

**ASSESSMENT OF BLOCK HEIGHT FOR
SATISFACTORY SPINAL ANAESTHESIA
FOR CAESAREAN SECTION IN KENYATTA
NATIONAL HOSPITAL**

DISSERTATION SUBMITTED IN PART FULFILMENT OF THE
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I hereby declare that this dissertation is my original work and that it has not been submitted to any university or institution for examination or any other purposes.

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DEDICATION

To my family for their unwavering love and support and to my daughter Nadia.

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LIST OF ABBREVIATIONS

SA – Spinal anaesthesia

CS – Caesarean section

KNH – Kenyatta National Hospital

GA – General Anaesthesia

CSF – Cerebrospinal fluid

PDPH – Post dural puncture headache

CNS – Central nervous system

NS – Normal saline

RL – Ringer's lactate

IV – Intravenous

SPO₂ - Oxygen saturation

BP – Blood pressure

ECG – Electrocardiogram

O₂ - Oxygen

mg – milligram

mcg – microgram

I/M – Intramuscular

PRN – Pro re nata (as needed)

NSAIDS – Non-steroidal anti-inflammatory drugs

ABSTRACT

Background

Spinal anaesthesia (SA) is the most common anaesthetic technique in use for the facilitation of caesarean delivery, both locally as well as internationally due to its various advantages over alternative methods. Confirmation of the level of spinal block prior to beginning the surgery is mandatory, to ensure adequate block for maximal patient comfort intraoperatively. It also gives the anaesthesia practitioner an indication of spread of spinal block higher than intended, allowing early intervention and avoidance of complications.

Objective

To assess and record the level and density of sensory and motor block being achieved by spinal anaesthesia for caesarean delivery in Kenyatta National Hospital.

Methodology

After obtaining informed consent from patients planned for caesarean section, spinal anaesthesia was administered as per the current protocol in Kenyatta National Hospital (KNH) maternity theatre. The patient was then positioned on the operating table. The different sensory modalities and motor block assessments were performed sequentially on each side and the highest dermatomal level reported by the patient was recorded on a chart. The assessment was performed 2 minutes after drug administration, with a repeat assessment after 5 minutes and 8 minutes, before surgery was begun.

Any intraoperative event, rescue analgesia administered or change in anaesthetic technique was recorded.

INTRODUCTION

Neuraxial anaesthesia has now become the technique of choice for caesarean delivery both locally and internationally. This is largely due to the numerous advantages offered over other techniques, especially general anaesthesia (GA). These techniques, namely epidural and subarachnoid (spinal) anaesthesia, involve the administration of local anaesthetic agents, with or without additive agents (e.g. opioids), around the spinal cord with the aim of anaesthetising the target spinal nerve roots to cause sensory and motor blockade for painless surgery.

The rate of caesarean delivery in Kenya stood at 6% in 2008, up from 4% in 2003 according to the Kenya Demographic and Health Survey¹. This steady rise in the rate of these surgeries indicates a similar rise in the rate of spinal anaesthesia administration. It is therefore imperative that the anaesthesia provided be adequate, even as the burden of caesarean sections goes up.

Caesarean deliveries are broadly classified into 2: elective and emergency surgeries. An elective caesarean section (CS) refers to a caesarean section that is performed on a pregnant woman on the basis of an obstetrical or medical indication or at non-indicated maternal request for the caesarean section. The elective CS is usually also a "planned CS" and executed prior to labour. In contrast, a CS done during labour by necessity is termed an emergency caesarean section². Emergency CS may range in urgency from mild urgency to the extremely emergent³.

Indications for CS are either foetal or maternal in nature and sometimes a combination of both. Maternal indications for CS include: previous CS, obstruction of the lower genital tract, worsening pre-existing disease e.g. cardiac disease, pre-eclampsia/eclampsia among others. Indications related to the foetus include: foetal distress/non-reassuring foetal status, malpresentation, multiple gestation, congenital anomalies e.g. hydrocephalus, cord prolapse. Other indications include placenta praevia, abruption placenta, labour dystocia and cephalo-pelvic disproportion³.

The anaesthetic technique chosen depends on factors that include the urgency of the surgery, the wishes of the patient, obstetric indication for surgery and even anaesthesia practitioner's preference³.

Single shot spinal anaesthesia is currently the preferred anaesthetic technique for elective and urgent emergency CS. Therefore, SA accounts for the majority of anaesthesia for this type of surgery, highlighting its significance in practice. Its popularity lies with its benefits and advantages, both to the patient as well as the practitioner. These benefits include lower cost, maintenance of airway (lower risk of aspiration or loss of patent airway), adequate muscle relaxation for surgery, reduced incidence of post-operative deep vein thrombosis as well as less blood loss when compared to surgery done under GA. Other advantages include high rates of patient satisfaction and decreased length of hospital stay.

The assessment of block height of spinal anaesthesia after administration of an intrathecal anaesthetic agent is done as part of the protocol for spinal anaesthesia in KNH maternity theatre. This is to ensure that the anaesthesia is adequate for surgery, allowing the patient to remain pain free and comfortable throughout the procedure, and the same time monitoring for possible spread of anaesthesia beyond the intended level, which can be managed accordingly. This practice not only provides a good standard of care, but also allows early intervention for complications.

HISTORY OF SPINAL ANAESTHESIA

Spinal anaesthesia is an old method of anaesthesia, with description of subarachnoid injections of cocaine for surgical anaesthesia being performed by James Leonard Corning, a neurologist in New York, USA in 1885. In 1891 Essex Wynter described dural puncture, as did Heinriche Quincke 6 months later.⁴

Dudley Tait and Guido Caglieri performed the first spinal anaesthetic in the United States in San Francisco in 1899. Their studies included cadavers, animals, and live patients in order to determine the benefits of lumbar puncture, especially in the treatment of syphilis.⁴ Arthur Barker, a professor of surgery at the University of London, reported on the advancement of spinal techniques in 1907, including the use of a hyperbaric spinal

local anaesthetic, emphasis of sterility, and ease of midline over paramedian dural puncture. Advancement of sterility and the investigation of decreases in blood pressure after injection helped make spinal anaesthesia safer and more popular.⁴

The early development of spinal needles paralleled the early development of spinal anaesthesia. Herbert Greene realized that loss of CSF was a major problem in spinal anaesthesia and developed a smooth tip, smaller gauge needle that resulted in a lower incidence of post dural puncture headache (PDPH). Barnett Greene described the use of a 26-gauge spinal needle in obstetrics with a decreased incidence of PDPH. The Greene needle was very popular until the introduction of the Whitacre needle. Hart and Whitacre used a pencil-point needle to decrease PDPH from 5–10% to 2%. Sprotte modified the Whitacre needle and published his trial of over 34,000 spinal anaesthetics in 1987. Modifications of the Sprotte needle occurred the 1990s to produce the needle that is in use today.⁴

FUNCTIONAL ANATOMY⁶

The back forms the posterior aspect of the trunk, and extends inferiorly from the neck and ends superior to the buttock. It includes skin, subcutaneous tissue, ligaments, vertebral column, meninges, spinal cord, various nerves, blood vessels, and ribs in the thoracic region.

The vertebral column (backbone, spine) forms the skeleton of the neck and back and the main part of the axial skeleton, extending from the skull to the apex of the coccyx. It consists of 33 vertebrae arranged in 5 regions: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral and 4 coccygeal. The anterior and posterior longitudinal ligaments respectively lie anterior and posterior to the vertebral bodies, and maintain stability of the vertebral column. The cervical, thoracic and lumbar vertebrae articulate at facet synovial joints that facilitate and control the spine's flexibility, together with IV discs, ligaments and muscles.

The spinal cord and the surrounding spinal meninges lie in the vertebral canal which is formed by successive vertebral foramina. The spinal cord begins as a continuation of the medulla oblongata and extends from the foramen magnum to L2 vertebral level in most

adults, tapering onto the conus medullaris. At the inferior end, the filum terminalis leaves the dural sac and attaches to the dorsum of the coccyx. Thirty one pairs of spinal nerves emerge from the spinal cord along its entire length, each containing afferent fibres that convey sensory input and efferent fibres that arise from spinal motor neurones.

The spinal meninges are made up of the dura, arachnoid and pia matter and surround the spinal cord. The dura is outermost, thick and is continuous with the cranial dura matter, forming the dural sac. The arachnoid matter is a delicate, avascular membrane composed of fibrous and elastic tissue that lines the dural sac and encloses the subarachnoid space. The pia matter closely follows the surface of the spinal cord and also covers the roots of the spinal nerves and spinal blood vessels.

The subarachnoid space lies between the arachnoid matter and the pia matter and is filled with cerebrospinal fluid (CSF). It contains the spinal cord, spinal nerve roots and spinal ganglia.

Cerebrospinal fluid (CSF) is produced mostly in the lateral ventricles of the brain. Its functions include cushioning the brain in the skull and transport of substances in the maintenance of normal homeostasis of the central nervous system (CNS).

Spinal nerve physiology⁷

Spinal nerves are mixed nerves, meaning they are composed of motor, sensory, and also include autonomic fibres at some spinal levels. The dorsal root on one side of a given spinal segment is composed entirely of the central processes of dorsal root ganglion cells. The ventral root consists chiefly of motor axons, including α motor axons, γ motor axons, and at certain segmental levels, autonomic preganglionic axons.

A given dorsal root ganglion supplies a specific cutaneous region, which is called a dermatome. Although a dermatome receives its densest innervation from the corresponding spinal cord segment, collaterals of afferent fibres from the adjacent spinal segments also supply the dermatome. Thus, transection of a single dorsal root causes little sensory loss in the corresponding dermatome. Anaesthesia of any given dermatome requires the interruption of several adjacent dorsal roots.

