EXPERIMENTAL CANINE SURGICAL EXPLORATIONS UNDER SUBCUTANEOUSLY (KETAMINE) IN DUCED ANAESTHESIA WITH CHLORPROMAZINE PREMEDICATION IN DOGS.

BY

BABALOLA SAMUEL ADEOLA.

DEPARTMENT OF VETERINARY SURGERY AND MEDICINE, FACULTY OF VETERINARY MIDICINE
AHMADU BELLO UNIVERSITY
ZARIA.
NIGERIA.

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ANAESTHESIA WITH CHLORPROMAZINE PREMEDICATION IN DOGS.

BY

BABALOLA SAMUEL ADEOLA. (DVM 1997)
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DEPARTMENT OF VETERINARY SURGERY AND MEDICINE, FACULTY OF VETERINARY MIDICINE.
AHMADU BELLO UNIVERSITY, ZARIA.
NIGERIA.

DECLARATION.

I declare that the work in this thesis entitled EXPERIMENTAL CANINE SURGICAL EXPLORATIONS UNDER SUBCUTANEOUSLY (KETAMINE) INDUCED ANESTHESIA WITH CHLORPROMAZINE PREMEDICATION IN DOGS has been performed by me in the Department of Veterinary Surgery and Medicine Faculty of Veterinary Medicine Ahmadu Bello University Zaria under the supervisions of:
DR. A.Z.HASSAN, PROFESSOR. E.O. GYANG and DR. D.A.Y. ADA WA.
The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis had been presented for another degree or diploma at any University.

……. ……

Babalola Samuel Adeola (DVM 1997)
Name and Signature of student. Date.

CERTIFICATION

This thesis entitle EXPERIMENTAL CANINE SURGICAL EXPLORATION UNDER SUBCUTANEOUSLY (KETAMINE) INDUCED ANESTHESIA WITH CHLORPROMAZJNE PREMEDICATION IN DOGS by
Babalola Samuel Adeola (DVM 1997) meets the regulations governing the award of the degree of Master of Science (MSc), of Ahmadu Bello University, Zaria, Nigeria and is approved for its contribution to knowledge and literary presentation.

…….. ……..
Dr. A.Z. Hassan (D.V.M, MSc, PhD) Date
Department of Vet. Surgery and Medicine,
Faculty of Veterinary Medicine,
Ahmadu Bello University Zaria Nigeria.
Chairman Supervisory Committee.

……. ……
Professor E.O. Gyang (D.V.M, MS, PhD). Date
Department of Vet. Surgery and Medicine,
Faculty of Veterinary Medicine,
Ahmadu Bello University Zaria Nigeria.
Member, Supervisory Committee.

……. ……
Dr. D.A.Y. Adawa (D.V.M, MSc, PhD) Date
Veterinary Teaching Hospital,
Ahmadu Bello University Zaria Nigeria.
Member, Supervisory Committee.

…… ……
Professor A.B. Ogunkoya (D.V.M, MSc, PhD) Date
Head of Department
Department of Vet. Surgery and Medicine,
Faculty of Veterinary Medicine,
Ahmadu Bello University Zaria Nigeria.

……. ……..
Prof. Nkom S. A (BSc, PhD) Date
Dean of Postgraduate School

DEDICATION

To my wife: OLUWATOYIN

My children: -DEVINE-FAVOUR
-TRIUMPHANT
-EXCEL

ACKNOWLEDGEMENT:

"It is not of him, who wills, nor of him who runs, but of GOD who shows mercy" (Rom.9:16). I really appreciate GOD for divine speed, grace and divine enablement for accomplishment of my Post Graduate programme. "I am the LORD, that is MY name; and MY glory I will not give to another, nor MY praise to carved images" (Ish.42:8.).

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My parent's, Mr. and Mrs. T.S.B. Babalola. "lya ni wura, baba ni giji ola" Your numbers of days the Lord shall fulfill and you shall leave to eat the fruits of your labours, in JESUS name Amen.

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"The LORD of host has sworn, saying, "Surely, as I have thought, so it shall come to pass, And as I have purposed, so it shall stand" (Isah. 14:24).

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ABSTRACT.

This study was undertaken to explore the possibility or otherwise of conducting invasive (gastrotomy) and non invasive (intergumentry (H-plasty)) surgical procedures following subcutaneous administration of ketamine hydrochloride in dogs. Twenty four (24) Nigerian indigenous dogs were used for the study, 10 underwent integumentry (H-plasty) procedures, while 10 underwent gastrotomy procedures. They were premedicated with chlorpromazine at a dose of 3.0 mg/kg and atropine at a dose of 0.03 mg/kg, employing the intravenous and intramuscular routes respectively. Ketamine was administered subcutaneously at an initial dose of 10 mg/kg and the dogs evaluated for surgical anaesthesia using standard assessment protocol and thereafter subjecting them to the above mentioned surgical procedures. During surgery, basic anaesthetic parameters were monitored and recorded.

A concurrent observational study was carried out on four other Nigerian indigenous dogs; they were premedicated with chlorpromazine at a dose of 3.0 mg/kg, atropine at a dose of 0.03 mg/kg intravenously and intramuscularly respectively and anaesthetized with thiopental intravenously at an initial dose of 10 mg/kg. Being the standard anaesthetic protocol used at the Ahmadu Bello University Veterinary Teaching Hospital, Small Animal Surgery Unit.

At the end of the study, 10 mg/kg single administration and 14.5 mg/kg total multiple administration of ketamine were judged adequate for integumentry and gastrotomy procedures respectively.

CHAPTER 1

INTRODUCTION

Anaesthetics are a group of drugs that abolish sensory perception due to their effect on the nervous system locally or systemically, resulting in anaesthesia (Hassan and Hassan, 2003). It is the state of anaesthesia that enables a surgeon to perform operations and or manipulations on patients with ease and without resistance from the patients.

Classes of anaesthesia: 1. Local anesthesia is achieved by blocking the peripheral or regional nerve innervations to a target surgical site without loss of consciousness.

2. General anesthesia results from administration of anesthetics systemically and acts directly or indirectly on the central nervous system rendering the patient unconscious (Glen, 2004). The process is however reversible

The choice of drug is often determined by the nature and duration of the surgical procedure.

At the Ahmadu Bello University Veterinary Teaching Hospital (A.B.U.V.T.H) Zaria, Small Animal Surgery Unit, most surgical procedures are performed after induction of general anesthesia using Barbiturate such as thiopental (Anesthetic). However, it's been documented that surgical anesthesia can be induced by subcutaneous administration of ketamine hydrochloride (Anesthetic) at a dose rate of 10 mg/kg in dogs (Babalola, 1995).

1.1. Objectives

Babalola (1995) conducted a preliminary study on the subcutaneous and rectal routes for the induction of ketamine hydrochloride anesthesia in dogs. He found out that 10 mg/kg

of ketamine administered subcutaneously at the dorsal neck fold produced anesthesia in the dogs.

This study is to ascertain the possibility of conducting

1. Gastrotomy and H-plasty surgical procedures following subcutaneous administration of ketamine HC1 anesthetic at 10 mg/kg.

2. Determine suitable dosage of ketamine HC1 for the performance of the stated surgical procedures.

1.2. Justification

The evaluation of the subcutaneous route for the induction of surgical anesthesia using ketamine anesthetic in dogs is significant because of:

I. Availability and non restriction of sale of ketamine in Nigeria.

2. Its wide range of safety margin in most domestic species.

3. Retention of pharyngeal and laryngeal reflexes with ketamine anesthesia.

4. Maintenance of temperature and essential cardiac and respiratory functions with ketamine anesthesia.

5. Psychotomimetic effect associated with the recovery phase of ketamine anesthesia.

6. Flexibility of the route of administration of ketamine.

7. Minimal anesthetic equipment and staff training is involved in ketamine administration.

The rationale for the choice of gastrotomy and H-plasty was to have representative of both an invasive and noninvasive surgical procedures; (Gastrotomy- invasive and H-plasty-non invasive).

1.3. Hypothesis

Following induction of surgical anesthesia with ketamine subcutaneously at 10 mg/kg, gastrotomy and H-plasty surgical procedures are feasible.

CHAPTER 2

LITERATURE REVIEW

2.1 ANAESTHESIA

Despite the synthesis of ether in 1540 by the German scientist Valerius Cordus, the use of anaesthetic agent (inhaled ether) was first demonstrated by Dr. Crawford W. Long, a rural doctor in Georgia anaesthetized a, patient for neck surgery in I 842 (unpublished) (Glen et al 2004). In 1846, a Boston dentist named Williams Morton demonstrated the anesthetic effect of ether in front of a live audience at Massachusetts General Hospital in a patient undergoing submandibular mass resection and as published by the Boston Daily Journal, the next day the medical world came to know the discovery of surgical anesthesia (Glen et al 2004).

Numerous other discoveries paved way for modern anaesthesia to flourish. Nerve block anesthesia with cocaine was popularized by Halsted in 1885 with epidural and spinal anesthesia emerging thereafter. Intravenous agents became popular after sodium thiopentone was first used in I 934 since then, many additional anaesthetic agents have been developed and anaesthesia emerged as an important specialized field in medicine (Glen *et al* 2004).

2.1.1 Inhalation anaesthesia; Inhalation anesthesia refers to the delivery of gasses or vapors into the body via the respiratory tract to produce anesthesia. Through uptake and distribution, some portion of the anaesthetic agent reaches the brain resulting in the lose of sensation. (Examples: Ether, Nitrous Oxide, Halothane) (Glen et al 2001).

2.1.2 Intravenous anaesthesia; Intravenous anesthesia is achieved by injecting anaesthetic into the body via the blood vessel which is then carried to the brain through

the circulatory system. These drugs are generally classified as non opioids, opioids and muscle relaxants. (Examples; Barbiturates, Ketamine, Benzodiazepines) (Glen et al 2004).

