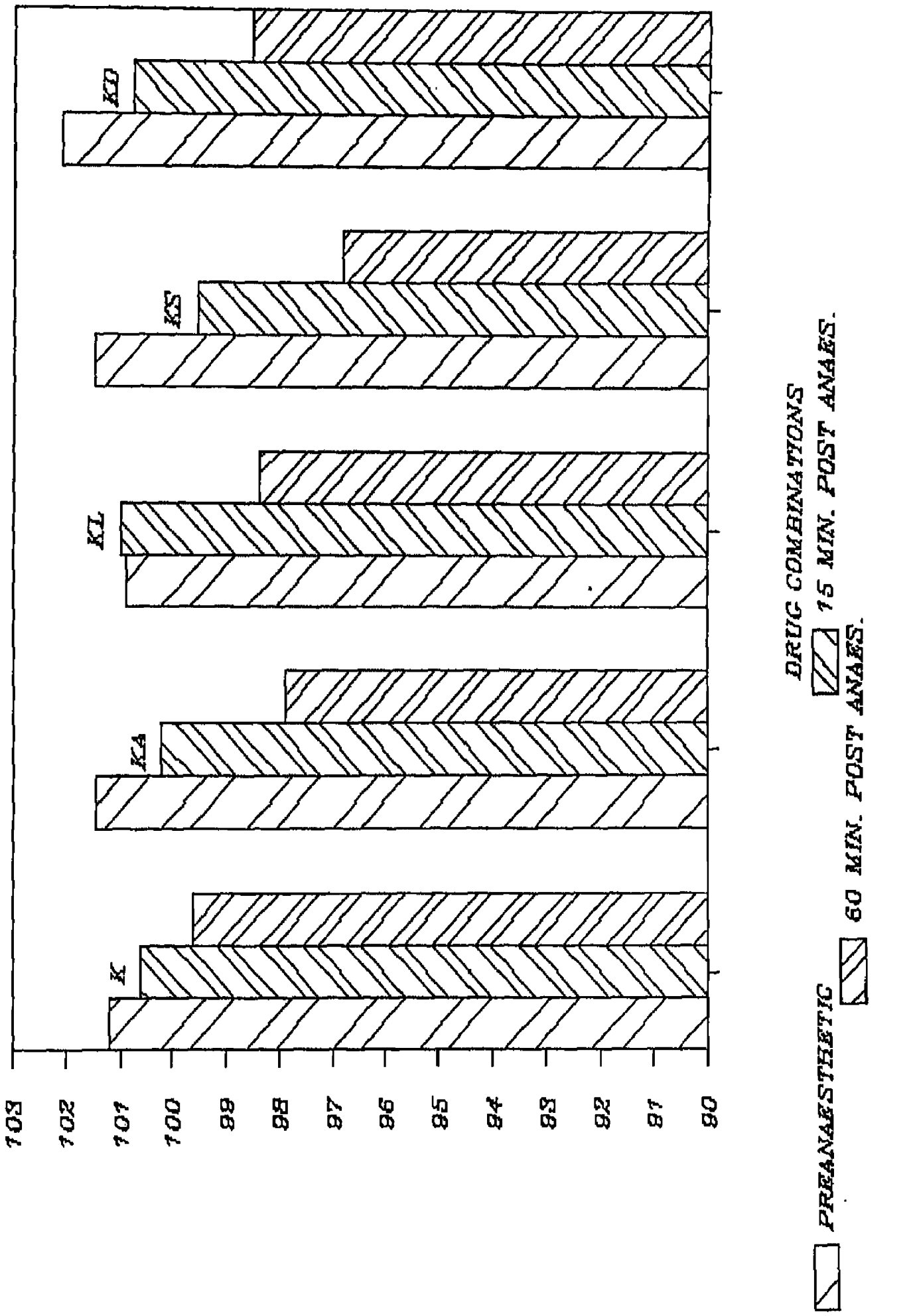
A drop in the body temperature of an average of 1.19 F (0.66 C) was noted in the first fifteen minutes and and a further drop of an average of 2.17 F (1.21 C) was noted after sixty minutes in all the five groups (Table 4).

Between group analysis however revealed that Group KS recorded the greatest fall in temperature. Beck et al. (1971) observed an average drop of 2.88 F (1.6 C) using ketamine alone. This drop in temperature although statistically significant was not considered to be of much clinical significance as none of the animals succumbed to anaesthesia and body temperatures were found to return to normal after twenty four hours.

Effect on Blood Gas and pH

The effect of different drug combinations on blood pH and PvCO2 is

(Graph - 1)


EFFECT ON BODY TEMPERATURE
TEMP. IN DEG. F
103
102
101
100
99
98
97
96
95
94
93
92
91
90
K
KA
KS
KD
PREANAESTHETIC
60 MIN. POST ANAES.
DRUG COMBINATIONS
15 MIN. POST ANAES.

(Table - 4)

Analysis of Variance for Body Temperature

Source of Variation	Degree of Freedom	Mean Squares Body Temperature
Between Groups	4	4.93 **
Between Stages	2	87.29 **
Group x Stage	8	2.01 NS
Error	75	1.36

Comparison of Means

Between Groups

1	K	100.48	
2	KA	99.86	
3	KL	100.42	
4	KS	99.28	1(**), 3(**), 5(**)
5	KD	100.46	

Between Stages

1	Preanaesthetic	101.62 2(**),3(**)
2	15 Min. Post Anaes.	100.43 3(**)
3	60 Min. Post Anaes.	98.25

N S - Non Significant
* - $p < 0.05$
** - $p < 0.01$

Note :- Number on Mean value indicates Group or Stage which differs significantly from the Mean.

graphically represented (Graphs 2,3)