Pain and temperature sensations arise from pain receptors (nociceptors) that transmit impulses to the CNS via overlapping fibres and pathways. The axons that carry painful and thermal sensations are members of the A δ and C nerve fibre classes. A δ axons conduct signals faster than C fibres do and are thought to underlie what is called first pain, whereas C fibres are responsible for second pain. Touch sensations are carried by mainly A β fibres, as well as pressure.

Spinal anaesthesia

Spinal anaesthesia is the injection of local anaesthetic drugs in the spinal subarachnoid space to cause sensory blockade (analgesia) and motor blockade as well, often with an associated sympathetic blockade as well. Commonly additive drugs are included e.g. opioids for added analgesic effect.

Physiology of spinal anaesthesia^{4,5}

- 1) Cardiovascular effects: this occurs due to the sympathectomy effect of the block causing a bradycardia and hypotension most commonly. Hypotension occurs due to venous dilation, causing a drop in venous return and subsequently lower cardiac output. Bradycardia occurs mostly due to block of the cardiac accelerator fibres and also occurs as a response to lower filling pressures in the atria from the lower venous return.
- 2) Respiratory effects: tidal volume remains largely unchanged while vital capacity may reduce slightly due to a reduction in expiratory reserve volume caused by the relaxation of abdominal wall muscles. The main respiratory effect of spinal anaesthesia occurs during high spinal blockade when active exhalation is affected due to paralysis of abdominal and intercostal muscles
- 3) Gastrointestinal effects: due to blockade of sympathetic innervation and unopposed parasympathetic tone, secretions increase, sphincters relax, and the bowel becomes constricted. Nausea and vomiting may be associated with neuraxial block in up to 20% of patients.

- 4) Renal effects: spinal anaesthesia has not been found to affect renal autoregulation of blood flow. The kidneys remain perfused when the MAP remains above 50 mmHg.
- 5) Hepatic effects: There is no autoregulation of hepatic blood flow, thus, as arterial blood flow decreases after spinal anaesthesia, so does hepatic blood flow.

PHARMACOLOGY^{4, 8, 9}

Local anaesthetic (LA) drugs are drugs that are used clinically to produce reversible inhibition of excitation and conduction in peripheral nerve fibres and nerve endings, and thus produce loss of sensation. The choice of local anaesthetic drug largely depends on the surgery and the duration of block that is intended, with shorter acting agents being favoured for shorter procedures or outpatient surgeries.

Local anaesthetic drugs are either amides or esters, differentiated by the bond that connects the lipophilic aromatic portion and the hydrophilic tertiary amine intermediate chain. Esters contain an ester link between the aromatic portion and the intermediate chain, and examples include procaine, chlorprocaine, and tetracaine. Amides contain an amide link between the aromatic portion and the intermediate chain, and examples include bupivacaine, ropivacaine, etidocaine, lidocaine, mepivacaine, and prilocaine.

Local anaesthetic agents act by blocking the fast sodium channel in neuronal membranes. To do so the drug must be in the protonated form and the ion channel must be in the open state. The drug enters the ion channel from the intracellular direction, but is administered extracellularly.

Among the list of additives used together with LA agents for spinal anaesthesia, opioids are common. Their main effect is to synergistically prevent pain by acting on mu and kappa opioid receptors in the spinal cord⁸.

LITERATURE REVIEW

The aim of spinal anaesthesia, just as with other neuraxial anaesthetic techniques is to ensure a block at a sensory level that is adequate to allow surgery to be performed while allowing the patient to remain comfortable and pain free. Following the administration of a spinal block, the level of the anaesthesia attained should be tested and recorded, before allowing surgery to begin to ensure adequate anaesthesia has been achieved¹¹. In many centres this has become a standard of care, as pain felt during a caesarean section under spinal anaesthesia has become a common medico-legal claim against anaesthetists, replacing awareness under general anaesthesia as the most common medico-legal claim related to anaesthesia in Great Britain and elsewhere^{12, 13}.

The level of block attained during spinal anaesthesia may be determined by testing either afferent nerve block or efferent nerve block.¹⁰ Afferent nerve function is determined by testing sensory nerve function, mainly using temperature, touch and sharp pin prick. Efferent nerve function is assessed by looking at changes in motor and autonomic function.

The efferent nerve function that is commonly assessed is motor block. This is easily assessed through the use of the Bromage scale (see Appendix 5), which is based on the patient's ability to move their lower limbs. Weakness or paralysis of abdominal wall and intercostal muscles points to block extending up to thoracic level; however these cannot be accurately tested to identify the specific level of spinal block¹⁰. Block of sympathetic output causes bradycardia and hypotension after spinal block administration and while their occurrence is related to level of the block attained, they are even less reliable in identifying the level of spinal block¹⁰.

There are differences seen in block of sensory modalities, occurring due to different rates of block of the sensory nerve fibres, namely A β , A δ and C fibres. A β fibres mediate touch sensation; A δ fibres mediate pin prick sensation while C fibres mediate cold impulses¹¹. Generally, C fibres are inhibited first, followed by A δ and finally A β fibres, meaning there is usually loss of sensation to cold, then pin prick and finally touch after a spinal block. Sensory losses to vibration and proprioception have also been used to assess spinal block¹⁰.

Various methods of testing these modalities have been described^{11, 14, 15}. Pin prick sensation may be assessed by use of an 18G needle, or a safety pin¹¹. Cold sensation has been tested through the application to the skin of ice, a cold gel bag, alcohol skin preparation, ethyl chloride spray or a cooling thermode^{11,15}. Touch sensation is assessed by application of light pressure with a finger, or by using a Von Frey hair¹¹. The Neurotip™ (Owen Mumford, Oxford, UK) has also been described as a tool to measure the loss of sensation to touch sensation, and when mounted on the Neuropen, it provides a standardised pressure of 40 g to the skin¹⁶. The use of ice, alcohol skin preparation, light finger pressure and 18G needle are most commonly used, likely due to ease of availability as well as low cost^{14, 15}. Ethyl chloride spray is not readily available, is expensive and pollutes the environment. Cooling thermodes and Von Frey hairs are not easily available either and while use of a needle for pin prick is commonly used, it has fallen out of favour due to the potential for tissue trauma as well as infection¹⁵. In their study Ousley et al used an Interlink® vial access cannula (BD™, North Ryde NSW, Australia; designed for needleless access of rubber-topped vials) to assess pin prick without risk of skin breakage and trauma¹⁷.

A number of other methods of sensory assessment for spinal block have been described in literature. Curatolo et al outlined mechanical methods that in addition to pressure and pin prick include the use of pressure algometer probes to assess pressure pain. He also outlined the use of electrical and chemical stimuli as well the use of ischemia as methods for testing of analgesia after a spinal block¹⁸. In addition, the use of tetanic stimulation using peripheral nerve stimulators, and transcutaneous electrical nerve stimulation (TENS) have both been found to correlate well with block to surgical pain^{18,19}. It has been found that a block to transcutaneous electrical stimulation at 60 mA is equivalent to the dermatomal level of surgical anaesthesia after spinal block administration¹⁹.

While a number of methods for testing spinal block height have been described and in use^{11,15,18}, debate remains as to which sensory modality is the most accurate indicator for testing block height and adequacy. The highest level of block of the 3 modalities normally tested is usually different, with block to cold being the highest followed by block to pin prick and block to touch being the lowest. Studies done have revealed a common, but not constant 2 dermatome segment difference between upper level of block

to cold and pin prick; and 2 segment difference between touch and either pin prick or cold⁵. This is widely variable between patients and even may vary with the same patient, with differences in block to touch and cold of up to 10 dermatome segments^{5, 14}. A common acceptable practice is attainment of block extending up to T4 on both sides to cold or pin-prick, while a block to fine touch extending to T5 has been shown to be associated with a low incidence of intraoperative pain³.

Some authors have proposed that the use of loss of sensation cold and pin prick is inaccurate and overall unhelpful, in favour of loss to touch as the superior mode of testing spinal sensory block. In 1995 Russell found that the use of pin prick alone may misleadingly indicate adequate spinal sensory block²⁰, while in 1999, Sarvela et al found that the use of cold as the sole testing modality does not reliably give the true level of anaesthesia²¹. At the same time the use of loss to touch only may falsely point to inadequate spinal sensory block, increasing the risk of topping up an already adequate spinal block, or unnecessarily putting a patient under general anaesthesia¹⁷.

Debate also exists as to which level should be recorded, where the level of “some” sensation felt and “normal” sensation felt may vary by 2-3 dermatomes¹¹ when the test is started from lower dermatomes proceeding upwards, as blocks gradually change in density over more than one single dermatome. Nonetheless, recording the level of “some” sensation tends to be the most common practice and is found to be acceptable. In 2006 Russell found that the first sensation of light touch is reported to be ‘the best predictor of the likely efficacy of a spinal or epidural block’²² supporting this practice. In 2012 Ousley et al published that “cold and pinprick testing of block height correlate well with touch and can provide useful information during the assessment of adequacy of spinal anaesthesia for caesarean section”¹⁷. This allows one to effectively discern the adequacy of spinal block regardless of the modality that is chosen for testing.

It is also of note that anaesthetists vary in their location of different dermatomes with Congreve et al showing that one in seven anaesthetists were unable to correctly locate T5 dermatome, missing it by at least 2 dermatomes²³. This creates a potential for inaccurate recording of a block as being inadequate, leading to unnecessary spinal top-up

anaesthesia or conversion to general anaesthesia, or may lead to a block being recorded falsely as being adequate and potentially exposing the patient to pain during surgery.