2.1.3 Thiopental; This commonly used barbiturate anesthetic has been for more than 60 years as a standard anesthetic induction agent, to which all others are compared (Greg, 2003). It is an intravenous centrally acting general anesthetic and mimics as well as enhance the action of Gama-aminobutyric acid (GABA) at the GABAA receptor complex. Thiopental (barbiturate) binding to this receptor decreases the rate of GABA dissociation and increases the duration of GABA-activated chloride channel opening (Greg 2003). At slightly higher concentrations, barbiturates directly activate chloride channel opening even in the absence of GABA, leading to "barbiturate anesthesia" (Greg, 2003).

Thiopental induces general anesthesia rapidly and pleasantly (painlessly); it acts in one arm-to-brain circulation time with maximum effect in about 1 minute and duration of about 5-8 minutes. Induction dose produces the highest blood concentration, the greatest effect on body systems and the most side effects (Greg, 2003).

2.2 KETAMINE HYDROCHLORIDE

2.2.1. Chemistry

Ketamine is a dissociative anaesthetic, originally synthesized in 1963 as an analogue to phencyclidine. Clinical trials began in 1964. The term "dissociative anesthetic" was coined to describe the state in which the patient experiences profound analgesia and amnesia while completely disconnected from his surroundings (Corssen, 1990).

All afferent information's seems to enter the brain through the thalamus; this system then sends out slightly processed sensory data to the rest of the brain. The limbic system receives data and in turn, influences everything from emotion to movement in response to these signals. By severing the connection between these two systems, the brain is cut off, or dissociated from the world (Anon. 2003).

Ketamine is chemically designated 2-(0-chloropheny 1)2-(methyl amino) cyclohexanone hydrochloride; it has two stereoisomer, R (-) and S (+). (Figure 2.la and figure 2.lb) (PDR 1992).

Ketamine is a fairly gentle anesthetic with relative benign respiratory effects, a bronchodilator and causes negligible levels of respiratory depression. It can cause increase in blood pressure and heart rate but the effects are generally only of concern in patients with pre-existing heart conditions (Kohrs and Durieut; 1998). There have been several instances of overdose with patients receiving up to 10 times the needed dosage and making an extended but complete recovery (Anon; 2007 b)

Ketamine is an antagonist at both the N-methy-D-asparate (NMDA) and non-NMDA glutamate receptors. It acts at nicotinic receptors and has also been shown to inhibit serotonin, dopamine and nor epinephrine re-uptake transporters, although its effect seems to be minimal at clinically relevant anesthetic doses (Nishimura, et al., 1998). Ketamine has an affinity roughly 10 to 20 times greater for the NMDA receptor than for the other receptors mentioned above. Antagonism at the NMDA receptor generally account for most of ketamine's psychoactive properties (Kohrs and Durieux; 1998).

The NMDA receptor is a ligand-gated ion channel that is permeable to calcium and to a lesser degree, sodium and potassium. It is naturally activated by glutamate and requires glycine as a co-agonist. It is inhibited by magnesium in a voltage-dependent manner. When the potential across the membrane depolarizes to a certain degree the Mg^{++} leaves the channel. Only when Mg leaves the channel are the co-agonists able to open it. There is also a phencyclidine binding site, this is the same site that ketamine binds to noncompetitively inhibiting the receptor (Kohrs and Durieux; 1998).

NMDA receptors have been implicated in the phenomena known as long-term potentiation (LPT), a process many investigators believe is crucial to memory formation (Dowling; 1992). They (NMDA) have also been found to mediate central sensitization, which appears to be an important factor in chronic pain and might possibly explain ketamine's analgesic properties. NMDA receptors may even play a role in mental processes such as sensory perception, cognition, and consciousness (Oye 1998).

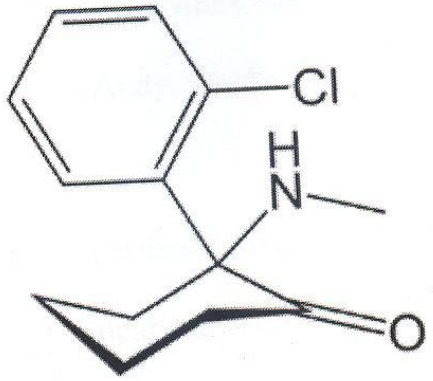


Figure 2.1a. Chemical structures of ketamine hydrochloride (Anon. 2007).

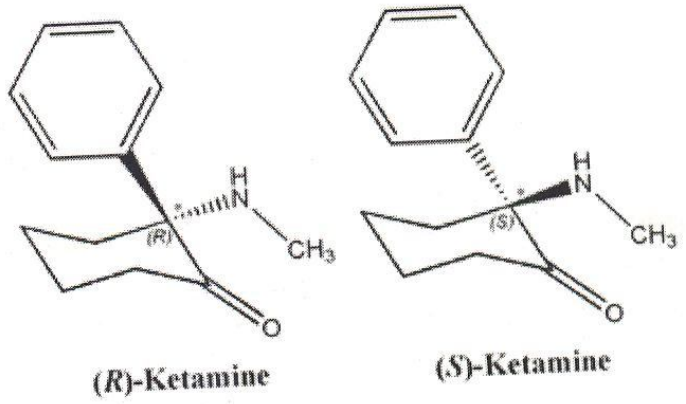


Figure 2.1b. Stereochemistry of ketamine hydrochloride (Anon. 2007).

2.2.2. Dosage, Induction and route of administration

Ketamine is available in three different concentrations 10 mg/ml, 50 mg/ml and 100 mg/ml. The l0mg/ml is for intravenous (i.v) use, while the 50 mg/ml and 100 mg/ml preparations are for intramuscular (i.m) use (Andy, 1994).

i. Intravenous route

Initial doses of ketamine used for surgical anesthesia range from 1mg/kg to 4.5mg/kg injected intravenously. At this dose rate, surgical anesthesia in produced in 30 seconds and can last for 5 to 10 minutes (Andy, 1994).

ii. Intramuscular route

The dose rate for i.m administration range from 6.5 to 13mg/kg and will produce 12 to 25 minutes of surgical anesthesia. (Andy, 1994).

iii. Rectal route

The use of ketamine rectally to induced anesthesia in 150 children, in combination with atropine (0.2mg/kg) i.m route and diazepam (0.2mg/kg) i.m route, was described by Maurice (1979). The response of rectal administration of ketamine at 8 to 10mg/kg, was judged to be excellent in 139 children, good in 7 and fair in others (Hanna, et al., 1988)

iv. Caudal epidural route

The Analgesic effect of ketamine at dose rates of 5m1, l0ml and 20ml of 50% ketamine in cattle using the caudal epidural route was described by Inhyung Lee, et al (2003).

v. Subcutaneous route

The subcutaneous route of ketamine administration at 10mg/kg has been described (Babalola, 1995; Hassan and Hassan, 2003).

2.2.3. Absorption, Metabolism and Excretion:

Ketamine is rapidly absorbed following parenteral administration. Animal experiment indicated that ketamine was rapidly distributed into body tissues, with relatively high concentrations appearing in body fat, liver, lungs, and brain. Lower concentrations were found in the heart, skeletal muscle, and blood plasma. Placenta transfer of the drug had been found to occur in pregnant dogs and monkeys. No significant degree of binding to serum albumin was however found with ketamine (Anon., 2007 b).

Ketamine is extensively metabolized in the liver of dogs, horses and humans by a process of N-demethylation and hydroxylation of the cyclohexanone ring; the metabolites thus formed are water soluble and are excreted in the urine (Paddleford, 1988). The metabolites may have a slight additive effect to the action of the parent drug (Hall and Clarke, 1991). In cats, the drug is excreted via the kidneys with little hepatic metabolism appearing to occur. Its physiologic effect may be inhibited partially by yohimbine due to the release of dopamine and nor epinephrine by central nervous system. (Paddleford, 1988).

Termination of activity is largely dependent on biotransformation and most studies suggest that marked accumulation does not occur with repeated doses following i.m and i.v routes of administration (Brander, et al., 1991).

Studies in rats, dogs and monkeys resulted in recovery of 85% to 95% of the administered dosage in urine, mainly in the form of degradation products. Small amount of the drug were also excreted in bile and feces. Balance studies with tritium labeled

ketamine in human subjects (2 mg/kg given i.v) resulted in the mean recovery of 91% of the amount administered in urine and 3% in the feces. Peak plasma levels average about 0.75pg/ml and cerebrospinal fluid levels were about 0.2pg/ml, one hour after dosing (Anon., 2007).

2.2.4 Clinical uses of ketamine

Ketamine has made many operations possible that would have been otherwise impossible with no anesthetic (James, 2005).

Ketamine use include emergency orthopedic manipulations, incision and drainage of abscesses, facial procedures, operations involving several sites at once in which local anesthesia would exceed dose limits, face-down procedures and emergency operations on patients who are hypotensive (Maharjan, 2004). In skilled hands, ketamine has been used successfully for dental procedures, cleft palate repairs, tonsillectomy, esophagoscopy and bronchoscopy (Maharjan, 2004).

Many consider ketamine to be the sedative agent of choice for emergency abdominal operations in which the surgeon must also act as the anesthetist (James, 2005).

Ketamine provides effective sedation for a wide variety of clinical procedures. Virtually any painful or otherwise anxiety-provoking procedure may benefit from ketamine effects, where expense and availability of narcotics are concerns. The drug is commonly used to reduce the pain and anxiety associated with painful wound debridement and dressing changes (Bonanno, 2002; Porter, 2004).

Ketamine may also have promise in the treatment of stroke. Animal models experimentation demonstrated a marked ketamine neuroprotective effect, mediated by antagonism of N-methyl-D-aspartate (NMDA) channels located on central neurons. Such

antagonism ultimately prevents calcium influx during states of neurocellular ischemia (Lin, et a!., 1996; Fitzal, 1997; Pfenninger and Himmelseher, 1997). Similarly, in a prospective trial of patients with head injuries and in animal models of stroke and head injury, ketamine was recently demonstrated to have neuroprotective effects. However, ketamine use in patients with head injuries (or in patients with stroke) is considered controversial (Reeker, et al, 2000). Ketamine may also be a useful agent in the treatment of refractory status epilepticus; although the drug's total effect on seizure disorders is unclear (Rasmussen, et al, 1996; Detsch and Kochs, et al., 1997; Stewarts and Persinger, 2001).