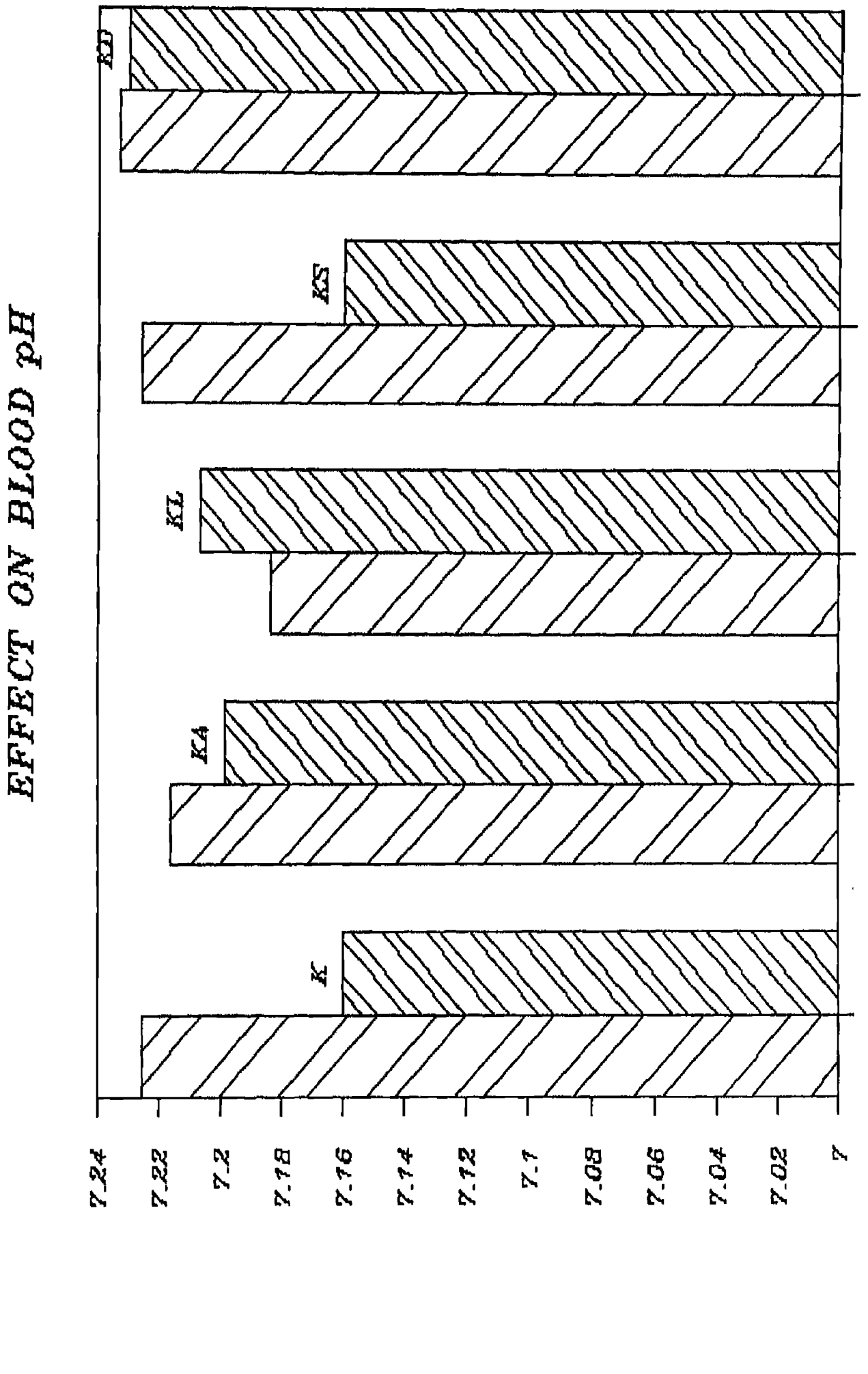
The effect of different drug combinations on blood pH and PvCO2, although variable, was not significant (Tables 5,6). From this it can be inferred that neither ketamine nor its combinations produce any appreciable change in blood pH or PvCO2 values. This is in accordance with the findings of Beck et al (1971) and Allen et al. (1986) who found that these parameters remained stable following administration of ketamine and ketamine with xylazine respectively. The most important factor in the clinical application of acid-base and blood gas analysis is the determination and control of pH (IL1306 Blood gas analyser manual). As long as the pH levels are within normal ranges it can be assumed that the physiological functions of respiration and metabolism are normal.The utility of monitoring blood gas related parameters (pH and PvCO2) is basically to ensure that these values do not register significant changes beyond normal levels due to administration of anaesthetic combinations. Absence of significant variation would thus ensure a negative correlation between anaesthetic levels in blood and pH, PvCO2 values.

Effect on Heart Rate

The effect of the different drug combinations is graphically represented (Graph 4).

No significant changes were observed either between stages or between groups (Table 7). These findings agree with those of Commons (1971), Child et al. (1972), Glen (1973) and Buyinsky and Christie (1978). They are also in accordance with those of Sanford and Colby (1982) and Ingerwerson et al. (1988) who studied the effect of a ketamine

(Graph - 2)


EFFECT ON BLOOD pH
KD
KS
KL
KA
K
7.24
7.22
7.2
7.18
7.16
7.14
7.12
7.1
7.08
7.06
7.04
7.02
7
BLOOD pH
DRUG COMBINATIONS
15 MIN. POST ANAES.
PREANAESTHETIC

(Table - 5)

Analysis of Variance for Blood pH

Source of Variation	Degree of Freedom	Mean Squares Blood pH
Between Groups	4	0.0005 NS
Between Stages	1	0.002 NS
Error	4	0.0007

Comparison of Means

Between Groups

1	K	7.19
2	KA	7.21
3	KL	7.20
4	KS	7.19
5	KD	7.23

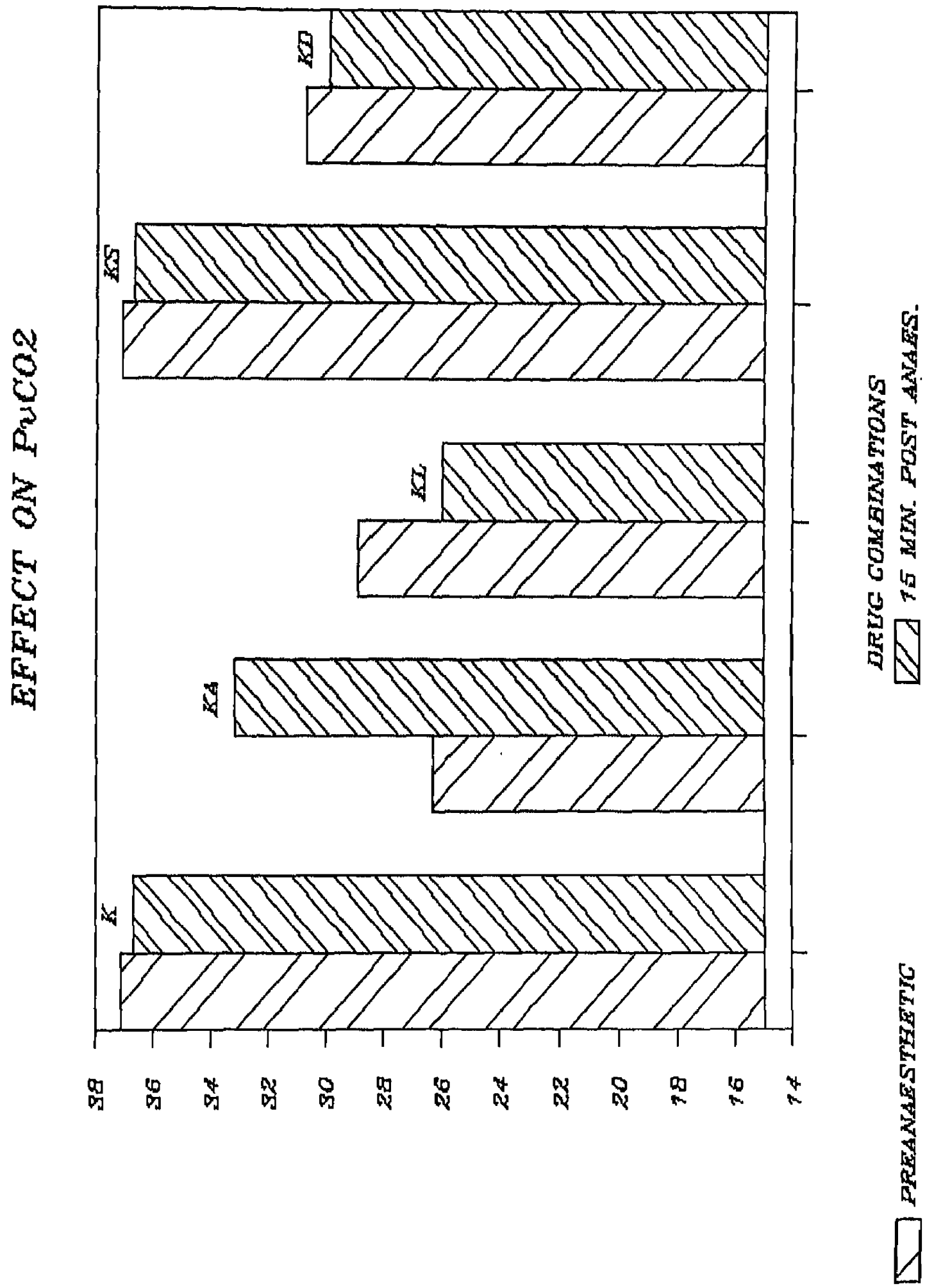
Between Stages

1	Preanaesthetic	7.22
2	15 Min. Post Anaes.	7.19

N S - Non Significant
* - $p < 0.05$
** - $p < 0.01$

Note :- Number on Mean value indicates Group or Stage which differs significantly from the Mean.