RESEARCH QUESTION

Is the block attained by spinal anaesthesia for caesarean section in Kenyatta National Hospital adequate for painless surgery?

STUDY OBJECTIVES

Broad objective

To assess the sensory and motor block attained by spinal anaesthesia for caesarean section in Kenyatta National Hospital.

Specific objectives

1. To determine the level of block to touch, cold and sharp pin prick attained after spinal anaesthesia for caesarean delivery.
2. To evaluate the density of motor block after spinal anaesthesia for caesarean section surgery by use of the Bromage scale.
3. To determine the incidence of adequate spinal anaesthesia for caesarean section surgery.
4. To determine the incidence of inadequate spinal block during caesarean delivery leading to analgesic and/or anaesthetic supplementation.

STUDY JUSTIFICATION

Spinal anaesthesia is currently the anaesthetic technique of choice for caesarean delivery in Kenyatta National Hospital as it offers numerous advantages to the patient. The technique is carried out as per the existing protocol for spinal anaesthesia which outlines the necessary steps for the procedure ensuring safe and correct administration of anaesthesia ^{App 6}.

There has been anecdotal evidence of the occurrence of inadequate spinal block, necessitating conversion to general anaesthesia or other interventions. The incidence of this has never been investigated however.

In addition, the quality and density of the spinal blocks have not been evaluated, and so it is currently unclear just how adequate the spinal blocks are, and whether or not there is need for improved standard of care.

There has been no similar study that has been undertaken previously in Kenyatta National Hospital, and the results will ultimately serve to increase knowledge, and more importantly, quality of care provided to patients.

MATERIALS AND METHODS

Study Design

This was a hospital based cross-sectional observational study, employing simple random sampling technique.

Study Site

The study was conducted at the maternity theatre in the Kenyatta National Hospital, Kenya's largest and busiest Level 6 referral facility, with a total average of 372 caesarean deliveries performed per month. The maternity theatre has two operating rooms. One operating room functions mainly on weekdays from 8 a.m. to 5 p.m. and it is here that mainly elective cases are performed, as well as emergency CS cases. The other operating room runs daily 24 hours a day, and is where most emergency caesarean sections are carried out. A majority of these cases are done under spinal anaesthesia, both elective as well as emergency.

Study Population

All pregnant women who presented to the Kenyatta National Hospital for delivery.

Inclusion criteria

All pregnant women planned for caesarean delivery, including elective as well as emergency surgeries.

Exclusion criteria

Patients who decline to give consent to participate in study

Patients who are not able to give informed consent

Patients with a history of neurological disorders

Patients considered unfit for spinal anaesthesia including patients with severe hypovolemia, raised intracranial pressure, bleeding diathesis, local infection at lumbar puncture site, fixed cardiac output states e.g. aortic stenosis, bacteraemia and inability to give consent and co-operate for placement of spinal anaesthesia.

Sample size

Using Fisher's formula for cross sectional studies, calculation of the sample size is as follows:

$$n = \frac{Z^2 \times P(1-P)}{d^2}$$

Where:

n= sample size

Z= 1.96 (95% confidence interval)

P=Estimated incidence of inadequate spinal block (50% used as there is no published data)

d= Margin of error (precision error) $\pm 7\%$

The study population was attained by taking a mean number of annual admissions to KNH labour ward between January 2011 and December 2013.

With annual admissions of 11255 patients in 2011, 10318 patients in 2012 and 11546 patients in 2013, the mean annual number of admissions comes to 11040 patients.

Substituting into the formula:

n= 196

Data collection, management and analysis

All patients planned for caesarean delivery under spinal anaesthesia were reviewed at the maternity theatre receiving area. Informed consent to participate in the study was obtained and a consent form was signed to enrol the patient in the study. Signed informed consent for surgery was also confirmed (Appendix 8). Those who declined to be included as well as those unable to give informed consent and those with any contraindication to spinal anaesthesia, including but not limited to neurological disorders, coagulopathy, spinal deformity, cardiac disease, hypovolaemia, were excluded from the study.

A large bore (G18) IV cannula was inserted and 500 – 1000mls of normal saline (NS) or ringer's lactate (RL) IV fluid was rapidly administered over duration of 30 to 60 minutes.

The practitioner then ensured all drugs and equipment required for the spinal block are ready, and resuscitation equipment and emergency drugs were readily available. Monitors were then placed, including non-invasive blood pressure (BP) monitoring, pulse oximetry (SPO₂), ECG monitors. Baseline vital signs were taken and recorded i.e. pulse rate, non-invasive BP, O₂ saturation. The patient was then positioned on the operating table for administration of the block, in either sitting position or lateral decubitus position according to the preference of the practitioner and the patient.

The patient's back was cleaned and draped, and the spinal anaesthesia was administered according to the current protocol for spinal anaesthesia for caesarean section (Appendix 6). This was done in the midline of the back at L2/L3 or L3/L4 intervertebral space with a Quincke spinal needle G25. The needle was introduced with the bevel facing parallel to the direction of the dural fibres. If necessary, an introducer was used. Once the dura was pierced the stylet was removed to allow for the flow of CSF to the hub of the needle. Upon establishing free flow of CSF, the local anaesthetic plus additive was administered – 10 mg to 12.5 mg of hyperbaric or plain bupivacaine plus 25 mcg fentanyl. It was given with the bevel facing up over a duration of 30 seconds. The patient was then placed in the supine position with left uterine displacement to reduce aortocaval compression. The time of spinal administration, drugs used and dose was noted down on questionnaire.

Assessment of the block height was then done by the principal investigator or a trained research assistant on each side of the body and recorded with the aid of a chart with a

diagram of dermatomes available on the questionnaire (Appendix 1). The modalities were tested sequentially on each side of the body and at intervals from the time of spinal administration; that is after 2, 5 and 8 minutes, before the beginning of the surgery.

To test the modality of touch, light finger pressure was used and was first applied to the clavicle, and the patient was asked to confirm that she can feel the finger pressure. This was used as a reference and the patient was asked to note the intensity of pressure felt on the clavicle. Next, finger pressure was applied along the mid-clavicular line, and then caudally beginning from L1 dermatome with pressure being applied every 2 cm each time asking the patient if she can feel the finger pressure at the same intensity as felt on her clavicle. This is continued until she confirmed that she can feel the finger pressure at the same intensity as the first reference touch. The block height to touch was recorded as the dermatome below the level that touch is first felt. This was repeated on the opposite side and recorded in the same manner.

Block to cold was tested in the same manner using a surgical spirit swab and similarly, block to pinprick was tested using a sterile needle (G18) for pinprick with initial stimulus applied to the clavicle as a reference. Extreme care was taken not to break the skin during testing for pinprick. A fresh needle was used for each patient.

After completing the sensory block assessment on each side, the patient was then asked if she was able to lift or move each of her lower limbs 2, 5 and 8 minutes after administration of the spinal anaesthesia. Surgery was allowed to proceed once spinal block was assessed and found to be adequate. If not adequate, the anaesthesia practitioner then decided on whether to repeat the spinal block or induce a general anaesthetic.

Intraoperatively for patients under spinal anaesthesia, if any intervention was given for patient's complaint of pain or abdominal discomfort, this was noted down, including the time of administration, the drug given, and the dosage used.

The data collected was analysed using Statistical Package for the Social Sciences (SPSS) analytics software version 22.0.

ETHICAL CONSIDERATIONS

Approval was sought and attained from Kenyatta National Hospital and University of Nairobi Ethical and Research Committee (Appendix 8).

Only patients who gave informed consent were involved in the study. All patients were given the opportunity to be involved, having been informed of the purpose of the study, the procedure of the study, and the potential benefits as well as risks.

Any patient was free to withdraw from the study at any time without any consequences.

The study did not at any point interfere with the provision of care and health care services to the patients. Neither did the patients incur any additional costs by participating in the study.

All data collected was recorded and kept private and confidential to maintain the integrity of the participants involved.

If at any point during the study a spinal block was noted to be inadequate, timely and adequate interventions were undertaken.

Quality assurance measures

1. Participants included will be limited to those whose spinal anaesthesia is administered by senior registrars in the University of Nairobi Department of Anaesthesia (Year 2 and above), registered clinical officer anaesthetists and consultant physician anaesthesiologists.
2. A dermatome chart is included in the data collection tool to standardise identification of dermatomes.
3. A reference test point that is not anaesthetised on the participant's body will be used before each test.