2.2.5. Toxicity and contraindications

The acute toxicity of ketamine has been studied in several species. In mature mice and rats, the intraperitoneal LD_{50} values are approximately 100 times the average human i.v dose and approximately 20 times the average human i.m dose. A slightly higher acute toxicity observed in neonatal rats was not sufficiently elevated to suggest an increased hazard when used in children. Daily i.v injection in rats of 5 times the average human i.v dose and i.m injection in dogs at 4 times the average human i.m dose demonstrated excellent tolerance for as long as 6 weeks. Similarly, 2 times weekly anesthetic sessions of one, three, or six hour's duration in monkeys over a four to six weeks period were well tolerated (Anon., 2007 b).

The adverse effect of ketamine include convulsion, transient local muscle pain at the site of injection and moderate to marked salivation. Precaution should be taken to control hemorrhage after surgery because arterial hypertension from use of ketamine may occur (Gray, 1980). Ketamine is contraindicated in patients with priorcerebrovascular

accidents, psychiatric disorders, increase intracranial pressure, upper respiratory tract infection, hypertension and also allergy to the drug (Drips, et al., 1977). The use of ketamine is also contraindicated in thyrotoxic and hyperpyrexic patients (Gray, et al, 1980) since the major routes of metabolism and elimination are the liver and kidneys, thus it is contraindicated in patients with liver or kidney disease (Diyyo, 1993).

In theory, the catecholamine-stimulating effects of ketamine makes it potentially contraindicated in patients with severe coronary artery disease, yet some cardiothoracic surgeons favor this drug (McLean, et al., 1996; Ketcham, 1990). There is a growing body of evidence that the dissociative anesthetics may also be responsible for a specific type of neurotoxicity (Olney, et al, 1991). While examining the neuroprotective aspect of NMDA antagonists in rats, it was noticed that specific neurons developed vacuoles (little holes or compartments in the cell) in response to the drug (Olney, et al, 1991).

2.2.6. Anaesthetic Properties

Like the phencyclidines, ketamine produces a trance-like state unique to the anesthesia. This state results from an electrophysiological dissociation between the limbic and higher cortical systems and is termed dissociative anesthesia (Lau and Zed, 2001; Petrillo, et al, 2001; Allen and Macias, 2005). Patients anesthetized with ketamine appear to be awake and have little higher cortical depression. At the same time, cortical awareness is blocked from external stimuli, including auditory, visual, or pain-related input. As in a dreamlike state, awareness of time during ketamine anesthesia is also blunted (Lau and Zed, 2001; Petrillo, et al, 2001; Allen and Macias, 2005). Brainstem activity remains normal and processes for maintaining essential cardiac and respiratory functions are unaltered. The

combinations of these traits in a single drug are remarkable (Lau and Zed, 2001; Petrillo, et al, 2001; Allen and Macias, 2005).

Only under ketamine anesthesia can a painful procedure be performed without the need for routine intubation, ventilatory control, or sophisticated cardiovascular monitoring. Ketamine has several other beneficial actions; bronchodilation makes ketamine a favored induction agent for rapid-sequence intubation during status asthmaticus. The effects of ketamine on the central sympathetic system mediate bronchodilation, causing an increase in circulating catecholamine (Lau and Zed, 2001; Petrillo, et al, 2001; Allen and Macias, 2005).

Ketamine has also been demonstrated to have a direct relaxant effect on airway smooth muscle, (Nehama, et al, 1996; Sato, et al, 1997; Lau and Zed, 2001; Petrillo, et al, 2001; Allen and Macias, 2005). Ketamine causes an increase in blood pressure and cardiac output; these two properties make ketamine a favored anesthetic agent for patients in shock (Doenicke, et al, 1992).

Evidence suggests that the adrenergic effects of ketamine are mediated centrally, similar to those of cocaine and that, premedication with central depressants can blunt or abort the myocardial effects of ketamine, such sympatholysis has been demonstrated with droperidol and multiple benzodiazepines, including diazepam, flunitrazepam, and midazolam hence their use in cases in which increases in cardiac output or blood pressure are undesirable (e.g., patients with severe coronary artery disease) (Doenicke, et al, 1992).

The peripheral adrenergic response to ketamine is characterized by catecholamine release and nor-epinephrine re-uptake inhibition. Mean arterial pressure is typically elevated by

approximately 25 mm Hg. Pulse rate, stroke volume, and cardiac output also increase, although systemic vascular resistance is unaffected (James, 2005). Ketamine has a depressant effect on the myocardium in patients who already have maximal circulating catecholamine levels (severe end-stage shock states) or in cases in which catecholamine activity is blocked (James, 2005). Nonetheless, most patients in shock states benefit rather than get worse from administration of ketamine (James, 2005).

Ketamine increases coronary artery blood flow, although the potential benefit of this effect during ischemic states is offset by the drug's other inotropic actions (James, 2005). In addition, ketamine blunts the myocardial response to catecholamine, making ketamine useful for decreasing epinephrine-induced dysrythmias (Niiya, 1990). The drug has other antidysrhythmic effects as well and was recently demonstrated to reduce reperfusion-induced ventricular fibrillation in animals (Baczko, et al, 1997).

2.3 EFFECT OF KETAMINE ON SPECIFIC ORGANS

i. Central nervous system (CNS)

Ketamine shares with the injectable general anesthetics the ability to produce loss of consciousness. Unlike other anesthetics it selectively depresses the thalamocortical system (association region of the cerebral cortex) while stimulating the reticular activating and limbic system producing anesthesia by functional disruption of the CNS. Ketamine also inhibits GABA binding in the CNS thus enhancing the CNS inhibitory mechanism through the action of the GABA system thus blocking the neuronal transport process for the monoamine transmitter such as 5- hydroxytryptamine, (serotonin), dopamine and nor epinephrine (Paddleford, 1988).

ii. Musculoskeletal system

Skeletal muscle tone is usually maintained and may increase following ketamine administration. Ketamine induces a state of cataleptic immobility and spontaneous unprovoked movement may occasionally occur in deeply anesthetized patients. Muscle tremor and purposeless tonic-clonic movement of the limbs has also been described, such movement do not indicate lightening of anesthesia though (Brander, et al, 1991). In contrast to some general anesthetics agents which usually provide little analgesia with sub-anesthetic dose and light surgical planes of anaesthesia, ketamine is a good somatic analgesia making it suitable for superficial surgeries (Andy, 1994).

The analgesic effect commences before and continues after the period of unconsciousness, thus the conventional means of assessing depth of anesthesia are not strictly applicable to ketamine anesthesia. The anesthetic evaluation in this case is indicated by the animals' response to handling and elicitation of painful stimuli (Brander, et al, 1991).

iii. Gastrointestinal tract

There is the retention of pharyngeal and laryngeal reflexes, which are abolished by other injectable general anesthetics (Paddleford, 1998). The retention of these reflexes is of practical importance in that an endotracheal tube is not essential to prevent aspiration pneumonia. There is also salivation which can be prevented by atropine (Brander, et al, 1991).

iv. Eye

Palpebra and corneal reflexes are normally present but are suppressed at high plane of anesthesia. The eyelids remain open, mydriasis occurs and nystagmus may be present

which may involve movement of the eye ball in a diagonal or elliptical path in contrast to the lateral nystagmus which is characteristic of classic light general anaesthesia (Brander, et al, 1991).

v. Respiratory system

Ketamine maintains respiration and this probably accounts for its wide safety margin in clinical use. However, at high doses, respiration is depressed which may result in apnea following rapid i.v injection of ketamine. In cats, pigs and sheep, respiration becomes apneustic and expiration may comprise of a series of short jerky phases. This however does not affect blood gases, but in some patients, it can produce marked hypoxia and hypercarbia especially when additional CNS depressant drugs are used alongside. Another central action it has is its stimulant action on the centers controlling outflow in sympathetic nerves and bronchodilating actions (Paddleford, 1988).

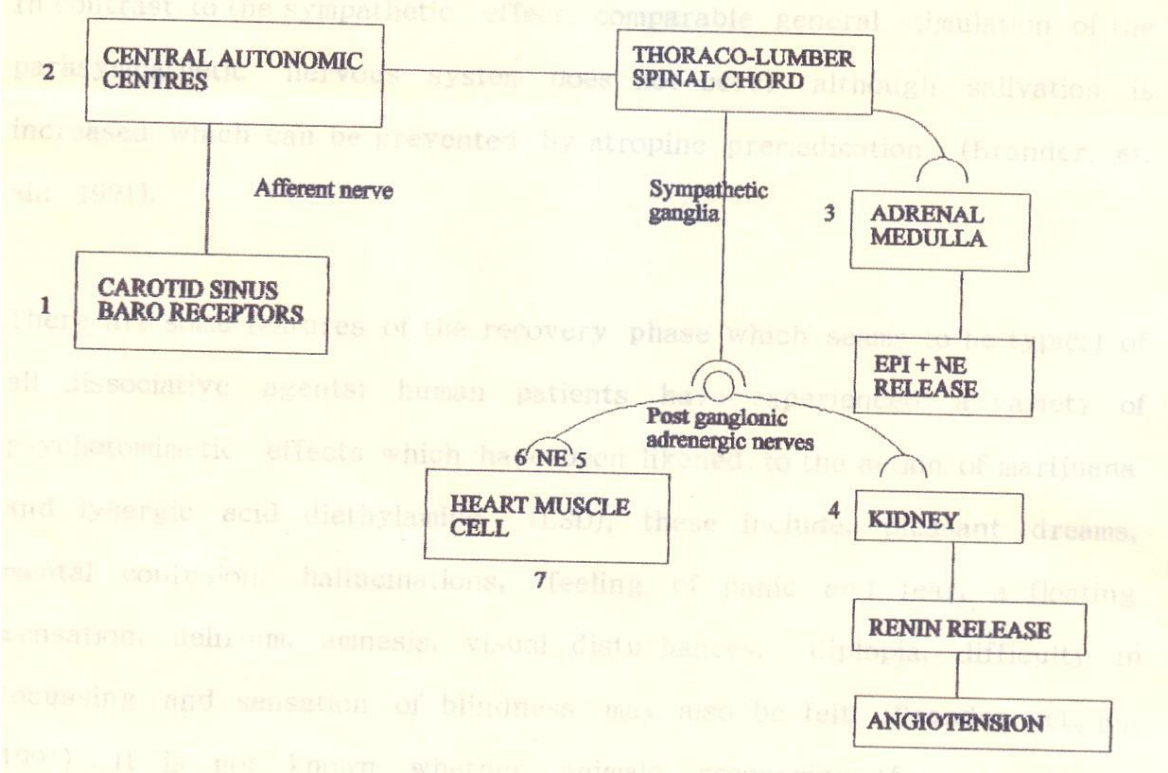
vi. Cardiovascular system (CVS)

Ketamine causes rise in blood pressure by about 25% (on average, the systolic pressure rise by 20 to 30 mmHg) and the heart rate is increased by about 20%; the overall effect is therefore to increase the workload of the heart (Andy, 1994).