(Graph - 3)


EFFECT ON PaCO2
K
K4
KL
KS
KD
38
36
34
32
30
28
26
24
22
20
18
16
14
PaCO2
DRUG COMBINATIONS
15 MIN. POST ANAES.
PREANAESTHETIC

(Table - 6)

Analysis of Variance for Blood PvCO2

Source of Variation	Degree of Freedom	Mean Squares Blood PvCO2
Between Groups	4	38.05 NS
Between Stages	1	0.56 NS
Error	4	6.93

Comparison of Means

Between Groups

1	K	36.93
2	KA	29.76
3	KL	27.48
4	KS	36.93
5	KD	30.41

Between Stages

1	Preanaesthetic	32.06
2	15 Min. Post Anaes.	32.54

N S - Non Significant
* - $p < 0.05$
** - $p < 0.01$

Note :- Number on Mean value indicates Group or Stage which differs significantly from the Mean.

acepromazine combination on heart rate.

These observations are of significance as they are a preliminary indicator that ketamine alone or in combination with either of the four preanaesthetics does not overtly interfere with the normal functions of the heart. This assumes importance in making a suitable choice of anaesthetic for use in very old, very young, moribund and other high risk patients.

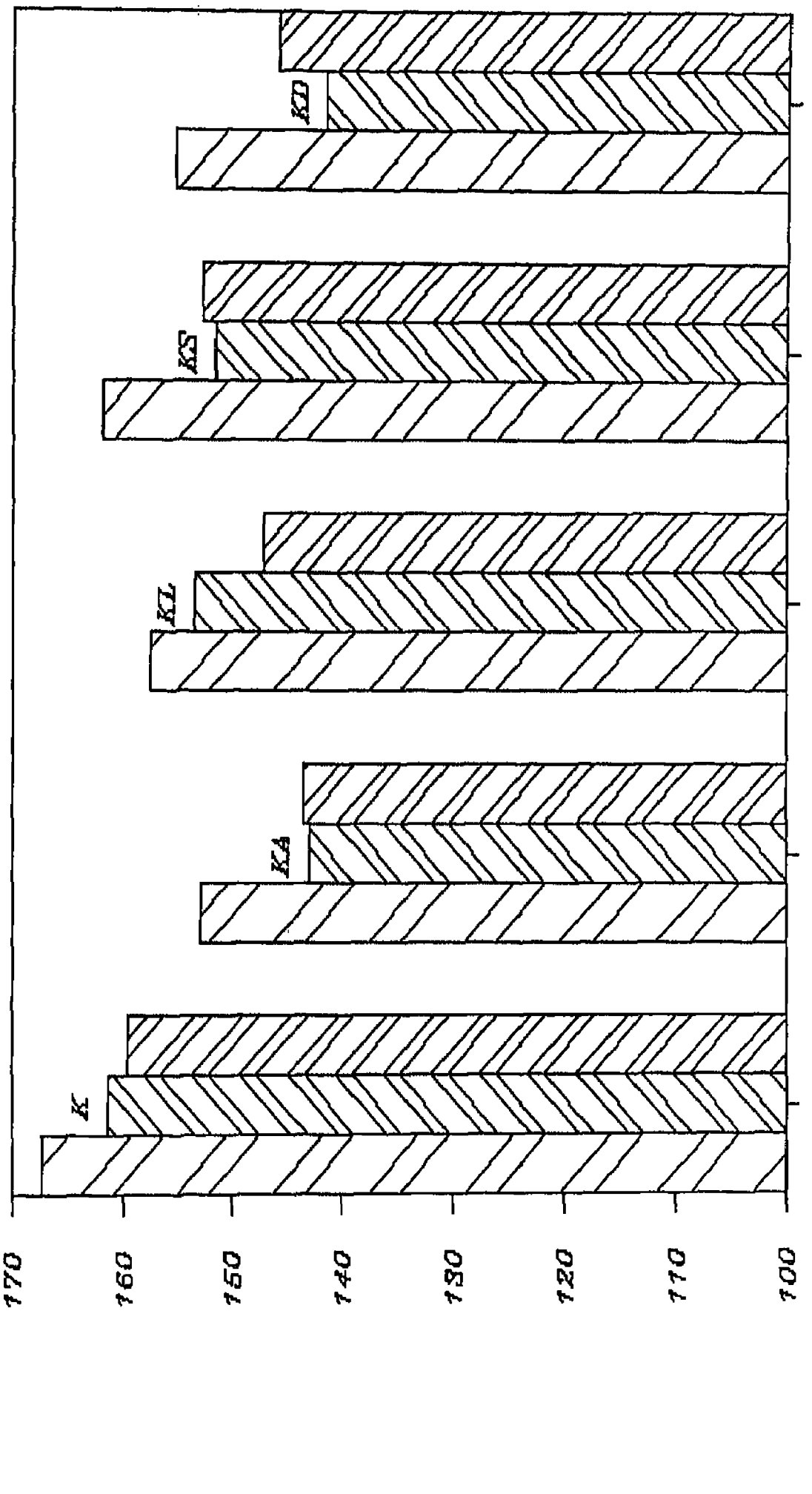
Effect on Respiratory Rate

The effect of the different drug combinations on mean respiratory rates is graphically represented (Graph 5)

Statistical analysis of the mean respiratory rates revealed marked variations between stages (Table 8). Fifteen minutes after administration of anaesthetic there was a decrease in mean respiratory rate from 30.23 per minute to 19.93 per minute . This was considered highly significant. At sixty minutes the the mean respiratory rate in all five groups rose significantly to 22.66 per minute. These findings agree with those of Buyinsky and Christie (1978) who observed the same fluctuations in respiratory rate using a commercial preparation (Keta set) containing a combination of ketamine, centrine and promazine. Sanford and Colby (1982) observed similar changes with a combination of ketamine with acepromazine and xylazine.

Between group variations were revealing (Table 8) . While there were no significant differences in the mean respiratory rates of Groups K, KA, KL and KS there was a marked decrease in the mean respiratory rate of Group KD, which was considered highly significant. It was

(Graph - 4)


EFFECT OF DRUG COMBINATIONS ON HEART RATE
HEART RATE PER MINUTE
170
160
150
140
130
120
110
100
K
KA
KL
KS
KD
PREANAESTHETIC
60 MIN. POST ANAES.
DRUG
15 MIN. POST ANAES.

(Table - 7)

Analysis of Variance for Heart Rate per minute

Source of Variation	Degree of Freedom	Mean Squares Heart Rate
Between Groups	4	771.52 NS
Between Stages	2	787.37 NS
Group x Stage	8	30.79 NS
Error	75	371.46