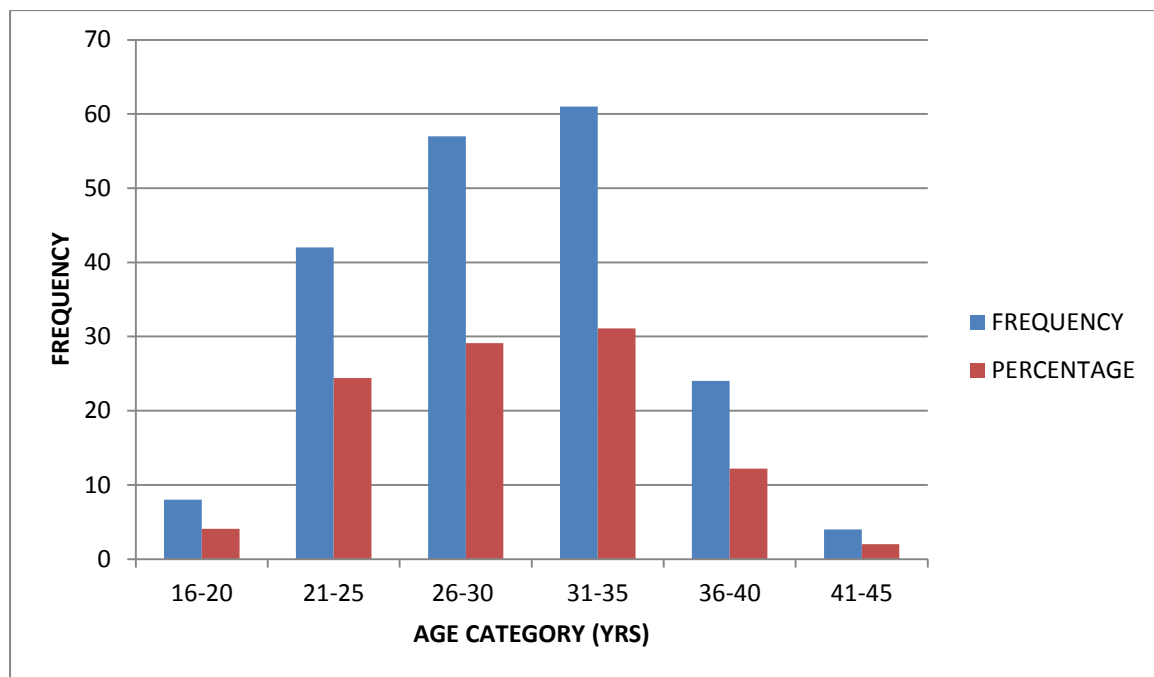
STUDY RESULTS

Bio data

A study to assess the sensory and motor block attained by spinal anaesthesia for caesarean section at Kenyatta National Hospital was conducted among 196 patients.

The average age of patients was 29.7(\pm 5.6) years within the range of 17-44 years. Majority 61(31.1%) of the patients were aged 31-35 years, 57(29.1%) were aged 26-30 years, 42(21.4%) were aged 21-25 years, 24(12.2%) were aged 36-40 years, 8(4.1%) were aged 16-20 years and 4(2.0%) were aged 41-45 years.

Figure 1: Bar graph showing age category distribution of study subjects



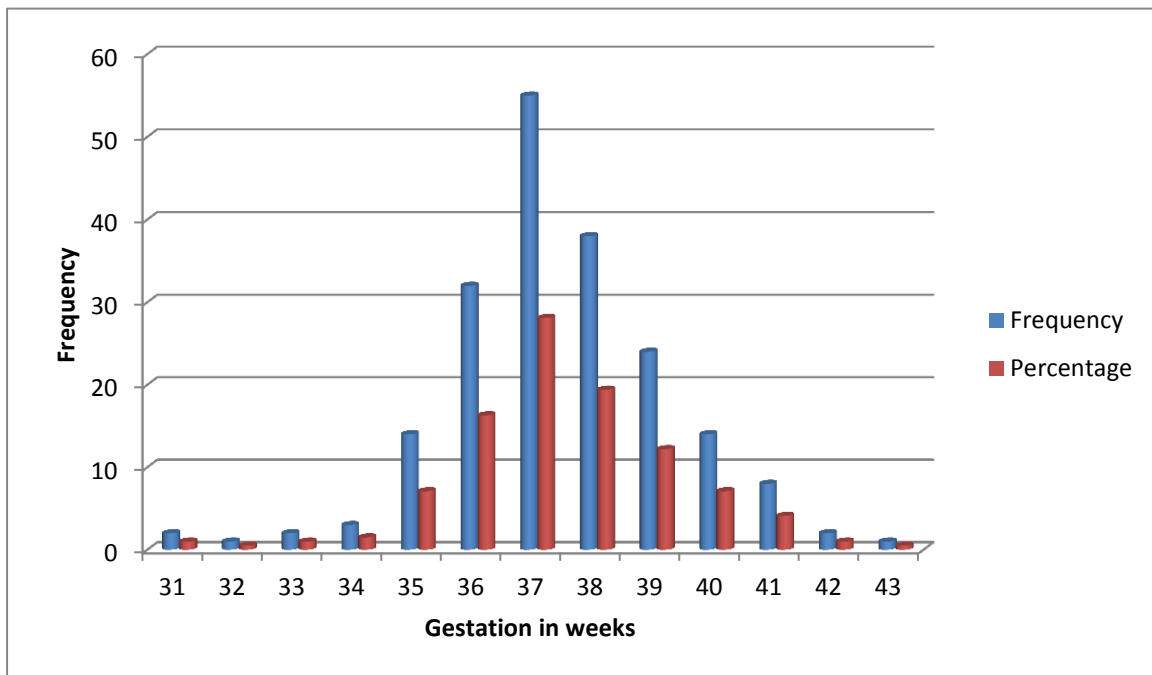
When it came to parity, 63 patients(32.1%) had 1+0G2 parity, 51(26%) had 0+0G1, 31(15.8%) had 2+0G3, 15(7.7%) had 3+0G4, 9(4.6%) had 1+1G3, 7(3.6%) had 2+1G4, 5(2.6%) had 0+1G2 and 3+1G5 each, 3(1.5%) had 2+2G5, 2(1%) had 1+2G4 and 1(0.5%) had 1+3G5, 4+0G5, 1+4G6, 5+0G6 and 6+0G7 each.

Table 1: Distribution of parity at time of caesarean section

PARITY	FREQUENCY	PERCENTAGE (%)
P0+0 G1	51	26
P0+1 G2	5	2.6
P1+0 G2	63	32.1
P1+1 G3	9	4.6
P2+0 G3	31	15.8
P2+1 G4	7	3.6
P3+0 G4 and above	30	15.3

The mean gestation period was 38(\pm 2) weeks within the range of 31 to 43 weeks. Gestation period was mostly recorded as 38 weeks among 55(28.1%) patients, 39 weeks in 38(19.4%) patients, 37 weeks in 32(16.3%) patients, 40 weeks in 24(12.2%) patients, 41 and 36 weeks in 14(7.1%) patients each, 42 weeks in 8(4.1%) patients, 35 weeks in 3(1.5%) patients, 31, 33 and 43 weeks in 2(1%) patients each and 32 weeks in 1(0.5%) patient.

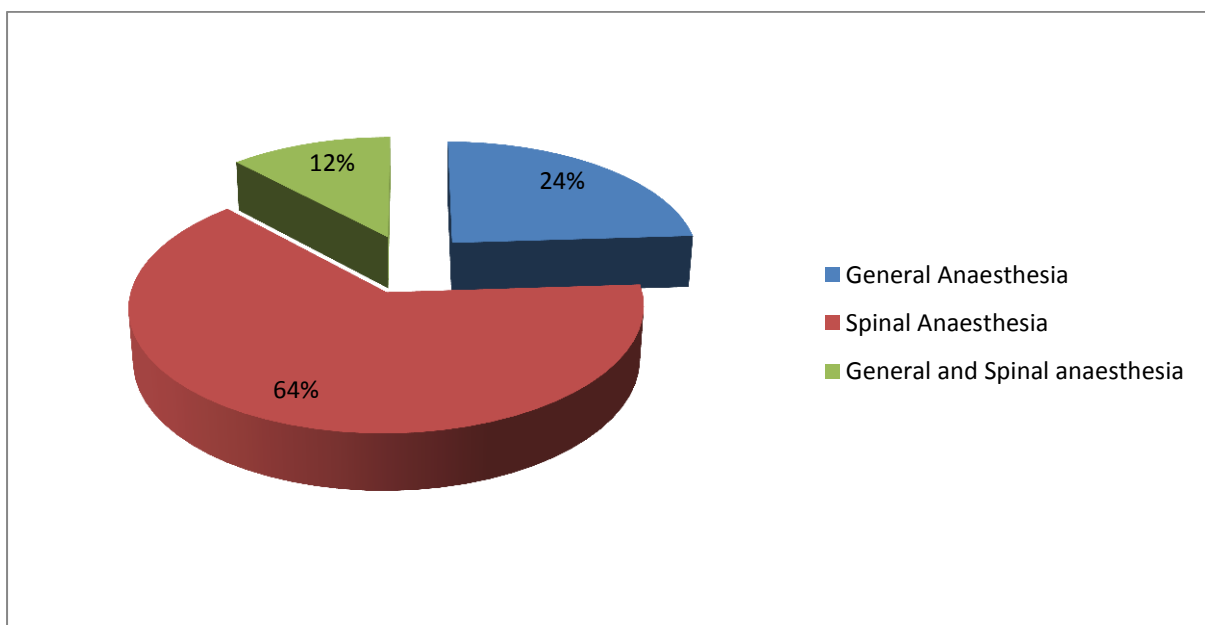
Figure 2: Chart showing gestation of patients at time of caesarean section



Past Medical History

86(43.9%) patients had undergone previous caesarean section; spinal anaesthesia was used on majority of them 55(28.1%). General anaesthesia was used on 21(10.7%) and both spinal and general anaesthesia used on 10(5.1%) patients. Only 5(2.6%) patients had undergone previous surgery other than caesarean section.

Figure 3: Pie chart showing type of anaesthesia previously received



Current Medical History

The distribution of surgeries into elective and emergencies showed a majority of cases being emergencies numbering 159 (81.1%) while elective cases were 37 (18.9%).

Table 2: Table showing distribution of type of surgeries performed

TYPE OF SURGERY	FREQUENCY	PERCENTAGE
Emergency	159	81.1
Elective	37	18.9

The indications for emergency surgery showed the highest number of surgeries being performed for non-reassuring foetal status which were 70 (35.7%), followed by 1 previous CS scar in labour or not keen on vaginal delivery 29 (14.8%), 2 previous CS scars in labour 15 (9%) and the rest as indicated in the table below.