In majority of patients, the blood pressure rises steadily over 3 to 5 minutes and then returns to normal 10 to 20 minutes after injection. There is a wide individual variation in CVS response and occasionally alarming increase in blood pressure can occur. These increases do not seem to be dose-related when more than 1 mg/kg is given and larger doses do not necessarily cause a greater increase in pressure. There is also no evidence to suggest that patients with a high preoperative blood pressure are at greater risk of

developing a rise in blood pressure following ketamine administration when compared with normotensive patients (Andy, 1994).

Ketamine however produces certain direct depression of the CVS, which include negative inotropic and spasmolytic actions. The stimulatory effect is attributable to synpathoadrenal activation. The net CVS effect represents a balance between the direct depressant and indirect stimulation, (this is shown in Figure 2.2) (Brander, et al, 1991).



(Brander et al 1991)

Figure 2.2. Summarizes the potential sites of CVS stimulatory effect of ketamine.

(1) Desensitization of the carotid sinus baroreceptors

(2) Direct stimulation of CNS region

(3) Release of adrenal catecholamine

(4) Release of renal rennin

(5) Inhibition of nor-epinephrine (NE) uptake into adrenergic neurons

(6) Release of nor-epinephrine from adrenergic neuron and

(7) Potentiation of inotropic response of heart muscle to catecholamine and cyclic adenosine monophosphate.

Activities (3) and (4) may be secondary to CNS effect (Brander, etal., 1991).

EPI = epinephrine

2.4. RECOVERY PHASE

The recovery phase of ketamine anesthesia in contrast to the smooth induction is characterized by features typical of dissociative agents. Human patients have experienced variety of psychotomimetic effects which have been likened to action of marijuana and lysergic acid diethylamide (LSD). These include: pleasant dreams, mental confusion, hallucinations, feeling of panic and fear, a floating sensation, delirium, amnesia, visual disturbance (diplopia), difficulty in focusing and sensation of blindness (Brander, et al, 1991; Andy, 1994).

It is not known whether an animal recovering from anesthesia experience psychic disturbance but it is wise to assume that they may and exposure to sensory stimulation should be minimized during recovery (Brander, et al, 1991).

There are both inter species and inter drug variation in the action of dissociative agents. The cat and monkey are said to respond well whereas some rodents are resistant to the anesthetic effects, exhibiting predominantly excitement. Similarly, excitement in the horse may be profound and the quality of anesthesia obtained in these species is crucially dependent on premedication with an alpha-2- agonist drug - Yohimbine (Brander, et al, 1991).

CHAPTER 3.

MATERIALS AND METHODS

3.1 ANIMALS

Twenty four (24) Nigerian indigenous dogs of ages 6 months to 1 year (using the dental eruption formulae), of both sex (10 males and 14 females) wet-c purchased from the focal market within the study area. The dogs were housed in the Ahmadu Bello University Veterinary Teaching hospital (ABU VTH) Small animal kennels and fed on rice and bean and left over food from a nearby restaurant: Water was supplied adlib for the period of the study.

3.1.1 Grouping and identification of experimental animal

Using the convenience method of sampling, 20 experimental dogs were numbered serially (numbers 1- 20) and distributed into four groups (A, B, C and D) of 5 dogs each (Table 3.1). The remaining four dogs were divided into four groups of one dog each (E, F, G and H). These served as the control Table 3.2.

3.1.2 Presurgical evaluation

A detailed presurgical evaluation of the dogs was carried out after allowing them to acclimatize for two weeks. All the dogs, irrespective of the anesthetic administered underwent the same presurgical protocols.

About 2 ml of non coagulated blood in EDTA was collected through venous puncture from each dog for hematological and protozoological analysis.

About 1gm of feceas was collected from the rectum of each dog for helminthological analysis.

The respiratory rate, pulse rate and rectal temperature of each dog was documented. The dogs were treated accordingly, before surgeries, based on the outcome of the laboratory results.

Table 3.1. Grouping of experimental dogs

Group	Number of dogs	Anaesthetic	Anaesthetic route.	Surgical procedure	Preanaesthetic/ Route
A	5 (1-5)	Ketamine	Subcutaneous	H-Plasty	Chlorpromazine + Atropine (i.v)
B	5 (6-10)	Ketamine	Subcutaneous	H-Plasty	Chlorpromazine + Atropine (i.m)
C	5 (11-15)	Ketamine	Subcutaneous	Gastrotomy	Chlorpromazine + Atropine (i.v)
D	5 (16-20)	Ketamine	Subcutaneous	Gastrotomy	Chlorpromazine + Atropine (i.m)

Table 3.2. Grouping of control dogs

Group	Number of dogs	Anaesthetic	Anaesthetic route.	Surgical procedure	Preanaesthetic/ Route
E	1 (21)	Thiopental	Intravenous	H-Plasty	Chlorpromazine + Atropine (i.v)
F	1 (22)	Thiopental	Intravenous	H-Plasty	Chlopromazine + Atropine (i.m)
G	1 (23)	Thiopental	Intravenous	Gastrotomy	Chlopromazine + Atropine (i.v)
H	1 (24)	Thiopental	Intravenous	Gastrotomy	Chlopromazine + Atropine (i.m)

Irrespective of the laboratory findings, all the dogs were treated with long acting oxytetracyclin (Avicycline 20% "L.A". Inj. ® AVICO Jordan, 20 mg/kg i.m) used for systemic infection, praziquantel (10 mg/kg orally) and ivermectin (Avimec-Inj .® AVICO Jordan) (400ug/kg subcutaneously) for deworming the dogs and 0.0 6% permethrin powder was used topically to control ectoparasites.

3.2 Preanaesthetic

Following the determination of the individual weights of the dogs using the bathroom scale (Camry® China) method, the dogs were prepared for aseptic surgeries, after they were premedicated with:

i. Atropine (Atocan® Sinochem Ningbo, China) at a dose of 0.03 mg/kg

ii. Chlorpromazine (Clomazin® Maxheal Pharmaceuticals Mumbai India) at a dose of 3.0 mg/kg. Ten dogs received preanaesthetic medication intravenously while 10 received it intramuscularly.

The same protocol was applied to control dogs in groups E, F, G and H.

3.3. Anesthetic

The dogs being in stable physiologic conditions and based on their individual body weight already determined, a time lag of 1-2 minutes and 5-10 minute for i.v and i.m preanaesthetic administration respectively (depending on sedation) was allowed before administration of the anesthetics. The dogs in groups A, B, C and D were each given Ketamine Hydrochloride 50% (Rotex® Medica, Tritau. Germany) subcutaneously at the

dorsal neck fold, at an initial dose of 10 mg/kg and then evaluated for surgical anaesthesia, with additional dose given where necessary.

Groups E, F, G and Fl (Appendix A) were given intravenous Sodium thiopental 1 G (Rotex® Medica, Tritau.Germany) at an initial dose of 10 mg/kg and then evaluated for surgical anaesthesia, with additional dose given where necessary.

3.4 Surgical procedures

Standard routine procedures for the performance of surgeries were strictly adhered to and presurgical protocols were also observed (Bojrab 1975; Hassan and Hassan 2003) Gastrotomy and H-plasty surgical procedures were performed. Standard steam sterilized general surgical instruments were used and the consumables included suture materials and gauze. The duration of the procedure by the surgeon was documented for each patient.

3.4.1 Intergumentry (H-plasty) surgical procedure

Dogs 1 to 10 (Groups A and B) were used. Dog 1 to 5 (Group A) received preanaesthetic medication Chlorpromazine (3 mg/kg) and atropine (0.03 mg/kg)) intravenously while dogs 6 to 10 (Group B) were given intramuscularly (Table 3.1). Ketamine was then given subcutaneously at an initial dose of 10 mg/kg at the dorsal neck fold in all the ten dogs.

Rectal temperature, Pulse rate and Respiratory rate as well as the extent and level of anaesthesia (determined by the patients response to toothed haemostatic forceps clamping at the interdigital space) were monitored and noted throughout the surgery at interval of 5

minutes until end of surgery and post surgically at interval of 10 minutes until the dogs were out of anesthesia (by the patients assuming sternal recumbency).

3.4.2 Gastrotomy surgical procedure

Dogs 11 to 20 (Groups C and D) were used; dog 11 to 15 (Group C) were given preanaesthetic medication (Chlorpromazine (3 mg/kg) and atropine (0.03 mg/kg)) intravenously while dog 16 to 20 (Group D) were given same intramuscularly (Table 3.1). Ketamine was then given subcutaneously at an initial dose of 10 mg/kg at the dorsal neck fold in dogs 11 and 12; 10 minutes into surgery, the dose was increased by 3.0 mg/kg. Thus the maintenance of 13 mg/kg single dose for the rest of the dogs except for dogs 14 and 15 that were given ketamine at 20 mg/kg as single dose before anesthesia was achieved.

Rectal temperature, Pulse rate and Respiratory rate as well as the extent and level of anaesthesia (determined by the patients responds to toothed haemostatic forceps clamping at the interdigital space) were monitored and noted throughout the surgery at interval of 5 minutes until end of surgery and post surgically at interval of 10 minutes until the dogs were out of anesthesia (by the patients assuming sternal recumbency).