Comparison of Means

Between Groups

1	K	162.78
2	KA	146.61
3	KL	152.83
4	KS	155.44
5	KD	147.61

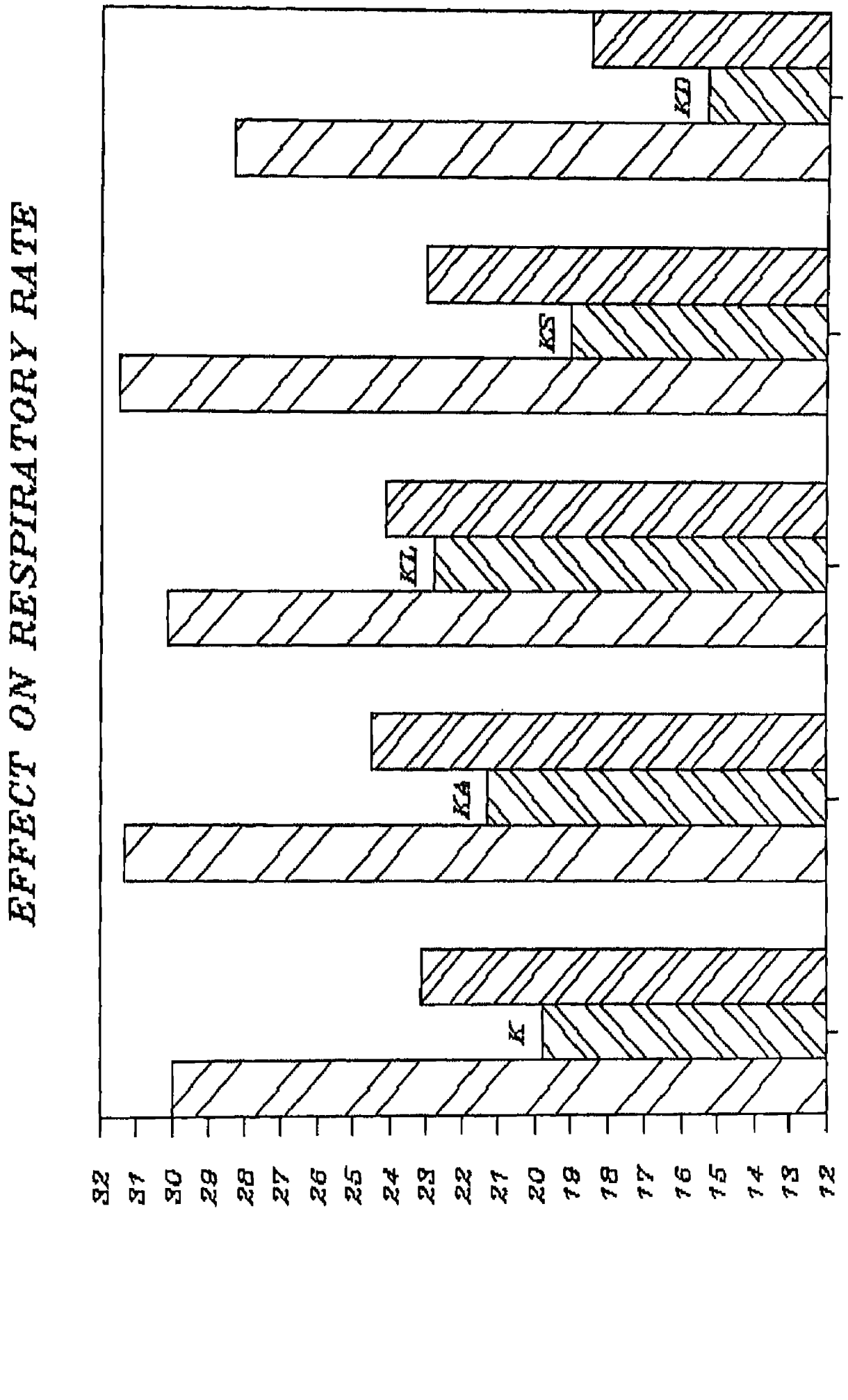
Between Stages

1	Preanaesthetic	158.97
2	15 Min. Post Anaes.	150.3
3	60 Min. Post Anaes.	149.9

N S - Non Significant
* - $p < 0.05$
** - $p < 0.01$

Note :- Number on Mean value indicates Group or Stage which differs significantly from the Mean.

(Graph - 5)


EFFECT ON RESPIRATORY RATE
KD
KS
KL
K4
K
32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12
R.R PER MINUTE
DRUG COMBINATIONS
PREANAESTHETIC
60 MIN. POST ANAES.
15 MIN. POST ANAES.

(Table - 8)

Analysis of Variance for Respiratory Rate per minute

Source of Variation	Degree of Freedom	Mean Squares Respiratory Rate
Between Groups	4	62.47 **
Between Stages	2	854.07 **
Group x Stage	8	7.27 NS
Error	75	19.62

Comparison of Means

Between Groups

1	K	24.33 5(**)
2	KA	25.72 5(**)
3	KL	25.72 5(**)
4	KS	25.44 5(**)
5	KD	21.16

Between Stages

1	Preanaesthetic	30.23 2(**),3(**)
2	15 Min. Post Anaes.	19.93 3(**)
3	60 Min. Post Anaes.	22.66

N S - Non Significant
* - $p < 0.05$
** - $p < 0.01$

Note :- Number on Mean value indicates Group or Stage which differs significantly from the Mean.

also qualitatively observed that the respiration following anaesthesia with KD was shallow and irregular, interrupted by short periods of apnoea. From this it may be inferred that the KD combination caused significant respiratory depression. These findings differ from those of Lee et al. and Clement (1981) who did not find any change in respiration using the same drug combination. Respiration overtly appeared normal in Groups K,KA,KL and KS in spite of lowered respiratory rates.

Assessment of Body Reflexes, Muscle Relaxation and Analgesia

Ketamine does not abolish most reflexes unlike traditional anaesthetics. As observed by Jones (1979) the condition is more one of clinical unresponsiveness, characterised by analgesia and immobility. Persistence of skeletal muscle tone and inadequate muscle relaxation have made the use of preanaesthetics in combination with Ketamine essential (Reid and Frank 1972, Glen 1973, Amend et al. 1974 and others). An attempt will be made here to first discuss the effect of Ketamine alone on the various body reflexes and to compare them with the effects of each of the drug combinations KA, KL, KS and KD. (For details of operations performed under each drug combination , please refer to Table in Chapter "Material and Methods".)

Group K

Following the administration of Ketamine, the pupils were found to dilate. They did not constrict in response to light.The corneal reflex was present and the eyelids remained open throughout.

Pharyngeal, laryngeal and swallowing reflexes persisted.Excessive salivation was noticed in a number of cases along with continuous licking of lips. Ear reflex was not abolished. The pedal reflex was easily stimulated and there was increased muscle tone, especially of the fore limbs. Visceral relaxation was poor but anaelgesia was reasonably profound. Lack of sufficient abdominal relaxation made surgery in that region difficult. These findings agree with those Commons (1970), Beck et al. (1971), Glen (1973) and Jones (1979).

Group KA

This combination did not dull the corneal or palpebral reflexes and eyes remained open throughout.Pupils were dilated and did not constrict in response to light.No lachrymation was observed in any of the cases.Pharyngeal and laryngeal reflexes persisted as did swallowing.No salivation was observed These agree with the observations of Glen(1973).The ear reflex remained.The pedal reflex was easily stimulated and the hypertonus observed, when ketamine alone was used did not diminish.Shivering was noted in one case and another case recorded convulsions.Visceral relaxation and analgesia were not found to be much more than when ketamine alone was used.Surgery in the abdominal region was not facilitated by using this combination.

Group KL

This combination seemed to produce a slightly greater degree of sedation.In the occasional case eyelids remained closed.Pupils were dilated but unresponsive to light.Lachrymation was observed in a few cases.Palpebral and corneal reflexes were slightly

sluggish.Pharyngeal, laryngeal and swallowing reflexes remained in all cases.Excessive salivation was present in some cats which was considered undesirable.The ear reflex was absent in a few cases.Pedal reflex was easily stimulated and increased skeletal muscle tone was initially observed but disappeared as anaesthesia progressed.Visceral relaxation and analgesia were good and surgery in the abdominal region could be easily performed.