Table 3: Table showing emergency indications for caesarean section

INDICATION	FREQUENCY	PERCENTAGE
Reduced foetal movements/Non reassuring foetal status	70	35.7
1 previous scar in labour/Not keen on VBAC*	29	14.8
2 previous scar in labour	15	9.0
Breech/brow/face presentation/transverse lie	11	5.6
Cranio-pelvic disproportion/obstructed labour	10	5.1
PET**, Severe PET, Eclampsia	7	3.6
Antepartum haemorrhage	7	3.6
Prolonged labour	2	1.0
Failed induction of labour	2	1.0
Chorio-amnionitis	2	1.0
Post term gestation	1	0.5

Rhesus negative mother	1	0.5
Twin gestation	1	0.5
Intrauterine growth restriction	1	0.5

*VBAC – Vaginal delivery after caesarean section

**PET – Pre-eclampsia

Elective caesarean sections were most commonly performed on patients with 1 previous CS scar including those not keen on vaginal delivery who numbered 12 (6.1%), followed by those with 2 previous scars who were 10 (5.1%), presence of retroviral disease 4 (2%), 3 previous CS scars 3 (1.5%) and the rest as shown in table 4 below.

Table 4: Table showing indications for elective caesarean section

INDICATION	FREQUENCY	PERCENTAGE
1 previous scar/Not keen on VBAC	12	6.1
2 previous scars	10	5.1
RVD*	4	2.0
3 previous scars	3	1.5
Rhesus negative mother	3	1.5
Cranio-pelvic disproportion	2	1.0
Reduced foetal movements	1	0.5
Pre-eclampsia	1	0.5
Placenta praevia	1	0.5

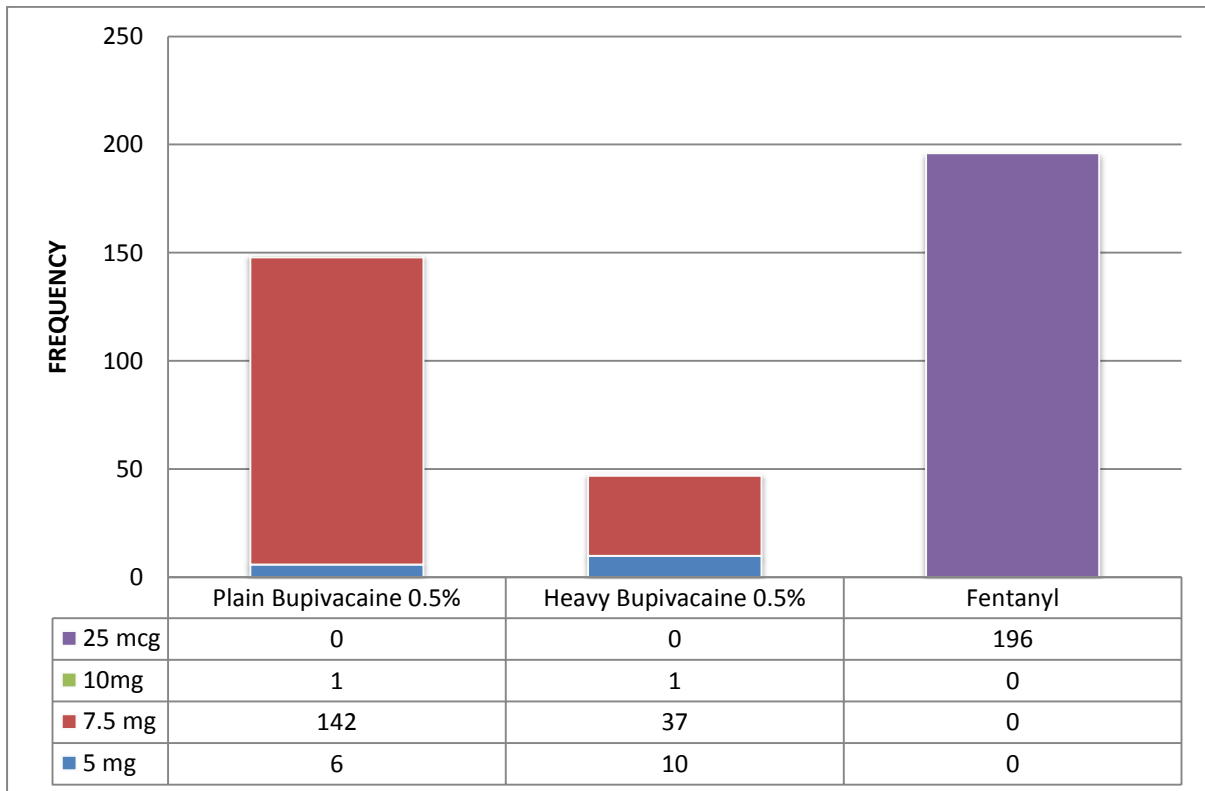
*RVD – Retroviral disease

Spinal Anaesthesia

Fentanyl was the mostly used drug at a dose of 25 mcg, being used 196 times, in all the spinal anaesthetics administered. Plain bupivacaine was the second mostly used drug in different doses: 5.0mg used 5 times, 7.5mg used 142 times and 10.0mg used. Hyperbaric

bupivacaine was also used in different dosages: 5.0mg used 10 times, 7.5mg used 37 times and 10.0mg used once.

Figure 4: Bar graph showing drugs used for spinal anaesthesia, their frequency and dosage used



Spinal Block Assessment

1. Sensory Block Assessment: Touch

On assessment at 2 minutes from the time of spinal block, mean block height to touch was found to be at T8(± 3.008) with a range of no block to T6. At 5 minutes mean block height was T8(± 2.009) with a range of T12 to T4. At 8 minutes the mean block height was T6(± 1.557) with a range of T12 to T3.

Table 5: Table showing mean block height to touch during assessment

Time from spinal administration	Lowest block height	Highest block height	Mean block height	SD
2 min	None	T6	T8	3.008
5 min	T12	T4	T8	2.009
8 min	T12	T3	T6	1.557

2. Sensory Block Assessment: Cold

On assessment at 2 minutes from the time of spinal block, mean block height to cold was found to be at T7(± 2.102) with a range of L1 to T3. At 5 minutes mean block height was T6(± 1.692) with a range of T12 to T2. At 8 minutes the mean block height was T4(± 1.305) with a range of T10 to T2.

Table 6: Table showing mean block height to cold during assessment

Time from spinal	Lowest block height	Highest block height	Mean block height	SD
2 min	L1	T3	T7	2.102
5 min	T12	T2	T6	1.692
8 min	T10	T2	T4	1.305

3. Sensory block assessment: Pin prick

On assessment at 2 minutes from the time of spinal block, mean block height to pin prick was found to be at T8(± 2.041) with a range of T12 to T3. At 5 minutes mean block height was T6(± 1.750) with a range of T12 to T1. At 8 minutes the mean block height was T5(± 1.390) with a range of T12 to T2.

Table 7: Table showing mean block height to pin prick during assessment

Time from spinal	Lowest block height	Highest block height	Mean block height	SD
2 min	T12	T3	T8	2.041
5 min	T12	T1	T6	1.750
8 min	T12	T2	T5	1.390

4. Motor block

On assessment at 2 minutes from the time of spinal block, mean grade of motor block was found to be at grade 2(± 0.835) with a range of 1 to 4. At 5 minutes mean grade of motor block was 3(± 0.969) with a range of 1 to 4. At 8 minutes the mean grade of motor block was 4(± 0.597) with a range of 1 to 4.

Table 8: Table showing mean grade of motor block during assessment

Time from spinal	Minimum grade of block	Maximum grade of block	Mean grade of block	SD
2 minutes	1	4	2	0.835
5 minutes	1	4	3	0.969
8 minutes	1	4	4	0.597

Intraoperative complaints

Intraoperative patients' complaints of pain and/or abdominal discomfort were noted down together with the time of complaint from spinal administration. 10(5.1%) patients complained of pain after an average of 14.8(± 13.5) minutes within the range of 5 to 52 minutes from time of spinal administration. 31(15.8%) patients complained of abdominal

discomfort after an average of 29.3(\pm 21.8) minutes within the range of 5 to 77 minutes from time of spinal administration.

Table 9: Table showing frequency and timing of intraoperative complaints

Complaint	Frequency	Percentage (%)	Range Of Time Of Complaint After Spinal (min)	Mean Time Of Complaint After Spinal (min)	SD
Pain	10	5.1	5 – 52	14.8	13.5
Abdominal discomfort	31	15.8	5 - 77	29.3	21.8

Intraoperative drug administration

Analgesic was administered in 9(4.6%) patients and mainly comprised of IV fentanyl 50mcg and IV tramadol 100mg. Analgesic was administered after an average of 11.6(\pm 13.8) minutes within the range of 2 to 45 minutes. Sedative medication was administered in 19(9.7%) patients and mainly comprised of IV midazolam 1mg and 2 mg doses and IV ketamine 50mg and 100mg doses. Anxiolytic was administered after an average of 2.5(\pm 3) minutes within the range of 0 to 10 minutes.

Table 10: Table showing frequency and timing of intraoperative drug administration

Type Of Drug	Frequency	Percentage (%)	Range Of Time Of Administration After Spinal (Min)	Mean Time Of Administration After Spinal (Min)	SD
Analgesic	9	4.6	2 - 45	11	13.8
Sedative	19	9.7	0 - 10	2.5	3

Failed spinal anaesthesia

High doses of IV ketamine (>25mg) were administered to 13(6.7%) patients with 7(3.6%) patients receiving IV ketamine 50mg and 6(3.1%) patients receiving IV ketamine 100mg.