3.5 Parameters Assessed

i. Temperature: This was assessed using clinical thermometer (UNESCO FEVER®) rectaly. It was shaken until the mercury was completely inside the bulb; it was then lubricated with water. With a rotating motion, it was inserted into the rectum gently; 1/4

of its length for 2 minutes, then withdrawn and the height of the mercury along the stem was read and recorded.

ii. Pulse rate: This was assessed by applying light digital pressure on the femoral artery to feel its pulsation. The numbers of pulse per minute was counted and recorded.

iii. Respiratory rate: It was assessed visually by observing the inspiratory and expiratory movements of the ribs. The inspiratory and expiratory phases were counted as one respiratory rate.

iv. Anal opening and pupillary reflexes (Response to the ordinary environmental light): Were assessed visually by examining the anal opening for constriction or relaxation while the response to ordinary environmental light was used the pupillary reflex. Pupillary response to light or anal opening is denoted by +, normal by ++ and absence by --); (Appendices A and C).

v. Assessment of the swallowing reflex: Was done manually by applying light friction on the esophagus to stimulate peristaltic movement of the esophagus (Minimal reaction is denoted by +, normal by ++ and absence by --);

(Appendices A and C).

vi. Muscle relaxation: Was assessed by noting the limbs at rest as well as the presence or absence of muscular resistance when the limbs were flexed and extended.

vii. Induction time: Time between ketamine administration and when the dog becomes recumbent and disconnected.

viii. Duration of anesthesia: Time between when the dog became recumbent, loss of sensory perception and when the dog becomes environmentally conscious by lifting up its head.

ix. Down time: Time between when the dog becomes recumbent and when the dog could support itself standing unaided.

x. Duration of surgeries: This is the time between initial skin incision and placement of the last skin suture.

The mean rectal temperature, mean pulse and respiratory rates for each of the experimental groups were calculated using GraphPad InStat3 statistical package. Individual rectal temperature, pulse and respiratory rates were documented for each dog (Appendices A and C).

CHAPTER 4

RESULTS

4.1. PRESURGICAL EVALUATION

4.1.1. Fecal samples

Of the 24 fecal samples sent to the helmithology laboratory for analysis, three samples (3 dogs) showed evidence of toxocara eggs while there were no ova or oocyst found in the remaining samples.

4.1.2. Blood samples

The 24 blood samples sent to protozoology laboratory revealed Hepatozoon canis in one sample; the remaining 23 were negative for any blood parasite.

4.1.3. Clinical pathology results

Clinical pathology laboratory results showed mild aneamia in two samples (dogs 3 and 9), with PCV of 27% and 29% while the rest had normal heamograme.

4.2 SURGICAL PROCEDURES

There was no intraoperative complication due to the anaesthetic combinations used for the non-invasive and invasive surgical procedures. All the patients recovered from the anaesthesia. 10 mg/kg of ketamine administered subcutaneously was found to be adequate for intergumentry (non- invasive) surgical procedure while an average dose of 18 mg/kg was adequate for gastrotomy (invasive) surgical procedure (Appendix C)

4.3 ANAESTHETIC PARAMETERS

Tables 4.1 and 4.2. Mean changes (and standard deviations) in the basic anaesthetic parameters of the experimental dogs (Appendices C, individual dog data) and Appendix A for the observational dogs data (control).

Table 4.1 Mean changes in the basic anaesthetic parameters of dogs Groups A and B, subjected to intergumentyr surgical procedure.

Time interval (minute)		0	5	10	15
MEANS	Groups				
Rectal Temperature(°C)	A	38.12 ± 0.44	37.94 ± 0.26	37.98 ± 0.28	38.00 ± 0.31
	B	38.68 ± 0.20	38.76 ± 0.24	38.68 ± 0.24	38.68 ± 0.24
Pulse rate (Cycle/minute)	A	98 ± 14.70	114.60 ± 13.63	117.6 ± 12.60	109.60 ± 14.47
	B	96 ± 8.94	118 ± 4.47	114 ± 5.48	102 ± 4.47
Respiratory rate (Beat/minute)	A	36.60 ± 2.30	41 ± 2.65	41.80 ± 2.01	40.40 ± 2.07
	B	39 v 2.24	41.60 ± 1.14	42.20 ± 0.43	40.80 ± 0.10
Induction time (minute)	A	2 ± 0.00			
	B	5 ± 0.00			
Duration of anaesthesia (minute)	A	41 ± 6.52			
	B	28 ± 7.58			
Down time (minute)	A	53 ± 11.51			
	B	37 ± 10.37			
Duration of Surgeries (minute)	A	18 ± 2.74			
	B	20 ± 0.00			

Table 4.1 continue.

Time interval (minute)		20	25	30	35	45
MEANS	Groups					
Rectal Temperature(°C)	A	37.90 ± 0.00	37.97 ± 0.36		37.86 ± 0.21	37.90 ± 0.25
	B	38.64 ± 0.20		38.66 ± 0.18		
Pulse rate (Cycle/minute)	A	110 ± 14.14	108 ± 15.03		100 ± 11.48	99.4 ± 12.12
	B	100 ± 0.00		99.6 ± 0.89		
Respiratory rate (Beat/minute)	A	39 ± 1.41	38.50 ± 3.70		37.80 ± 3.03	37.80 ± 3.03
	B	39.60 ± 0.89		39 ± 2.24		
Induction time (minute)	A					
	B					
Duration of anaesthesia (minute)	A					
	B					
Down time (minute)	A					
	B					
Duration of Surgeries (minute)	A					
	B					

Table 4.2 Mean changes in the basic anaesthetic parameters of dogs Groups C and D, subjected to gastrotomy surgical procedure.

Time interval (minute)		0	5	10	15	20	30	40	50
MEANS	Groups								
Rectal	C	39.18 ± 0.58	38.78 ± 0.29	38.78 ± 0.33	38.93 ± 0.39	38.76 ± 0.46	38.76 ± 0.46	38.93 ± 0.42	38.87 ± 0.40
Temperature(°C)	D	39.24 ± 0.88	39.18 ± 0.87	38.96 ± 0.87	39.22 ± 1.03	39.36 ± 0.75	39.18 ± 0.78	39.58 ± 0.52	39.55 ± 0.50
Pulse rate	C	96.40 ± 4.10	116 ± 5.48	118 ± 5.48	114 ± 15.17	112 ± 12.55	106 ± 5.48	98.75 ± 2.5	97.67 ± 2.52
(Cycle/minute)	D	108.40 ± 12.36	120 ± 10	115 ± 13.48	116 ± 15.17	113.60 ±15.08	113 ± 14.40	113.75 ± 11.09	113.75 ± 11.09
Respiratory rate	C	35 ± 2.24	42.40 ± 2.88	42.40 ± 1.82	41.40 ± 1.34	41.40 ± 1.34	40.40 ± 0.89	40.50 ± 1.00	39.33 ± 1.15
(Beat/minute)	D	39.60 ± 0.89	45 ± 0.00	45 ± 0.00	43.40 ± 2.30	42.40 ± 1.82	40.40 ± 1.67	41 ± 1.15	40.50 ± 1.00
Induction time	C	2 ± 0.00							
(minute)	D	5 ± 0.00							
Duration of anaesthesia	C	70 ± 34.71							
(minute)	D	53 ± 18.57							
Down time	C	90 ± 36.06							
(minute)	D	68 ± 19.56							
Duration of surgeries	C	20 ± 0.00							
(minute)	D	20 ± 0.00							

Table 4.2 continue

Time interval (minute)		60	70	80	90	100	110	120
MEANS	Groups							
Rectal	C	38.87 ± 0.40	38.87 ± 0.40	38.87 ± 0.40	38.80 ± 0.00	38.80 ± 0.00	38.80 ± 0.00	38.80 ± 0.00
Temperature(°C)	D	39.85 ± 0.07	39.90 ± 0.00	39.90 ± 0.00				
Pulse rate	C	97.67 ± 2.52	97.67 ± 2.52	97.67 ± 2.52	100 ± 0.00	100 ± 0.00	100 ± 0.00	100 ± 0.00
(Cycle/minute)	D	121 ± 1.41	120 ± 0.00	120 ± 0.00				
Respiratory rate	C	39.33 ± 1.15	39.33 ± 1.15	39.33 ± 1.15	40 ± 0.00	40 ± 0.00	40 ± 0.00	40 ± 0.00
(Beat/minute)	D	40 ± 0.00	42 ± 0.00	40 ± 0.00				
Induction time	C							
(minute)	D							
Duration of anaesthesia	C							
(minute)	D							
Down time	C							
(minute)	D							
Duration of Surgeries	C							
(minute)	D							

CHAPTER 5

5.0. DISCUSSION.

The induction of surgical anaesthesia in Groups A and B with 10 mg/kg of ketamine agrees with that reported by Babalola (1995), while the increase in anaesthetic dose from 10 mg/kg to an average 14.5 mg/kg (Groups C and D) shows that this dose (10 mg/kg) does not produce the desired anaesthesia for an invasive surgery such as gastrotomy. The administration of 20 mg/kg in two dogs (dogs 14 and 15) could be due to intrinsic factor in these dogs necessitating this dosage.

The induction time was 2 minutes in Groups A and C (i.v) administration of preanaesthetic drug (Chlorpromazine), while the intramuscular administration as in Groups B and D was 5 minutes. Groups A and B was superior to 3 minutes reported by Babalola (1995) though he did not use chlorpromazine (pre-anaesthetic). Thus i.v administration of chlorpromazine reduced the induction time, while i.m administration extends the induction time.

The range of the mean 'down time" of between 37- 90 minutes observed, seems to be dose related and the type of stress the animals were subjected to as compared 70-80 minutes reported by Babalola (1995) when the dogs were not subjected to external stress such as surgery.

The varied duration of anaesthesia could be said to be proportional to the anaesthetic dose and some intrinsic factors in the dogs which were not investigated in this study.

During all the surgeries the rectal temperature, respiratory rate were maintained within normal range; with these parameters maintained with in normal range especially during

gastrotomy, possibilities of patients going into stress shock was minimal. Swallowing reflex (which protect the animal from aspiration pneumonia and vomiting) was maintained while the pulse rate increased and returned to normal after a short while. These findings agree with those of i.m and i.v route of administration of ketamine (Andy 1994; Paddleford 1988).