Group KS

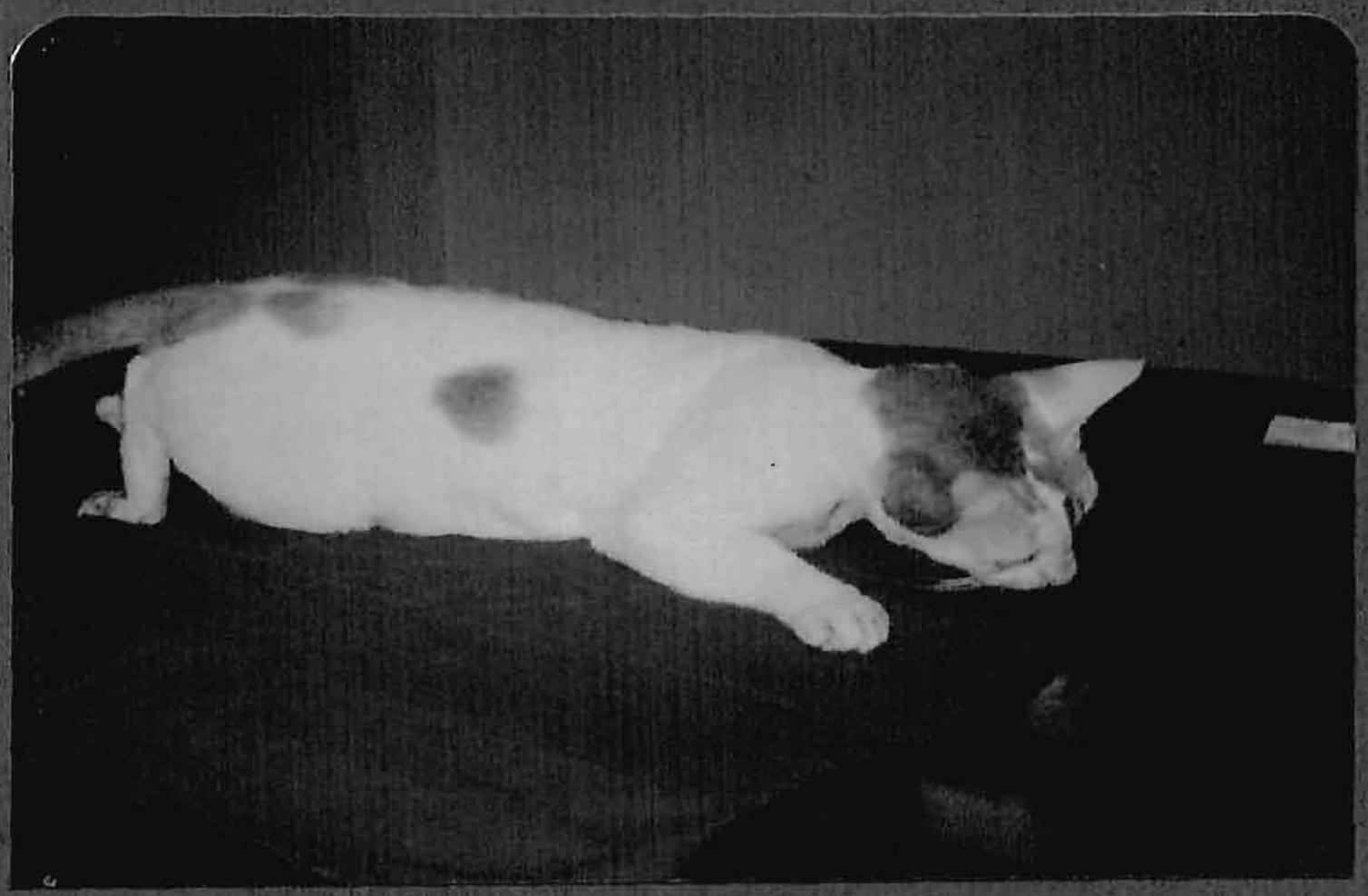
This combination seemed to provide the greatest sedation.Pupils were dilated and as anaesthesia progressed in many cases the eyelids closed.Palpebral and corneal reflexes were sluggish.There was no pupillary response to light.No lachrymation was observed in any of the cases.Pharyngeal, laryngeal, swallowing and licking reflexes persisted but excessive salivation was never apparent.The ear reflex was absent in some cases.The pedal reflex was mostly present and an initial stiffening of skeletal muscles was observed.Skeletal muscle tone decreased considerably as anaesthesia progressed and was later found absent in most cases.Visceral relaxation and analgesia were profound and the anaesthetic combination was conducive to abdominal surgery.This drug combination produced an anaesthetic state ideal for surgical intervention.Reid and Frank (1972) had obtained similar favourable results with a trifluprom azine ketamine combination.

Group KD

With this combination the pupils were dilated and fixed.They did not respond to light.The nictitating membrane prolapsed in a few cases.Palpebral and corneal reflexes were present but dull and the

eyes remained open.Excessive lachrymation was observed in a number of cases.Pharyngeal, laryngeal and swallowing reflexes were present with frequent licking movements.Considerable salivation was observed in a number of cases.Ear reflex was not abolished.Skeletal muscle tone diminished slightly but the pedal reflex remained.Shivering was noted in an occasional case.Visceral relaxation and analgesia were slightly enhanced. Abdominal surgery was not greatly facilitated by this combination.These findings agree with those of Lo and Cumming (1971) and Reid and Frank (1972).