Spinal block was repeated in 2(1.0%) cases. Two comments were made as follows:

1. There was no block after 15minutes. Block repeated using plain bupivacaine 5mg and there was successful spinal block
2. There was no motor or sensory block after 15 minutes. Spinal block was repeated using plain bupivacaine 5mg only with subsequent successful block.

There were 4(2.0%) cases of conversion to general anaesthesia with the following comments:

1. After 8 minutes no motor or sensory block. General anaesthesia was induced and Caesarean section performed
2. Failed spinal anaesthesia after 10 minutes. Caesarean section was done under general anaesthesia
3. General anaesthesia induced at 20 minutes after spinal anaesthesia failed
4. General anaesthesia induced 15 minutes after failed spinal anaesthesia.

Correlation between motor and sensory block attained at 8 minutes and the intraoperative complaint of pain or abdominal discomfort. The results are as shown in table 11.

Table 11: Table showing correlation between block height at 8 minutes and intraoperative complaints

TEST	INTRAOPERATIVE PAIN		INTRAOPERATIVE ABDOMINAL DISCOMFORT	
	Dermatome/ Grade	P-value	Dermatome/ Grade	P-value
TOUCH	T6 T7 T10 T12	0.002	T5 T6 T7 T10 T12	0.592
COLD	T5 T6 T7 T8 T12	0.000	T3 T4 T5	0.064
PIN PRICK	T6 T7 T12	0.000	T4 T5 T6 T7 T8 T12	0.011
MOTOR BLOCK GRADE	2, 3	0.001	4	0.028

Pain and abdominal discomfort were significant where block heights were lower at 8 minutes (p-value <0.05) as indicated in bold in table 11.

DISCUSSION

Spinal anaesthesia remains the commonest anaesthetic technique in use for the facilitation of caesarean delivery, internationally as well as at the Kenyatta National Hospital. It is therefore necessary to ensure that the quality of anaesthesia being provided is of a standard that allows safe and comfortable surgery to be performed. The intention of this study was to assess the adequacy of spinal anaesthesia being provided at the Kenyatta National Hospital by assessing block height attained as well as recording intraoperative complaints due to inadequate spinal anaesthesia as well as any intraoperative pharmacological interventions administered to alleviate these complaints.

The study was conducted among 196 female patients planned for caesarean delivery, both emergency and elective. The ages of the patients therefore fell within the reproductive age range, with the mean age being 29.7 years in a range of 17 – 44 years. Majority of the patients (31.1%) fell within the age group 31 – 35 years with the second largest group (29.1%) being within age group 26 – 30 years.

During the administration of spinal anaesthesia this study demonstrated a majority of anaesthesia practitioners in KNH opting for plain bupivacaine 0.5% over hyperbaric bupivacaine 0.5% with 149(76%) of cases being performed under plain bupivacaine and only 47(24%) being performed under hyperbaric bupivacaine. This greatly differs with international recommendations and practice where hyperbaric bupivacaine is the local anaesthetic of choice for spinal anaesthesia. For example in the UK, hyperbaric bupivacaine 0.5% is the only drug licensed for use for spinal anaesthesia³. In addition, the doses used in this study were much lower than those recommended for adequate spinal anaesthesia. A majority of CS cases (142 patients, 72.4%) were done under spinal block with 7.5mg plain bupivacaine, with 3% being done under 5mg plain bupivacaine and 1 case done under 10mg plain bupivacaine. The recommended dose for spinal anaesthesia with plain bupivacaine is 10 – 15mg²⁴. Where hyperbaric bupivacaine was used, again the doses used were much lower than the standard recommended doses of 12.5 – 15mg³. In this study 37(18.9%) patients received 7.5mg intrathecal hyperbaric bupivacaine for CS; whereas 10(5.1%) patients received 5mg and 1(0.5%) patient received 10mg. fentanyl at a dose of 25mcg was used in all spinal

blocks administered, with no other additive to the spinal recorded during the duration of the study. While the use of fentanyl is in line with international standards, the dosage used also was found to be different, this time being higher than recommended. It has been recommended to use 10 – 20mcg intrathecal fentanyl for spinal anaesthesia as higher doses increase risk of side effects being exhibited³.

It is commonly accepted that a spinal block to touch is considered adequate for comfortable CS when it extends up to T5 dermatome with lower block heights being associated with intraoperative pain and discomfort^{3, 11, 17}. In this study it was found that at 8 minutes from administration of spinal block, the mean block height attained for CS at KNH is T6. While slightly lower than the recommended, it was found however to be adequate for a majority of the surgeries performed without report of pain or discomfort, and without need for analgesic or anaesthetic supplementation. This finding could indicate that either a block to touch at T6 may be considered adequate for comfortable CS. Alternatively, it is possible that the block height to touch continued to rise after 8 minutes, and possibly reached T5 or higher by the beginning of surgery.

The use of cold and sharp pin prick modalities have been used for the assessment of adequate spinal block despite much evidence in literature regarding the unreliability of these modalities in predicting an adequate spinal block^{20, 21}. In addition to this huge disadvantage is the risk of trauma to skin and patient discomfort with use of G18 needle to test pin prick. However, if used, it is recommended that block to cold and pin prick should be up to T4³. In KNH, the mean block height at 8 minutes from spinal block administration to cold and pin prick was found to be T4 and T5 respectively.

Use of motor block is also commonly used to assess adequacy of spinal block, with a block of grade IV on the Bromage scale considered additional evidence of adequate spinal anaesthesia. This modality however cannot be used in isolation to assess a spinal block as a sensory assessment must be performed.

It is known that abdominal discomfort is a common complaint during the performance of the surgery, even in cases where the spinal anaesthesia is adequate^{3, 24}. This occurs

mostly during exteriorisation of the uterus, during traction on abdominal viscera and so is greatly dependent on the surgeon and their technique. In this study, 31 (15.8%) patients complained of intraoperative abdominal discomfort, at a mean time of 29.3 minutes from the administration of the spinal block, while 10 (5.1%) patients complained of pain at a mean time of 14.2 minutes after spinal block. However only 19(9.7%) patients were given a sedative, which was given early, at a mean time of 2.5 minutes from spinal block and 9 (4.6%) patients received supplemental IV analgesia at a mean time of 11 minutes from spinal block. While it is important that the patient remains comfortable and pain free, sedation is not recommended as a routine measure. Instead, the patient should be warned of the likelihood of feeling the sensation of abdominal traction as the surgery is ongoing as this will prepare her for it and reduce the need for additional drug administration.

For this study, a spinal anaesthetic was considered to have failed when a repeat spinal block was performed, when conversion to GA was necessitated, or when high doses of IV ketamine (50 mg or more) were required for the surgery to be performed. 19 (9.7%) patients had a failed spinal anaesthetic, a higher figure in comparison to a UK survey of anaesthetic techniques for CS which reported an overall failure rate for single-shot spinal anaesthetic of 1.9%²⁵. Out of these 6 cases, 2 patients received a repeat spinal block with low dose (5mg) 0.5% plain bupivacaine and 4 patients were converted to a general anaesthetic technique. The reasons for the choice of a repeat spinal block were not recorded. However, the initial blocks were noted to have been done with a low dose of local anaesthetic (5mg bupivacaine) allowing a repeat block with the same low dose of bupivacaine with low risk of a high spinal occurring. These 2 patients who received a repeat spinal were elective CS cases, allowing enough time to elapse before considering the spinal to have failed, and repeating the spinal block without risk of adverse consequence of delaying delivery. On the other hand, the spinal blocks that failed for emergency CS were all converted to GA technique, one within only 8 minutes of administering the spinal. While this may be considered inadequate time to consider a spinal block to have failed, allowing the recommended 20 minutes to elapse before intervening may not be suitable for emergency CS where this delay could lead to maternal and/or foetal compromise.

From the analysis of the data, it is clear that block to touch below T6 is correlated with intraoperative complaints of pain, as well block to pin prick below T6 and block to cold below T5. This tallies with other published data and corresponds with the current recommendation for a spinal block to have at least a block to touch at T6 to be considered adequate for spinal anaesthesia³.

CONCLUSION

The spinal anaesthesia being administered at Kenyatta National Hospital for caesarean delivery provides block to touch to T6, block to cold to T5 and block to pin prick to T6 dermatomes.

Motor block being attained by spinal anaesthesia is grade IV on the Bromage scale.

Overall, the spinal blocks performed in KNH for CS delivery are adequate for comfortable surgery, with a failed spinal rate of 9.7%.

RECOMMENDATIONS

Routine block height testing and recording should be mandatory after administration of a spinal block, including timing and modality used for assessment. The use of block to touch is best, based on its reliability in predicting adequate spinal block to allow for comfortable surgery.

A standardised method of testing block height should be established within the KNH obstetric anaesthesia unit, to provide clear guidelines on how the assessment of block height should be performed for uniformity in assessment and block height recording.

An algorithm for management of inadequate spinal anaesthesia should be drawn up and put in place, to aid in decision making in the event of an inadequate or failed spinal anaesthetic.

Further study on the subject is required and may include:

- Relationship between adequate spinal block and drug choice and dose
- Relationship between adequate spinal block and technique of spinal administration: positioning, level of spinal, cadre of practitioner
- Patient satisfaction with spinal block for CS

STUDY LIMITATIONS

1. The skill level and technical abilities of anaesthesia providers differs and may affect the quality of anaesthesia administered. Spinal blocks performed by inexperienced anaesthesia providers are more likely to fail and this may indicate a false high number of inadequate spinal blocks.
2. Nulliparous patients may be more sensitive to pain and discomfort than multiparous patients. A high number of nulliparous patients if sampled may indicate a false high number of inadequate spinal blocks.
3. Patients who have previously received spinal anaesthesia may give responses based on their previous experiences including reporting numbness where the

patient believes she should be numb rather than where she is actually experiencing it. The level of anaesthesia recorded will be false therefore.