The smooth recovery phase observed was as a result of combining ketamine with chlorpromazine as a pre-anaesthetic and agrees with the findings of others who used similar combinations in humans (Anon. 2007).

In the concurrent observational study (surgical procedures) (Appendix A) with thiopental, all the protective reflexes, swallowing and pupillary were lost while respiration and pulse rates were slowed down. Hypothermia vas also consistent with one of the dogs recording less than 35°C. Covering the dogs with cotton clothing was necessary to maintain the temperature of the dogs. This situation was not encountered with ketamine anaesthetic making it a safer anaesthetic for use in dogs.

5.1. CONCLUSION AND RECOMENDATIONS.

The work has shown that it is possible to perform non-invasive and invasive surgical procedures following induction of surgical anaesthesia via subcutaneous route (dorsal neck told) using ketamine anesthetic in dogs at the dose of 10 mg/kg and 14.5mg/kg (average) respectively, irrespective of the routes of pre-anaesthetic administration. The work has further confirmed the modification of the recovery phase of ketamine anaesthesia by chlorpromazine preanaesthetic (Anon. 2007) and has also shown that the

induction time of ketamine anaesthesia can he modified by chlorpromazine depending on the route of administration.

This route of administration of ketamine anaesthetic has advantages:

1. Unlike the i.v and i.m mutes, there was no damage to vascular tissue.

2. There was comparable onset of anaesthesia following single dose administration (10mg/kg - 20mg/kg subcutaneously) in combination with chlorpromazine preanaesthetic.

3. There was also the maintenance of normal range of temperature, maintenance of swallowing reflex and essential cardiac and respiratory functions with ketamine anaesthesia throughout the duration of and after the surgeries.

4. Minimal personnel training was required to administer the anaesthetic agent and to monitor the patients under anaesthesia.

Based on the out come of this study, it is recommended that this protocol be made applicable for both the invasive (gastrotomy) and non invasive (intergumentry) surgical procedures. For prolonged surgical procedures, it is important to use sterile gauze soak in normal physiologic saline to control mydraisis (exposure keratitis) in the patients.

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APPENDICES

Appendix A

Individual dog data collected following intravenous thiopental anaesthesia

.

INTEGUMENTRY PROCEDURE

Table 1 (Dog 21) Changes in basic anesthetic parameters with intravenous preanaesthetic medication followed by thiopental anesthetic at a total dose of 20mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.0	120	40	++	++	--	--
5	37.6	135	30	-	++	--	--
10	37.4	135	30	-	++	--	--
15	37.2	135	30	-	++	--	--
20	37.0	135	25	-	++	--	--
30	36.3	130	25	-	++	--	--
40	36.3	130	22	-	++	--	--
50	36.3	130	20	-	++	--	--
60	36.0	130	20	-	++	--	--
90	36.0	125	20	-	++	--	--
120	36.1	125	22	-	++	--	+
150	36.5	125	28	-	++	+	+
180	36.5	125	30	-	++	+	+
210	37.0	125	35	+	++	+	+

.

Age 6 months
Weight: 6kg
Sex: Female
Hemoglobin (Hb): 10.0 %
Pack cell volume (PCV): 30 %
White blood cell (WBC): 7.2 x $10^{9/l}$
Neutrophiles (Neut): 69 %
Lymphocytes (lymp) 31 %
Total protein (Tp): 8.0gm/dl
Induction time: 2 seconds
Duration of anaesthesia: 180 minutes
Down time: 195 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 2. (Dog 22) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by thiopental anaesthetic at a total dose of 20mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	37.5	100	40	++	++	--	--
5	37.3	125	35	-	++	--	--
10	37.1	125	30	-	++	--	--
15	36.8	125	30	-	++	--	--
20	36.8	125	25	-	++	--	--
30	36.3	125	25	-	++	--	--
40	36.1	120	22	-	++	--	--
50	36.0	120	20	-	++	--	--
60	36.0	120	20	-	++	--	--
90	36.3	115	25	-	++	--	+
120	37.0	115	35	+	++	+	+

.

Age 9 months
Weight: 8kg
Sex: Female
Hb: 11.4 %
PCV: 36 %
WBC: 9.3 x $10^{9/l}$
Neut: 67 %
lymp 33 %
Tp: 7.0gm/dl
Induction time: 2 seconds
Duration of anaesthesia: 150 minutes
Down time: 155 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

GASTROTOMY PROCEDURE

Table 3. (Dog 23) Changes in basic anaesthetic parameters with intravenous preanaesthetic medication followed by thiopental anaesthetic at a total dose of 20mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	40	120	40	++	++	--	--
5	38.5	135	30	-	++	--	--
10	36.5	135	30	-	++	--	--
15	36.5	135	25	-	++	--	--
20	36.0	135	25	-	++	--	--
30	35.5	135	25	-	++	--	--
40	35.0	135	22	-	++	--	--
50	34	135	20	-	++	--	--
60	34	135	20	-	++	--	--
90	34	130	20	-	++	--	--
120	34	130	20	-	++	--	--
150	35.0	130	20	-	++	--	--
180	35.0	130	25	-	++	--	--
210	35.0	130	25	-	++	--	--
240	35.2	125	28	-	++	--	--
270	35.3	125	30	-	++	+	+
300	35.8	125	32	-	++	+	+
330	36.0	125	35	+	++	+	+
360	36.5	125	40	+	++	+	+
390	37.5	125	40	+	++	+	+

Age 9 months
Weight: 8kg
Sex: Male
Hb: 12.2 %
PCV: 36 %
WBC: 16.0 x $10^{9/l}$
Neut: 68 %
lymp 31 %
Tp: 9.3gm/dl
Induction time: 2 seconds
Duration of anaesthesia: 340 minutes
Down time: 390 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 4. (Dog 24) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by thiopental anaesthetic at a total dose of 20mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.5	120	40	++	++	--	--
5	37.0	135	30	-	++	--	--
10	36.5	135	30	-	++	--	--
15	36.5	135	25	-	++	--	--
20	36.0	135	25	-	++	--	--
30	36.0	135	25	-	++	--	--
40	35.5	130	22	-	++	--	--
50	35.5	130	20	-	++	--	--
60	35.5	130	20	-	++	--	--
90	35.5	130	20	-	++	--	--
120	35.5	130	22	-	++	--	+
150	35.8	128	28	-	++	+	+
180	36.8	128	35	-	++	+	+
210	37..5	125	35	+	++	+	+
240	38.5	125	38	+	++	+	+

Age 7 months
Weight: 8kg
Sex: Female
Hb: 14.0 %
PCV: 41 %
WBC: 17.5 x $10^{9/l}$
Neut: 70 %
lymp 26 %
Tp: 5.8 gm/dl
Induction time: 2 seconds
Duration of anaesthesia: 225 minutes
Down time: 240 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Appendix B



Plate 1. Showing the injection site for ketamine anesthetic (Dorsal neck fold).

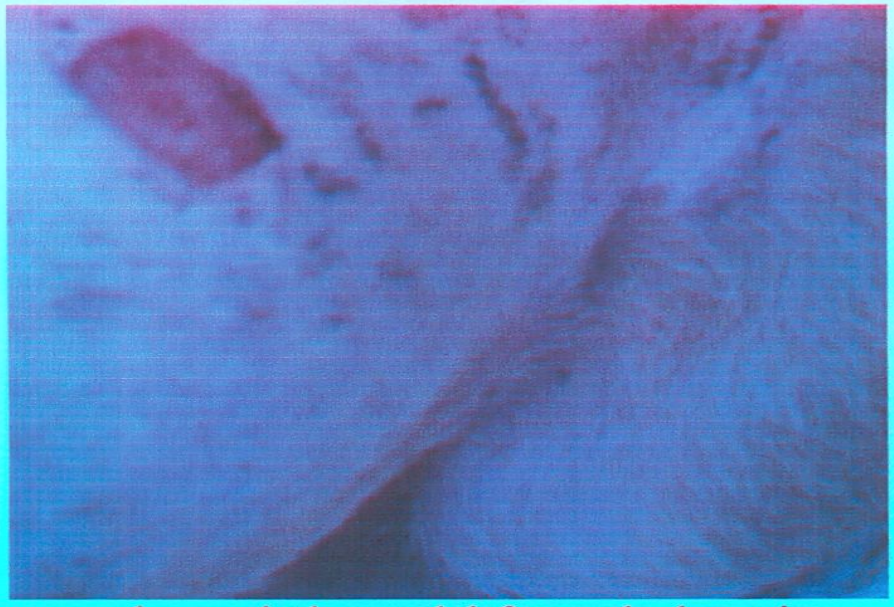


Plate 2. Rectangular surgical wound defect under ketamine anaesthesia.

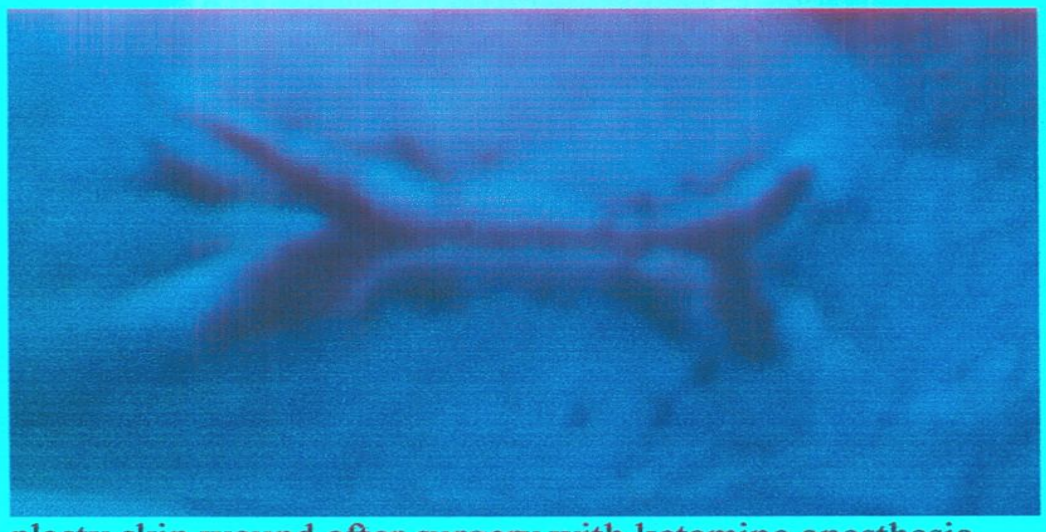


Plate 3. H-plasty skin wound after surgery with ketamine anesthesia.