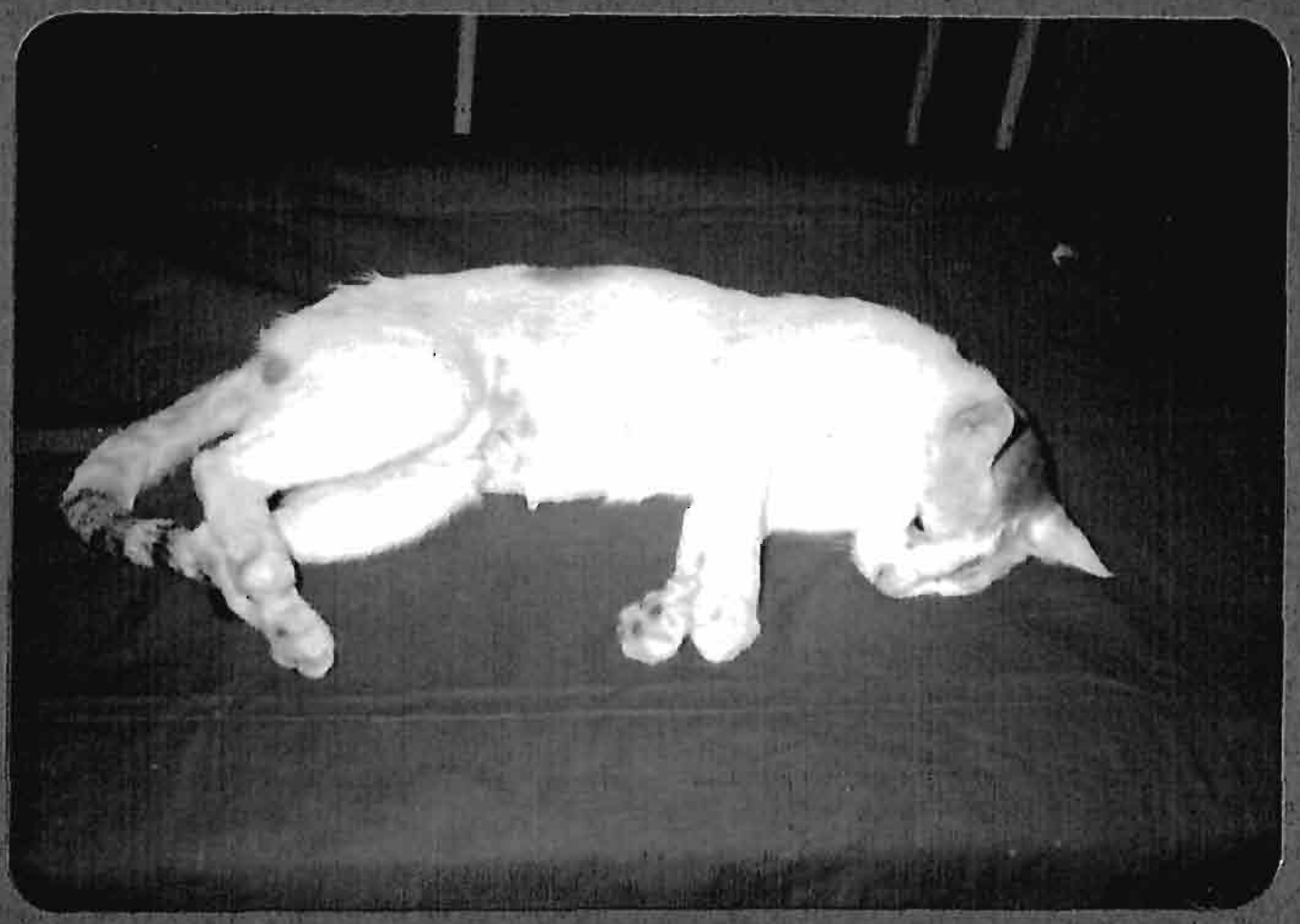
SEQUENCE OF EVENTS FOLLOWING I/M ADMINISTRATION OF KETAMINE I-4



1. Sternal Recumbency and Dropping of Head 5mins

2. Loss of Righting Reflex 10 mins

3. Hypertonus (Rigidity) of Skeletal Muscles '20 mins



4. Lightening of Anaesthesia 40mins

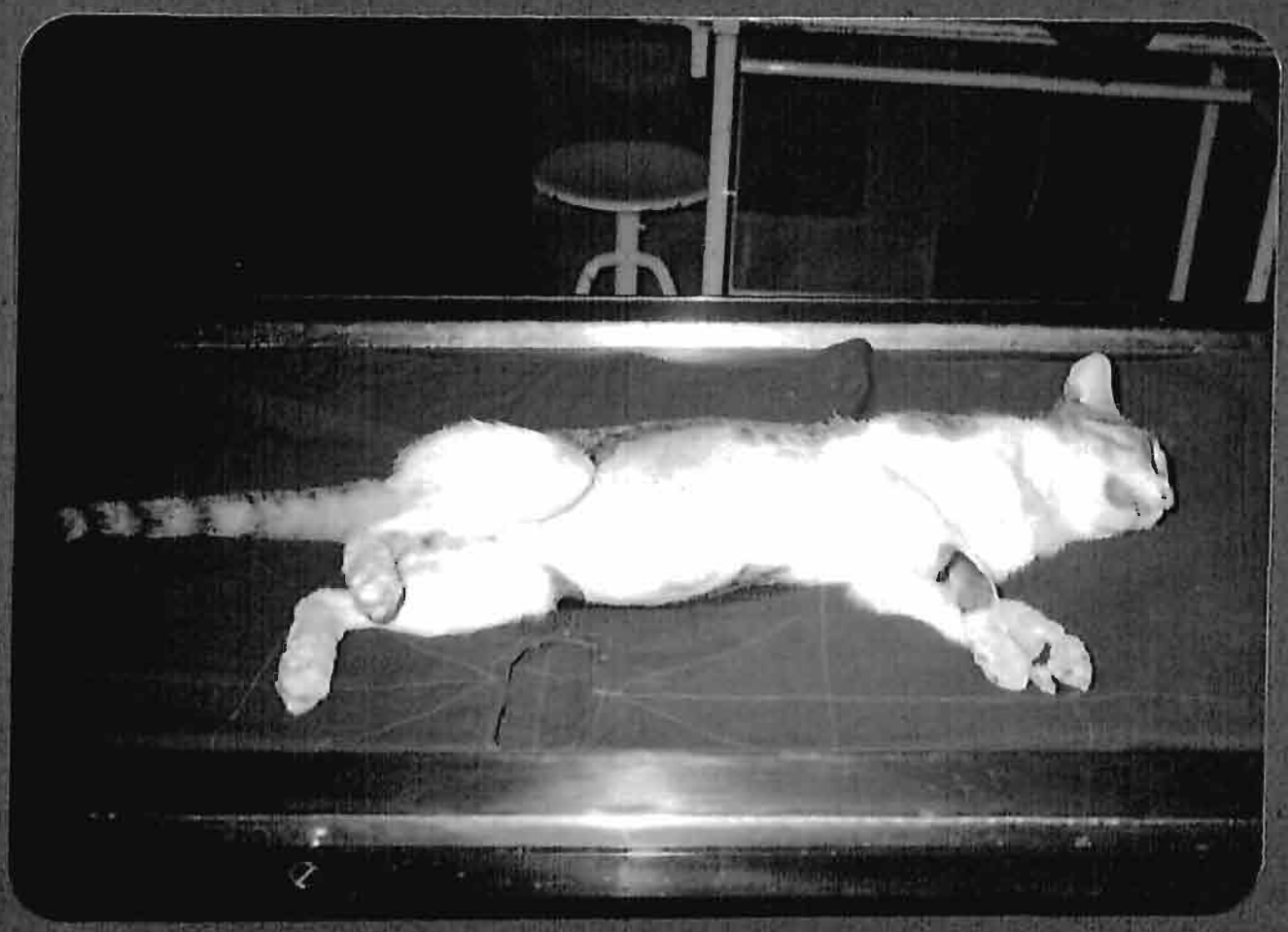
SEQUENCE OF EVENTS FOLLOWING I/M ADMINISTRATION

OF KETAMINE WITH TRIFLUPROMAZINE 5-8

5. Animal Crouching , Pupils Dilated 3 mins

6. Sternal Recumbency with Dropping of Head 5 mins.

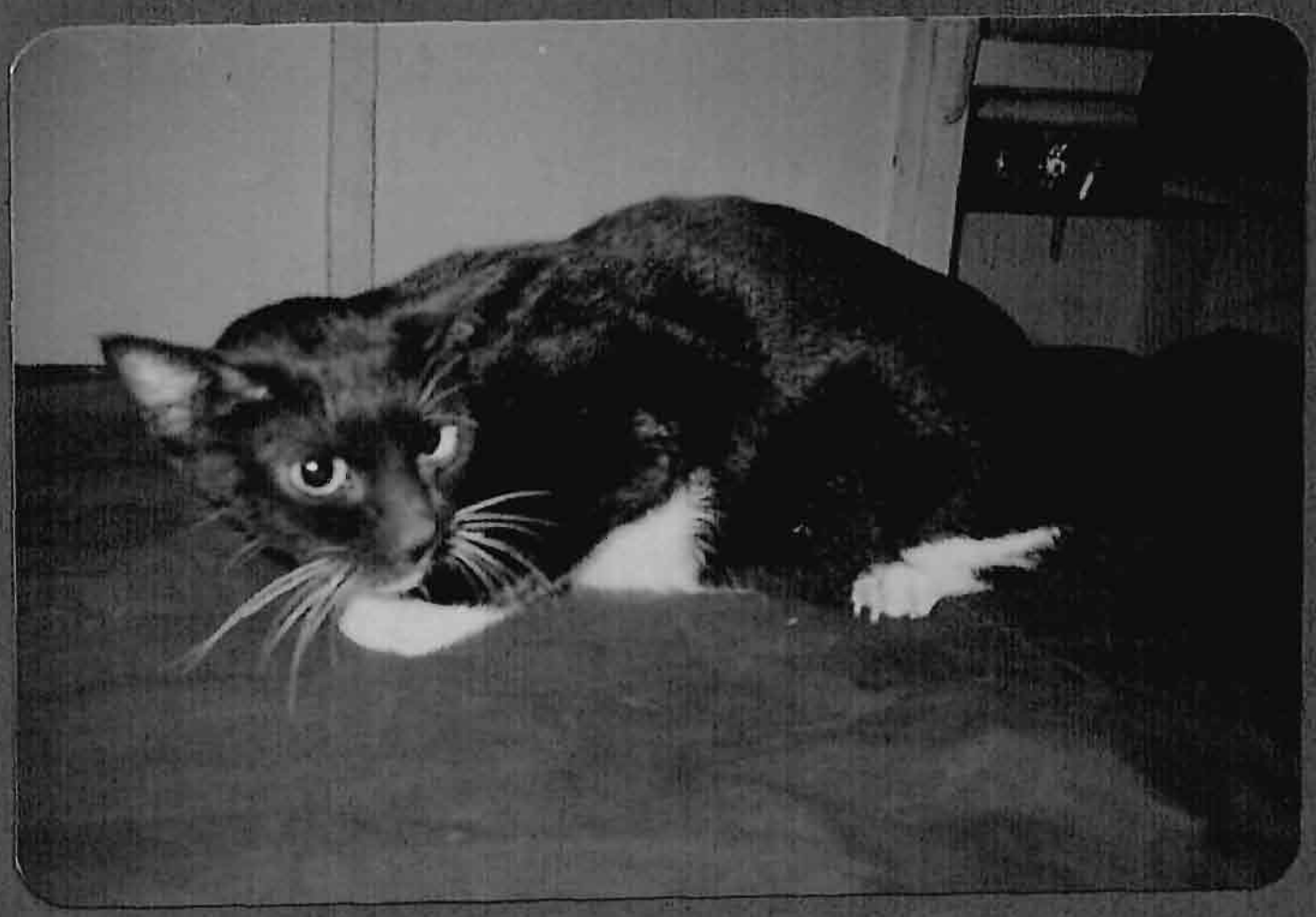
7. Loss of Righting Reflex 8 mins



8. Animal Sedated , Relaxed with Eyes Closed 20 mins

(Just Prior to Surgery)