4. There is a possibility that a rise in block height may have occurred beyond 8 minutes of block assessment.

APPENDIX 1: STUDY DATA FORM

Serial number _____

BIODATA

Age _____ Parity _____ Gestation _____ Weight _____

PAST MEDICAL HISTORY

Previous CS (Y/N) _____ If yes, type of anaesthesia used _____

Previous other surgery (Y/N) _____ If yes, type of anaesthesia used _____

CURRENT MEDICAL HISTORY

Diagnosis _____ Emergency/Elective surgery _____

Indication for surgery _____

SPINAL ANAESTHESIA

Time of spinal administration _____ Drugs, dosage used: 1) Plain bupivacaine _____

2) Hyperbaric bupivacaine _____

3) Fentanyl _____

4) Other _____

SPINAL BLOCK TEST

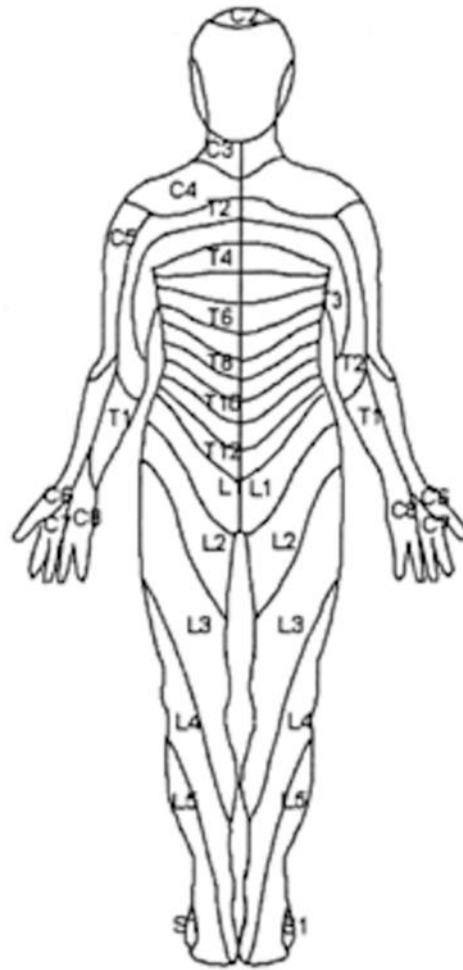
Kindly see table and dermatome chart

TIME FROM ADMIN OF SPINAL	HIGHEST LEVEL OF BLOCK (DERMATOME)						MOTOR BLOCK
	TOUCH		COLD		PIN PRICK		GRADE
	L	R	L	R	L	R	
2 minutes							
5 minutes							
8 minutes							

MOTOR BLOCK TEST

Grade	Criteria
I	Free movement of legs and feet
II	Just able to flex knees with free movement of feet
III	Unable to flex knees, but with free movement of feet
IV	Unable to move legs or feet

DERMATOME CHART



INTRAOPERATIVELY

Patient complained of pain (Y/N) _____ Time of first complaint _____

Patient complained of abdominal discomfort (Y/N) _____ Time of first complaint _____

Analgesic administered (Y/N) _____ Drug, dose given _____ Time given _____

Anxiolytic administered (Y/N) _____ Drug, dose given _____ Time given _____

Conversion to GA (If yes, please comment) _____

Repeat spinal block (If yes, please comment) _____

APPENDIX 2: CONSENT FOR PARTICIPATION IN SPINAL ANAESTHESIA ASSESSMENT STUDY

CONSENT EXPLANATION TO THE PATIENT

My name is Dr. Kimberly Kamau. I am currently pursuing a postgraduate degree in Anaesthesia at the University of Nairobi. As part of my degree coursework I am required to perform clinical research.

The purpose of my study is to assess the adequacy of the spinal anaesthesia being administered to allow for comfortable and pain free surgery. To achieve this, data on your age, weight, parity, surgical and anaesthetic history will be taken confidentially. We shall also record the level of numbness after the spinal anaesthetic and whether or not you will be able to move your legs prior to surgery. None of this information will include your personal details or your identity. The results of this study will help us to improve on our anaesthetic practice to ensure all patients receive adequate anaesthesia for comfortable and safe caesarean delivery. The results of this study will be made available to you upon request. Your participation in this study will be voluntary and you may decide to withdraw from it at any stage without any penalty. The study is purely observational, non-invasive and will not attract any additional cost to your treatment. Your participation will not interfere with the regular management of your condition before, during or after surgery. There will be no monetary benefit to you for participating in the study.

This study is being conducted with the approval of The Kenyatta National Hospital /University of Nairobi's Ethical and Research Committee.

CONSENT FORM

I,..... after being fully explained to by Dr. Kimberly Kamau and/or the research team the purpose, technique, advantages, possible complications and guarantees of confidentiality, do voluntarily agree to participate in this study. I have also been told that declining to participate in, or withdrawing from the study will not in any way compromise the care I receive.

Signature (Participant) Date.....

Name and Signature (Investigator)

Designation..... Date.....

For any clarifications or queries kindly contact:

Dr. Kimberly Kamau - 0722 669 209

You may also reach one of my supervisors as follows:

Prof. Zipporah Ngumi – 0722 218 921

Dr. Antony Gatheru – 0721 832 774

In addition, for any queries on ethical issues, contact:

Prof. Chindia, Secretary KNH/UON Nairobi Ethical and Research Committee - 020
726300-9

IDHINI MAELEZO KWA MGONJWA

Kwa jina naitwa Dkt Kimberly Kamau. Nipo kwenye harakati kusomea shahada ya uzamili katika Anaesthesia nikiwa Chuo Kikuu cha Nairobi.

Nafanya utafiti ambao lengo napenda kuelezea. Madhumuni ya utafiti wangu ni kutathmini utoshelevu wa anesthesia ya uti wa mgongo itakayo tumiwa kuruhusu upasuaji uliyo ya starehe na bila maumivu. Ili kufanikisha hili, data ikiwemo umri wako, uzito, usawa, pamoja na historia yeyote ya upasuaji na anesthesia iliyo shawahi kutumiwa kwako awali, zitachukuliwa kwa siri. Pamoja na hayo tutarekodi kiwango chako cha kuganda baada ya kupewa anesthesia ya uti wa mgongo, na kama utakuwa na uwezo wa hoja ya miguu yako kabla ya upasuaji. Hii habarihaitakuwa pamoja na maelezo yako binafsi au utambulisho wako. Matokeo ya utafiti huu utatusaidia kuboresha utendaji wetu wa anesthesia kuhakikisha wagonjwa wote wana pokea anesthesia ya kutosha kwa ajili ya starehe na usalama ya upasuaji wa kujifungua. Ikiwa utahitaji kuyajua matokeo ya utafiti huu zitolewa kwakobaada yako kulitoa ombi. Kujumuishwa kwako katika huu utafiti kunafanywa kwa hiari yako na unaweza kujiondoa kwa wakati wowote utakao.

Utafiti huu hautakugharimu pesa zozote na hautaongeza ada yako ya hospitali. Utafiti hautaingilia matibabu yako kwa vyovyote vile na wala hautapata marupurupu yoyote kwa kujumuishwa katika huu utafiti.

Utafiti huu umeidhinishwa na Kenyatta National Hospital/ University of Nairobi Ethics and Research Committee.

Mimi....., baada ya kuelezwa kwa kina sababu, manufaa, madhara na kupewa hakikisho ya kuweka siri jina langu, nakubali kwa hiari kushiriki katika utafiti huu. Sitalipishwa chochote kwa kushiriki katika utafiti huu, na sita lipwa kwa njia yoyote. Nimehakikishiwa kwamba, nikikataa kushiriki katika utafiti huu, sita dhulumiwa kwa njia yoyote ile.

Sahihi (mshiriki)..... Tarehe.....

Jina na sahihi (Daktari).....

Kitengo cha daktari..... Tarehe.....

Kwa maelezo zaidi na ufafanuzi, waweza kuwasiliana na

Dkt. Kimberly Kamau - 0722 669 209

Aidha, unaweza ukawasiliana na mmoja wa wasimamizi wangu kama walivyo andikwa hapo chini:

Prof. Zipporah Ngumi - 072 221 8921

Dkt. Antony Gatheru - 0721832774.

Pia, kwa maswali yanayohusu maadili, unaweza kuwasiliana na Prof. Chindia, Katibu wa KNH/UON Ethical and Research Committee -020 726300-9.