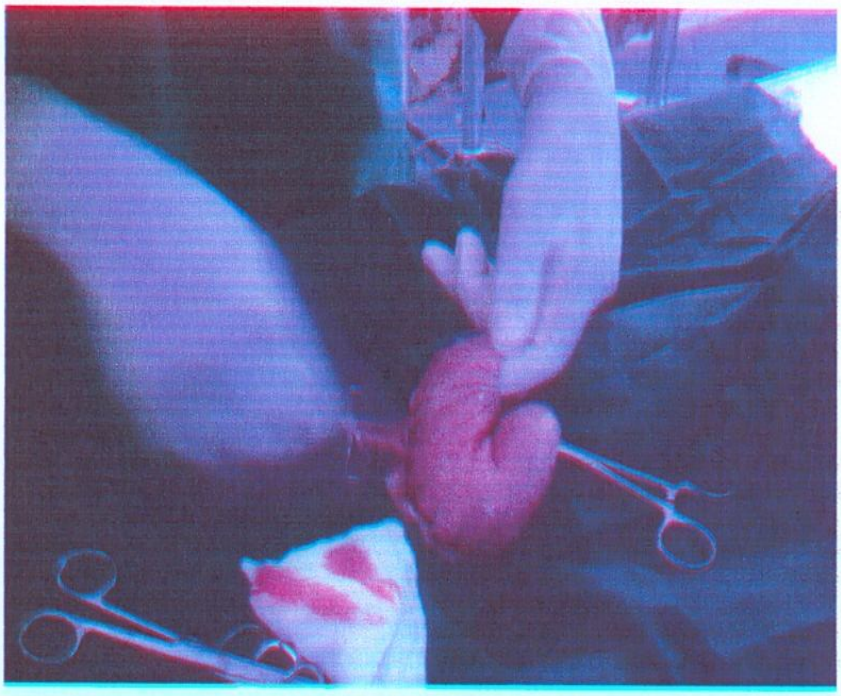


Plate 4. Bringing out the stomach from the abdominal cavity in readiness for Gastrotomy under ketamine anesthesia.



Plate 5. Highlight of Gastrotomy incision under ketamine anesthesia.

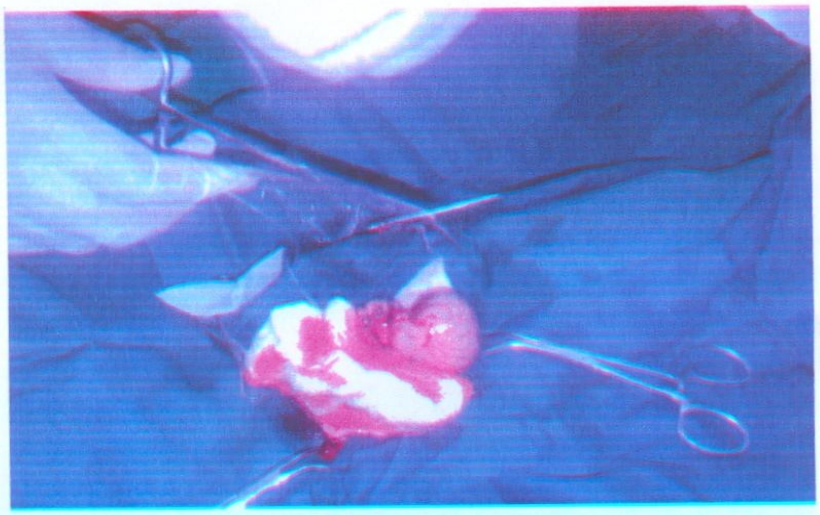


Plate 6. Closing the Gastrotomy incision with 2.0 catgut, Lambert suture pattern under ketamine anesthesia.



Plate 7. Closing of the abdominal laparatomy with single layered running subcutaneously with 2.0 nylon under ketamine anesthesia.

Appendix C

Individual data collected from ketamine induced anesthesia in dogs.

Integumentry procedure

Table 1. Dog 1) Changes in basic anesthetic parameters with intravenous preanaesthetic medication followed by subcutaneous ketamine anesthetic at a total dose of 10 mg/kg.

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.6	90	35	++	++	++	++
5	38	120	40	-	++	++	++
10	38.2	120	42	-	++	++	++
15	38	100	40	-	++	++	++
20	37.9	100	38	-	++	++	++
30	37.9	98	36	-	++	++	++
40	37.9	92	36	-	++	++	++

.

Age 8 months
Weight: 12kg
Sex: Male
Hb: 13.0 %
PCV: 39 %
WBC: 21.8 x $10^{9/l}$
Neut: 80 %
lymp 19 %
Tp: 7.0gm/dl
Induction time: 1.35 minutes
Duration of anaesthesia: 40 minutes
Down time: 65 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 2. (Dog 2) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 10mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.5	92	38	++	++	++	++
5	38	128	42	-	++	++	++
10	38.2	128	42	-	++	++	++
15	38	125	42	-	++	++	++
20	37.9	120	40	-	++	++	++
25	37.9	120	40	-	++	++	++
35	37.9	100	40	-	++	++	++

.

Age 8 months
Weight: 9 kg
Sex: Female
Hb: 11.3 %
PCV: 34 %
WBC: 14.6 x $10^{9/l}$
Neut: 71 %
lymp 27 %
Tp: 6.2 gm/dl
Induction time: 2 minutes
Duration of anaesthesia: 35 minutes
Down time: 50 minutes
Duration of surgery: 25 minutes
Recovery was smooth.

Table 3. (Dog 3) Changes in basic anaesthetic parameters with intravenous preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 10mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.0	92	35	++	++	++	++
5	38.2	100	38	-	++	++	++
10	38.0	110	40	-	++	++	++
15	38.3	100	38	-	++	++	++
20	38.3	95	36	-	++	++	++
25	38.0	95	36	-	++	++	++
35	38.0	95	36	-	++	++	++
45	38.0	95	36	+	++	++	++

.

Age 8 months
Weight: 7 kg
Sex: Male
Hb: 9.0 %
PCV: 27 %
WBC: 13.0 x $10^{9/l}$
Neut: 72 %
lymp 26 %
Tp: 6.6 gm/dl
Induction time: 2 minutes
Duration of anaesthesia: 50 minutes
Down time: 55 minutes
Duration of surgery: 25 minutes
Recovery was smooth.

Table 4. (Dog 4) Changes in basic anaesthetic parameters with intravenous preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 10mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	37.5	90	35	++	++	++	++
5	37.5	100	40	-	++	++	++
10	37.5	110	40	-	++	++	++
15	37.5	98	39	-	++	++	++
25	37.5	95	35	-	++	++	++
35	37.5	90	35	-	++	++	++

.

Age 8 months
Weight: 7 kg
Sex: Female
Hb: 14.0 %
PCV: 42 %
WBC: 17.8 x $10^{9/l}$
Neut: 70 %
lymp 27 %
Tp: 5.5 gm/dl
Induction time: 2 minutes
Duration of anaesthesia: 35 minutes
Down time: 35 minutes
Duration of surgery: 15 minutes
Recovery was smooth.

Table 5. (Dog 5) Changes in basic anaesthetic parameters with intravenous preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 10mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.0	120	40	++	++	++	++
5	38.0	125	45	-	++	++	++
10	38.0	130	45	-	++	++	++
15	38.2	125	43	-	++	++	++
25	38.2	122	43	-	++	++	++
35	38.0	120	42	-	++	++	++
45	38.2	120	42	-	++	++	++

.

Age 7 months
Weight: 6 kg
Sex: Female
Hb: 10.0 %
PCV: 30 %
WBC: 7.2 x $10^{9/l}$
Neut: 69 %
lymp 31 %
Tp: 8.0 gm/dl
Induction time: 2 minutes
Duration of anaesthesia: 45 minutes
Down time: 60 minutes
Duration of surgery: 15 minutes
Recovery was smooth.

Table 6. (Dog 6) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 10mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.6	90	40	++	++	++	++
5	38.9	120	42	-	++	++	++
10	38.9	120	42	-	++	++	++
15	38.9	100	40	-	++	++	++
20	38.9	100	40	-	++	++	++

.

Age 1 year
Weight: 11 kg
Sex: Female
Hb: 13.3 %
PCV: 40 %
WBC: 32.0 x $10^{9/l}$
Neut: 83 %
lymp 17%
Tp: 8.0 gm/dl
Induction time: 5 minutes
Duration of anaesthesia: 25 minutes
Down time: 30 minutes
Duration of surgery: 20 minutes
Recovery was associated with excitement, paddling of the limbs and hyper dilatation of the pupils.

Table 7. (Dog 7) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 10mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.5	90	40	++	++	++	++
5	38.5	120	42	-	++	++	++
10	38.5	120	42	-	++	++	++
15	38.5	100	40	-	++	++	++
20	38.5	100	40	-	++	++	++

.

Age 8 months
Weight: 7 kg
Sex: Male
Hb: 11.3 %
PCV: 34 %
WBC: 14.6 x $10^{9/l}$
Neut: 71 %
lymp 27 %
Tp: 6.8 gm/dl
Induction time: 5 minutes
Duration of anaesthesia: 20 minutes
Down time: 25 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 8. (Dog 8) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 10mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.9	90	35	++	++	++	++
5	39.0	110	40	-	++	++	++
10	38.9	110	42	-	++	++	++
15	38.5	100	40	-	++	++	++
20	38.5	100	38	-	++	++	++
30	38.5	98	35	-	++	++	++

.