SEQUENCE OF EVENTS FOLLOWING I/M ADMINISTRATION OF KETAMINE WITH CHLORPROMAZINE 9 - I2

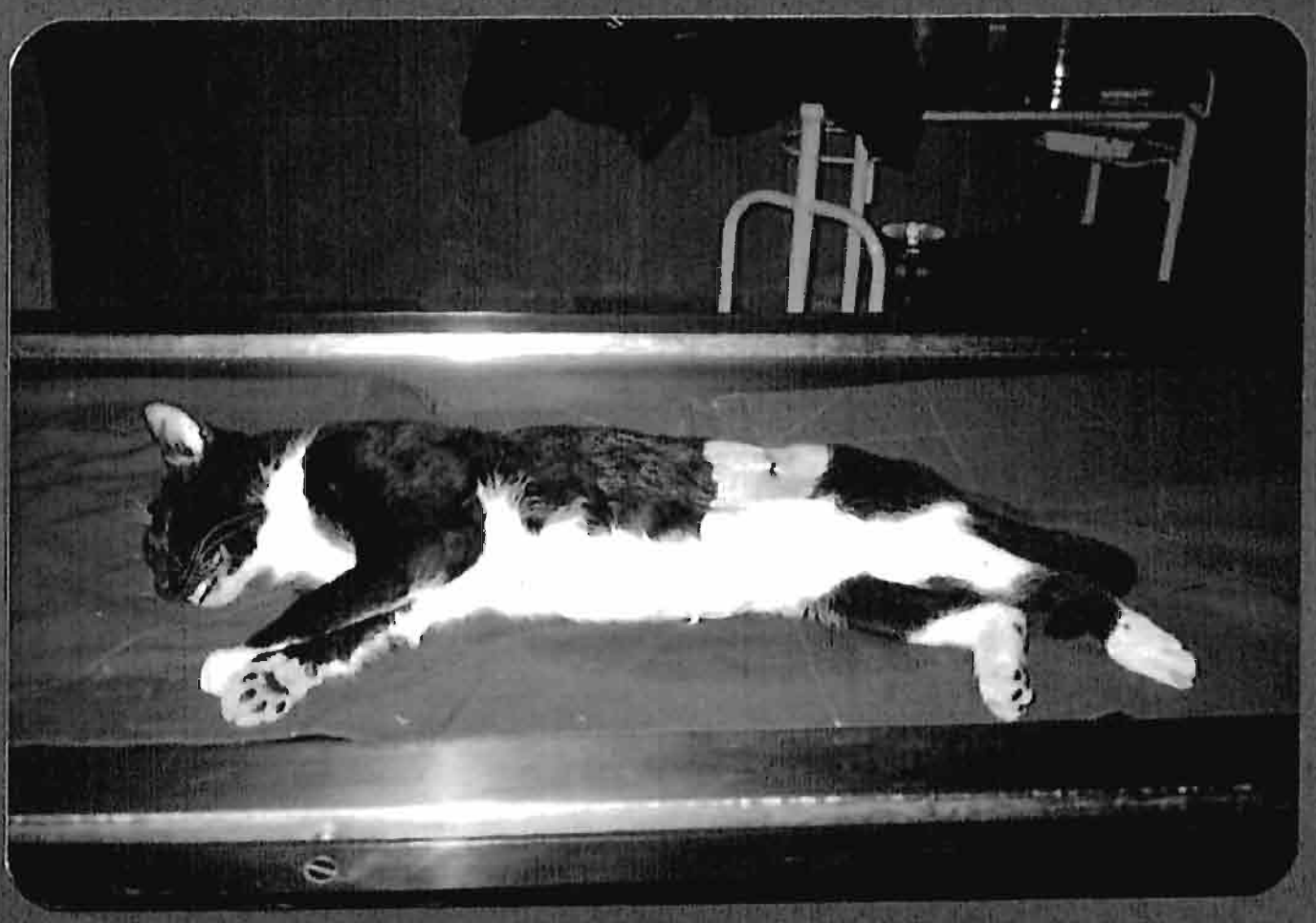


9. Animal Crouching , Pupils Dilated 2 mins

IO. Loss of Righting Reflex 5 mins

II. Animal Sedated , Relaxed with Eyes Closed 20 mins

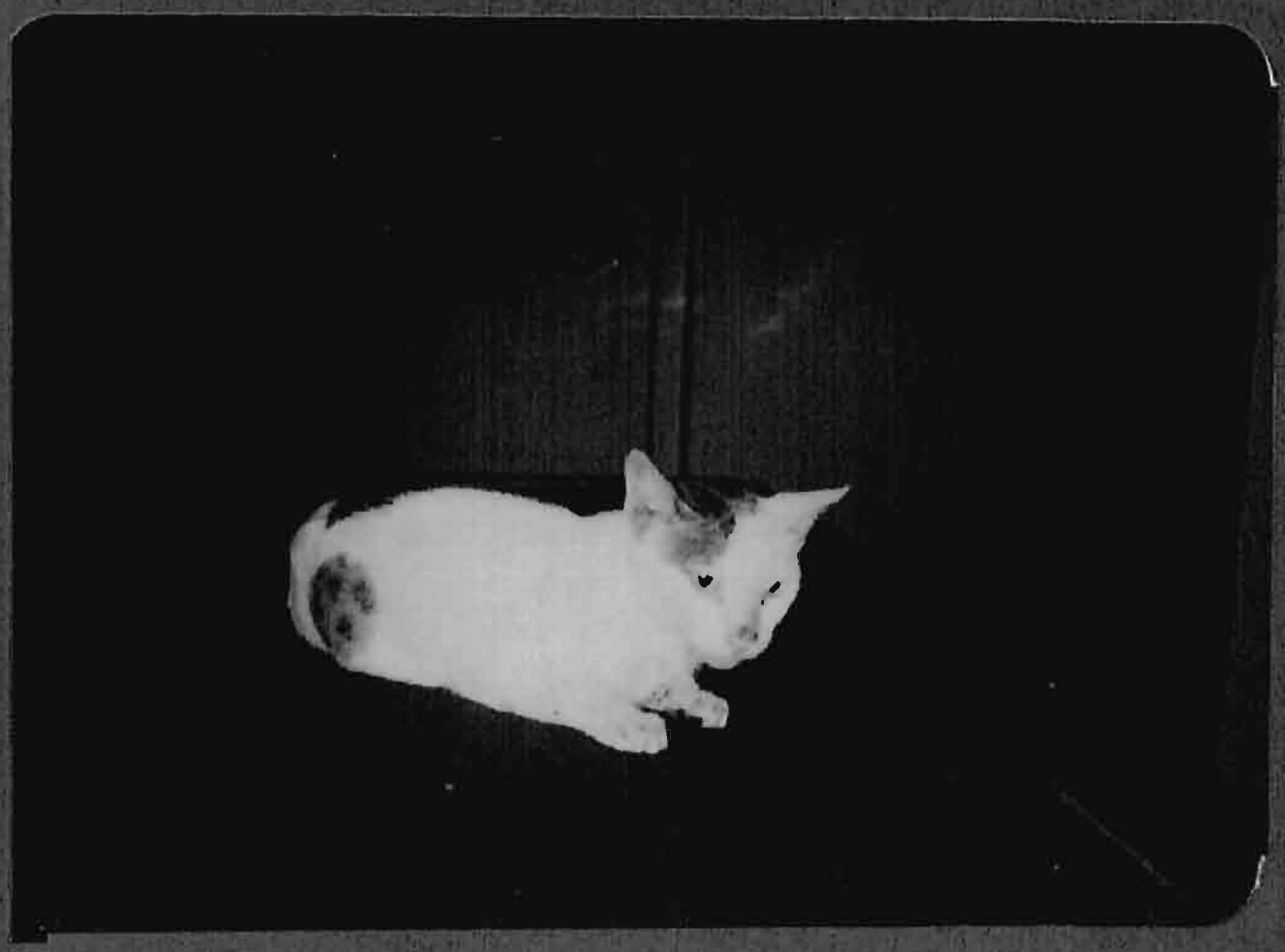
(Just Prior to Surgery)