APPENDIX 3: WORKING BUDGET

ITEM	UNIT COST (KSH)	QUANTITY	TOTAL COST(KSH)
Stationery	550	3	1650
Binding	450	5	2250
Spinal needles G25	85	80	6800
Fentanyl sulphate 100µg	90	80	7200
Bupivacaine 0.5% 10mls	235	80	18800
Lignocaine 2% 20mls	80	5	400
Normal Saline 500mls	200	80	16000
Methylated spirit 5litres	1200	1	1200
Betadine (aqueous) 250ml	180	3	540
Branula G18	100	80	800
Hypodermic needles G18	10	80	800
Infusion sets	100	80	8000
ECG electrodes	30	250	7500
Syringes (Assorted)	10	200	3500

Statistician's fee		15000	15000
Research Assistant		5000	5000
TOTAL			Ksh 70,640

APPENDIX 4: BROMAGE SCALE

Grade	Criteria	Degree of block
I	Free movement of legs and feet	Nil (0%)
II	Just able to flex knees with free movement of feet	Partial (33%)
III	Unable to flex knees, but with free movement of feet	Almost complete (66%)
IV	Unable to move legs or feet	Complete (100%)

APPENDIX 5: SPINAL ANAESTHESIA PROTOCOL KENYATTA NATIONAL HOSPITAL MATERNITY THEATRE

PROTOCOL FOR SPINAL ANESTHESIA AT THE KENYATTA NATIONAL HOSPITAL

1. Know the indications & contra-indications
2. Inform the patient what you wish to do and have their cooperation
3. Inform the rest of the team in theatre so you can be assisted appropriately
4. Insert a good gauge I/V cannulae (20 or larger)
5. Pre-load with ½ -1L N/saline / Hartmans over 30- 60mins

6. Install your monitors (pulse, respiration, SPO2, BP, ECG) and take baseline readings
7. Position the patient either sitting or lateral knee-chest. Make the patient comfortable
8. Open your Spinal Tray & clean the site & drape.

Spinal Tray should contain:-

- a) Sterile towels for draping the patient
- b) 2 gulley pots for holding cleaning solutions
- c) Appropriate spinal needle (with introducer where required)
- d) 2 syringes & Needles
 - i. 5ml syringe for infiltration of L.A to the site
 - ii. 2ml syringe for administering the spinal medication
 - iii. Sterile gauze pads for cleaning & dressing
9. Reconfirm the position of the patient (knee chest)
10. Identify the site: mid-line L3-4/ 4-5 & administer 3ml of 1% lignocaine using a gauze 21 needle to maximum depth. Withdraw the needle as you continue to administer L.A and raise a skin wheal.
11. Give 1-2 minutes for the L.A to take effect as you re-assure & position patient (if administered well, this usually covers one vertebra above & below, should you need to alter position of lumbar puncture)
12. While waiting for L.A to take effect, prepare your appropriate drug. You must have decided whether using plain or heavy L.A
 - a) Remember Heavy L.A is position dependent. The patient must be appropriately positioned after injection to allow desired distribution.

- b) Bupivacaine is usually 0.5% concentration. The highest volume in tall patients will be 4 ml (20mg). Most patients will require between 7.5mg (1.5mls) to 15 mg (3ml).
- c) Obstetric patients are more sensitive and will require between 10mg (2ml) to 12.5mg (2.5ml). Aim for a block up to T6. Test and record level of block.
- d) Additive: 25mg Fentanyl (0.5ml) is a useful additive to prevent the discomfort of gut handling during CS etc. This must still make up the total volume of 2-2.5 ml of drug injected into the spinal canal. Other drugs have been used as additives but its best to avoid them unless you have been trained to use them. The haphazard use of additives into the CSF may have disastrous results.
- e) Remember for CS the volume & position is critical to achieve a good or disastrous spinal block. Aim for a block up to T6.

13. Confirm the L.A has taken effect and note level/site for the block.

Insert the spinal needle. Usually there is a sudden give when the needle goes through the dura. Withdraw the stylet and check for CSF flow. Do not allow unnecessary drainage of CSF. Use the stylet to stop the flow temporarily, if you cannot administer the spinal drug immediately.

14. Administer the drug, dress the puncture site and position the patient appropriately to allow planned distribution of drugs. Rapid positioning after administration is critical if the drug used is hyperbaric (heavy).

15. Start your post-spinal monitoring & make adjustments accordingly. It is recommended to repeat BP readings at 1 minute intervals. You will need to respond rapidly to the initial changes in pulse & BP. Ask the patient to inform you immediately if nausea occurs. Nausea in spinal anaesthesia is most likely due to hypotension. It is an early warning sign that you must not ignore.

16. Test the level of the block. The tilt of the bed may have to be adjusted if using hyperbaric Local Anaesthetic to change drug distribution. This manipulation may only work within the first 10-20 minutes after administration of the L.A into the CSF.

17. Post-operative pain management - I/M Pethidine 1mg/kg 4-6 hourly for 24 hours

- Diclofenac suppository (or equivalent) stat & 12 hourly for 48 hours then orals.

- Follow up visit, within 24 hours.

18. Critical observation

a) Pulse – symptomatic bradycardia – Atropine 0.1 -0.6mg

b) SPO2 saturation $\leq 90\%$ - Increase the O2 flow.

c) BP –symptomatic Hypotension

-Ephedrine -5mg-10mg PRN (you may occasionally need an infusion)

- Phenylephrine

- Adrenaline

d) Respiration –falling respiratory rate (usually temporary)

-Give oxygen

-Assist with respiration briefly if required

-Reassure

e) Total Spinal Anaesthesia

i. Convulsions /loss of consciousness

ii. Respiratory failure

iii. Cardiovascular collapse

Intubate, ventilate, cardiac massage, vasopressors, anticonvulsants till vital signs stabilize.

f) Post spinal headaches

May occur post operatively. Are worse on standing & relieved by lying down.

Management

i. Bed rest

- ii. Plenty of fluids
- iii. Non-Steroidal Anti-inflammatory Drugs (NSAIDS)
- iv. Epidural blood patch as a last resort

19. Post-Operatively –monitor BP ¼ hourly for 2hrs.

Positioning –make patient comfortable with pillow under the head.

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January, 1999.

APPENDIX 6: STUDY TIMELINES

February 2014 – Submission of dissertation proposal for approval from KNH/UON Ethical and Research Committee

March 2014 – Data collection

April 2014 – Data compilation and analysis

May 2014 – Completion of study

APPENDIX 7: KENYATTA NATIONAL HOSPITAL CONSENT FORM FOR SURGERY

CONSENT BY PATIENT/NEXT OF KIN FOR AN OPERATION

I of hereby consent to undergo the operation(s) of the nature and effect of which have been explained to me by Dr./Mr.

I also consent to such further or alternative operative measures as may be found to be necessary during the course of the operation and to the administration of a local or other anaesthetic for any of these purposes.

*No assurance has been given to me that the operation will be performed by a particular surgeon.

Date..... (Signed) I confirm that I have explained to the patient the nature and effect of this operation.

Date (Signed)

*Delete if not required

KUKUBALI KWA MGONJWA/MCHUNGAJI KWA UPASUAJI

Mimi, kutoka nimekubali kwenda kwa utabibuwa kupasuliwa kwa Ugonjwa ambao nimeisha ambiwa na Daktari au Bwana

Mimi tena nimekubali kwa ugonjwa mwingine utakaopatikanawakati wa kupasuliwa na upeanaji wa dawa.

*Sina ukweli yakwamba upasuliwaji wangu utaendeshwa na Daktari yule au huyu.

Tarehe Sahihi

Nahakikisha yakwamba nimemweleza mgonjwa aina ya ugonjwa na namna ya upasuaji.

Tarehe Sahihi

*Futa kama haitakiwi

APPENDIX 8: STUDY APPROVAL



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Ref: KNH-ERC/A/139

Link: www.uonbi.ac.ke/activities/KNHUoN

15th May 2014

Dr. Kimberly N. Kamau
Dept. of Anaesthesia
School of Medicine
University of Nairobi

Dear Dr. Kamau

RESEARCH PROPOSAL: ASSESSMENT OF BLOCK HEIGHT FOR SATISFACTORY SPINAL ANAESTHESIA FOR CAESAREAN SECTION IN KENYATTA NATIONAL HOSPITAL (P88/02/2014)

This is to inform you that the KNH/UoN-Ethics & Research Committee (KNH/UoN-ERC) has reviewed and **approved** your above proposal. The approval periods are 15th May 2014 to 14th May 2015.

This approval is subject to compliance with the following requirements:

- a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
- b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH/UoN ERC before implementation.
- c) Death and life threatening problems and severe adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH/UoN ERC within 72 hours of notification.
- d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH/UoN ERC within 72 hours.
- e) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
- f) Clearance for export of biological specimens must be obtained from KNH/UoN-Ethics & Research Committee for each batch of shipment.
- g) Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/or plagiarism.

For more details consult the KNH/UoN ERC website www.uonbi.ac.ke/activities/KNHUoN.

Protect to Discover

APPENDIX 9: DECLARATION OF ORIGINALITY OF WORK



UNIVERSITY OF NAIROBI Declaration of Originality Form

Name of Student _____ Kimberly Nyaguthii Kamau _____

Registration Number _____ H58/68695/2011 _____

College _____ Health Sciences _____

Faculty/School/Institute _____ School Of Medicine _____

Department _____ Department Of Anaesthesia _____

Course Name _____ Master Of Medicine in Anaesthesia _____

Title of work _____ Assessment Of Block Height For Satisfactory Spinal
Anaesthesia For Caesarean Section In Kenyatta National Hospital _____

DECLARATION

1. I understand what Plagiarism is and I am aware of the University's policy in this regard
2. I declare that this _____ Thesis _____ (Thesis, project, essay, assignment, paper, report, etc) is my original work and has not been submitted elsewhere for examination, award of a degree or publication. Where other people's work or my own work has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi's requirements.
3. I have not sought or used the services of any professional agencies to produce this work.
4. I have not allowed, and shall not allow anyone to copy my work with the intention of passing it off as his/her own work.
5. I understand that any false claim in respect of this work shall result in disciplinary action, in accordance with University Plagiarism Policy.

Signature of student _____

Date _____

Signature of supervisor(s) _____

Date _____

Signature of supervisor(s) _____

Date _____

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