Age 1 year
Weight: 12 kg
Sex: Male
Hb: 12.0 %
PCV: 36 %
WBC: 15.9 x $10^{9/l}$
Neut: 68 %
lymp 31 %
Tp: 9.5 gm/dl
Induction time: 5 minutes
Duration of anaesthesia: 40 minutes
Down time: 50 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 9. (Dog 9) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 10mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.5	110	40	++	++	++	++
5	38.5	120	41	-	++	++	++
10	38.5	110	42	-	++	++	++
15	38.6	100	42	-	++	++	++
20	38.0	100	40	-	++	++	++

.

Age 8 months
Weight: 7 kg
Sex: Male
Hb: 9.6 %
PCV: 29 %
WBC: 12.7 x $10^{9/l}$
Neut: 66 %
lymp 33 %
Tp: 6.0 gm/dl
Induction time: 5 minutes
Duration of anaesthesia: 25 minutes
Down time: 35 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 10. (Dog 10) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 10mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.9	100	40	++	++	++	++
5	38.9	120	43	-	++	++	++
10	38.6	110	43	-	++	++	++
15	38.9	110	42	-	++	++	++
20	38.7	100	40	-	++	++	++
30	38.8	100	40	-	++	++	++

.

Age 10 months
Weight: 7 kg
Sex: Female
Hb: 11.3 %
PCV: 34 %
WBC: 9.78 x $10^{9/l}$
Neut: 67 %
lymp 33 %
Tp: 7.0 gm/dl
Induction time: 5 minutes
Duration of anaesthesia: 30 minutes
Down time: 45 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Gastrotomy procedure

Table 11 (Dog 11) Changes in basic anesthetic parameters with intravenous preanaesthetic medication followed by subcutaneous ketamine anesthetic at a total dose of 13 mg/kg.

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.5	92	40	++	++	++	++
5	38.5	120	42	-	++	++	++
10	38.5	130	42	-	++	++	++
15	38.5	130	42	-	++	++	++
20	38.5	125	42	-	++	++	++
30	38.5	110	42	-	++	++	++
40	38.5	95	42	-	++	++	++
50	38.5	95	40	-	++	++	++
60	38.5	95	40	-	++	++	++
70	38.5	95	40	-	++	++	++
80	38.5	95	40	-	++	++	++

.

Age 8 months
Weight: 12 kg
Sex: Female
Hb: 12.0 %
PCV: 37 %
WBC: 15.7 x $10^{9/l}$
Neut: 68 %
lymp 30 %
Tp: 9.2 gm/dl
Induction time: 2 minutes
Duration of anaesthesia: 80 minutes
Down time: 100 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 12. (Dog 12) Changes in basic anaesthetic parameters with intravenous preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 13mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	39.0	100	40	++	++	++	++
5	38.5	120	45	-	++	++	++
10	38.5	110	43	-	++	++	++
15	38.7	110	43	-	++	++	++
20	38.5	110	43	-	++	++	++
30	38.9	110	40	-	++	++	++
40	38.9	100	40	-	++	++	++

.

Age 7 months
Weight: 7 kg
Sex: Female
Hb: 10.2 %
PCV: 31 %
WBC: 7.3 x $10^{9/l}$
Neut: 69 %
lymp 31 %
Tp: 8.0 gm/dl
Induction time: 2 minutes
Duration of anaesthesia: 40 minutes
Down time: 60 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 13. (Dog 13) Changes in basic anaesthetic parameters with intravenous preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 13mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.9	98	40	++	++	++	++
5	38.8	110	45	-	++	++	++
10	38.8	110	45	-	++	++	++
15	38.7	100	42	-	++	++	++
20	38.7	100	42	-	++	++	++
30	38.7	100	40	-	++	++	++

Age 8 months
Weight: 7 kg
Sex: Male
Hb: 11.3 %
PCV: 34 %
WBC: 14.6 x $10^{9/l}$
Neut: 71 %
lymp 27 %
Tp: 6.2 gm/dl
Induction time: 2 minutes
Duration of anaesthesia: 35 minutes
Down time: 50 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 14. (Dog 14) Changes in basic anaesthetic parameters with intravenous preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 20 mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	40	100	40	++	++	++	++
5	38.8	120	42	-	++	++	++
10	38.8	130	42	-	++	++	++
15	38.8	130	40	-	++	++	++
20	38.8	125	40	-	++	++	++
30	38.8	110	40	-	++	++	++
40	38.8	100	40	-	++	++	++
50	38.8	100	40	-	++	++	++
60	38.8	100	40	-	++	++	++
70	38.8	100	40	-	++	++	++
80	38.8	100	40	-	++	++	++
90	38.8	100	40	-	++	++	++
100	38.8	100	40	-	++	++	++
110	38.8	100	40	-	++	++	++
120	38.8	100	40	-	++	++	++

.

Age 8 months
Weight: 10 kg
Sex: Male
Hb: 13.0 %
PCV: 39 %
WBC: 21.8 x $10^{9/l}$
Neut: 70 %
lymp 26 %
Tp: 7.8 gm/dl
Induction time: 2 minutes
Duration of anaesthesia: 120 minutes
Down time: 140 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 15. (Dog 15) Changes in basic anaesthetic parameters with intravenous preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 20mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	39.5	92	35	++	++	++	++
5	39.2	110	38	-	++	++	++
10	39.3	110	40	-	++	++	++
15	39.5	100	40	-	++	++	++
20	39.5	100	40	-	++	++	++
30	39.5	100	40	-	++	++	++
40	39.5	100	40	-	++	++	++
50	39.3	98	38	-	++	++	++
60	39.3	98	38	-	++	++	++
70	39.3	98	38	-	++	++	++
80	39.3	98	38	-	++	++	++

.

Age 8 months
Weight:12 kg
Sex: Female
Hb: 10.0 %
PCV: 30 %
WBC: 7.2 x $10^{9/l}$
Neut: 69 %
lymp 31 %
Tp: 8.0 gm/dl
Induction time: 2 minutes
Duration of anaesthesia: 80 minutes
Down time: 100 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 16. (Dog 16) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 13mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	39.8	110	40	++	++	++	++
5	39.8	120	45	-	++	++	++
10	39.5	125	45	-	++	++	++
15	39.8	120	45	-	++	++	++
20	39.8	120	42	-	++	++	++
30	39.5	120	42	-	++	++	++
40	39.8	110	42	-	++	++	++
50	39.8	110	42	-	++	++	++

.

Age 8 months
Weight: 7 kg
Sex: Female
Hb: 13.3 %
PCV: 40 %
WBC: 32.0 x $10^{9/l}$
Neut: 83 %
lymp 17 %
Tp: 8.0 gm/dl
Induction time: 5 minutes
Duration of anaesthesia: 45 minutes
Down time: 60 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 17. (Dog 17) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 13mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	39.8	120	40	++	++	++	++
5	39.8	130	45	-	++	++	++
10	39.5	130	45	-	++	++	++
15	39.9	130	45	-	++	++	++
20	39.9	125	45	-	++	++	++
30	39.8	125	42	-	++	++	++
40	39.8	125	42	-	++	++	++
50	39.9	125	40	-	++	++	++
60	39.9	122	40	-	++	++	++
70	39.9	120	42	-	++	++	++
80	39.9	120	40	-	++	++	++

.

Age 8 months
Weight: 7 kg
Sex: Female
Hb: 11.3 %
PCV: 35 %
WBC: 97 x $10^{9/l}$
Neut: 67 %
lymp 33 %
Tp: 7.2 gm/dl
Induction time: 5 minutes
Duration of anaesthesia: 80 minutes
Down time: 95 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 18. (Dog 18) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 13mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	38.0	120	40	++	++	++	++
5	38.0	125	45	-	++	++	++
10	38.0	130	45	-	++	++	++
15	38.2	125	43	-	++	++	++
20	38.2	122	43	-	++	++	++
30	38.0	120	42	-	++	++	++

.

Age 8 months
Weight: 7 kg
Sex: Male
Hb: 10.5 %
PCV: 32 %
WBC: 14.5 x $10^{9/l}$
Neut: 68 %
lymp 33 %
Tp: 8.0 gm/dl
Induction time: 5 minutes
Duration of anaesthesia: 30 minutes
Down time: 45 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 19. (Dog 19) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 13mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	39.0	100	40	++	++	++	++
5	38.5	110	45	-	++	++	++
10	38.8	110	45	-	++	++	++
15	39.0	100	42	-	++	++	++
20	39.0	100	42	-	++	++	++
30	38.8	100	40	-	++	++	++
40	38.8	100	40	-	++	++	++
50	38.8	100	40	-	++	++	++

.

Age 8 months
Weight: 7 kg
Sex: Male
Hb: 14.0 %
PCV: 42 %
WBC: 17.8 x $10^{9/l}$
Neut: 70 %
lymp 27 %
Tp: 5.5 gm/dl
Induction time: 5 minutes
Duration of anaesthesia: 50 minutes
Down time: 60 minutes
Duration of surgery: 20 minutes
Recovery was smooth.

Table 20. (Dog 20) Changes in basic anaesthetic parameters with intramuscular preanaesthetic medication followed by subcutaneous ketamine anaesthetic at a total dose of 13mg/kg

Time/minute	Temperature °C	Pulse rate	Respiration rate	Anal tone	Muscle relaxation	Swallowing Reflex	Pupillary Reflex
0	39.8	120	40	++	++	++	++
5	39.8	130	45	-	++	++	++
10	39.5	130	45	-	++	++	++
15	39.9	130	45	-	++	++	++
20	39.9	128	43	-	++	++	++
30	39.8	125	40	-	++	++	++
40	39.9	120	40	-	++	++	++
50	39.8	120	40	-	++	++	++
60	39.8	120	40	-	++	++	++

.

Age 6 months
Weight: 6 kg
Sex: Male
Hb: 13.0 %
PCV: 39 %
WBC: 21.8 x $10^{9/l}$
Neut: 80 %
lymp 19 %
Tp: 7.0 gm/dl
Induction time: 5 minutes
Duration of anaesthesia: 60 minutes
Down time: 95 minutes
Duration of surgery: 20 minutes
Recovery was smooth.