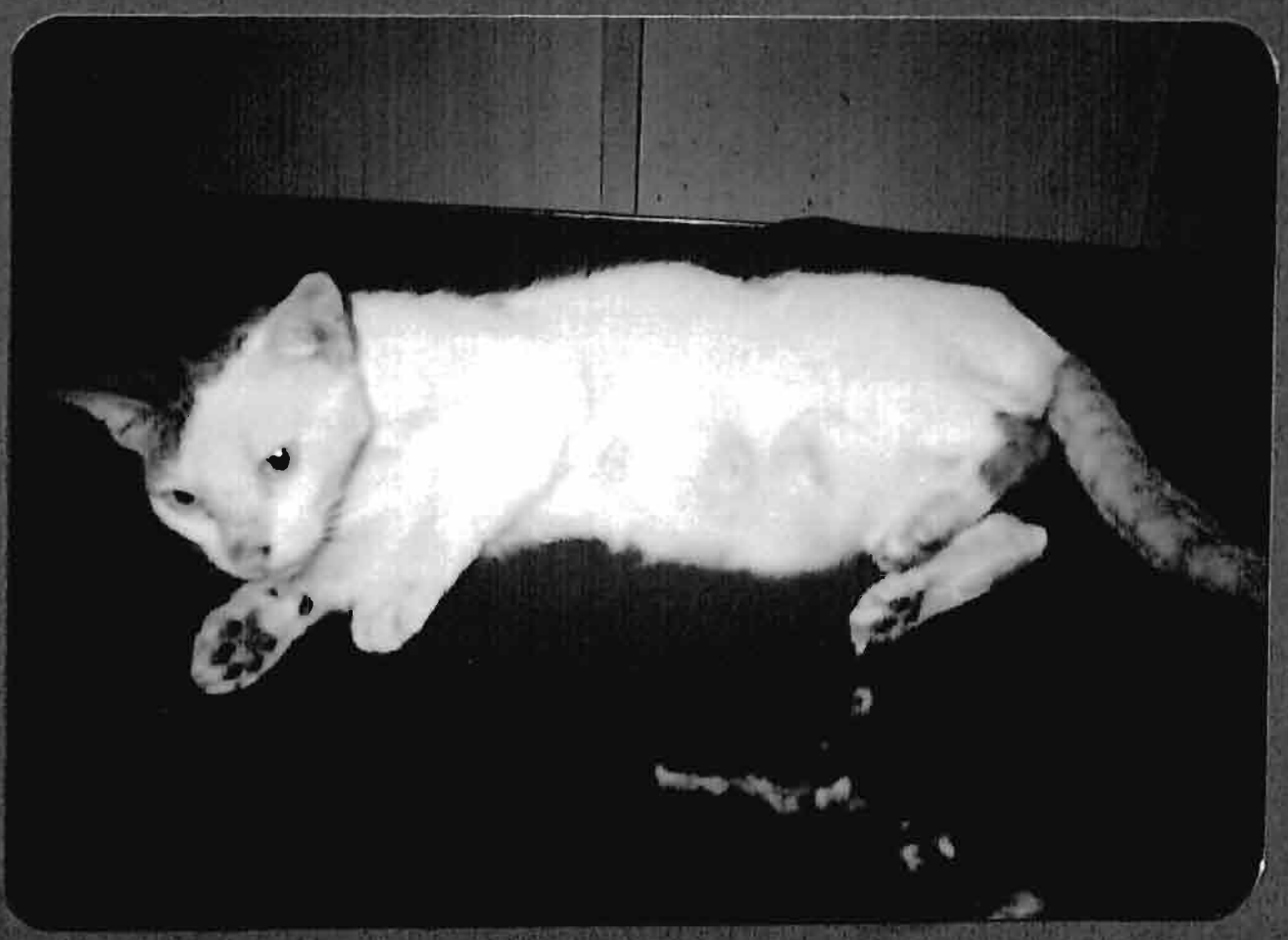
I2. Animal Still Under Effect Of Anaesthesia 40 mins

(Post Surgery)

SEQUENCE OF EVENTS FOLLOWING I/M ADMINISTRATION OF KETAMINE WITH DIAZEPAM I3 - I6



I3. Animal Quiet, Soon After Injection , Pupils Dilated Imin



I4. Rapid Loss of Righting Reflex 2 mins

I5. Pupils Fixed and Dilated. Lachrymation and Salivation present

I6. Animal Prior to Surgery. Inadequate Depth of Anaesthesia 20 mins

17. Recovery from Anaesthesia . Animal able to raise Head

SUMMARY

AND

CONCLUSIONS

SUMMARY AND CONCLUSIONS

The present study was undertaken to evaluate anaesthesia in cats using Ketamine HCl, alone and in combination with four different preanaesthetics, namely Atropine sulphate, Chlorpromazine HCl,Trifluprom azine and Diazepam.This study was conducted on one hundred and thirty nine cases.None of the animals succumbed to anaesthesia and nor were any anaesthetic emergencies encountered. All the five groups had the following advantages:

1. Easy availability
2. Ease of intramuscular administration
3. Minimal restraint required
4. No fasting required
5. Convenient dosage
6. Rapid smooth induction
7 No expensive equipment needed
8. Supplemental doses easy to administer
9. Little effect on heart rate
10. No marked change in blood pH or blood gas
11. Minimal side effects
12. Could be used on very young and very old patients

For the purposes of surgery however, the combination of Ketamine HCl (25 mg/kg) with Trifluprom azine (3 mg/kg), Group KS, proved the most suitable.

The advantages of this combination over the other four were:

1. Adequate muscle relaxation for major surgical interventions
2. No adverse effect on respiration
3. No salivation, lachrymation or shivering seen in any of the cases
4. Smooth recovery in all the cases
5. No incidence of convulsions in any of the cases
6. Supplemental dosing does not cause adverse effects
7. Could be safely used on high risk, shock and toxaemic patients (pyometra, dystokia and uraemic cases).

The drawbacks noted with the other combinations are summarised as follows:

Group K: Ketamine HCl (25 mg/kg)

- o Muscle relaxation not adequate for major surgical procedures
- o Excessive salivation and lachrymation observed in a number of cases
- o Incidence of convulsions during recovery

Group KA: Ketamine HCl (25mg/kg) with Atropine (0.1mg/kg)

- o Muscle relaxation often not sufficient for surgical intervention
- o Occasional cases suffered convulsions and shivering

Group KL: Ketamine HCl(25mg/kg) with Chlorpromazine HCl(2.5mg/kg)

- o Excessive salivation and lachrymation were observed in a number of cases
- o Smooth recovery (without convulsions) not assured with this

combination

Group KD: Ketamine HCl(25mg/kg) with Diazepam (0.5mg/kg)

- o Muscle relaxation not adequate for many surgical interventions
- o Excessive salivation and lachrymation observed in many cases
- o Respiratory system adversely affected and this makes supplemental dosing unadvisable

Following these observations it is concluded that the combination of Ketamine HCl with Triflupromazine produces safe and dependable anaesthesia in cats of all ages. It is also ideal for use in high risk, toxaemic patients as it does not produce any undesirable side effects. This combination is highly recommended for regular clinical use.

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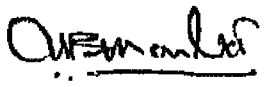
CERTIFICATE

The Viva-Voce Examination of Nitya Sambamurti Ghotge was conducted on 7th March 1989 and the necessary corrections/ modifications suggested by the external examiner and advisory committee members have been duly carried out and the thesis is submitted in the bound form for onward transmission.



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