“BODY MASS INDEX AND SPREAD OF LOCALANAESTHETIC IN SUB ARACHNOID BLOCK:AN OBSERVATIONAL STUDY”

By

Dr. THUMMALA SUSMITHA

DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, KOLAR, KARNATAKA

In partial fulfillment of the requirements for the degree of

DOCTOR OF MEDICINE

IN

ANAESTHESIOLOGY

Under the Guidance of

Dr. KIRAN N

Professor

DEPARTMENT OF ANAESTHESIOLOGY,

SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA,

KOLAR-563101

2025

SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR-563101

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled **""BODY MASS INDEX AND SPREAD OF LOCAL ANAESTHETIC IN SUB ARACHNOID BLOCK:AN OBSERVATIONAL STUDY**" is a bonafide and genuine research work carried out by me under guidance of **Dr. KIRAN N** Professor, Department of Anaesthesiology and Critical care, Sri Devaraj Urs Medical College, Tamaka, Kolar.

Date: **Dr. THUMMALA SUSMITHA**

Place: Kolar

SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR-563101

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation/thesis entitled **"BODY MASS INDEX AND SPREAD OF LOCAL ANAESTHETIC IN SUB ARACHNOID BLOCK:AN OBSERVATIONAL STUDY**" is a bonafide and genuine research work carried out by **Dr. THUMMALA SUSMITHA** in partial fulfilment of the requirement for the degree of **DOCTOR OF MEDICINE** in **ANAESTHESIOLOGY.**

Date :

Place : KOLAR

Dr. KIRAN N
PROFESSOR
Department of Anaesthesiology
Sri Devraj Urs Medical College
Tamaka, Kolar.

SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR-563101

ENDORSEMENT BY THE HOD, PRINCIPAL / HEAD OF THE INSTITUTION

This is to certify that the dissertation/thesis entitled **"BODY MASS INDEX AND SPREAD OF LOCAL ANAESTHETIC IN SUB ARACHNOID BLOCK:AN OBSERVATIONAL STUDY**" is a bonafide and genuine research work carried out by **Dr THUMMALA SUSMITHA** in partial fulfilment of the requirement for the degree of **DOCTOR OF MEDICINE** in **ANAESTHESIOLOGY.**

Dr. SURESH KUMAR N MD IDCCM	**Dr. PRABHAKAR K**
Professor & HOD	Principal,
Department of Anaesthesiology,	Sri Devaraj Urs Medical College
Sri Devaraj Urs Medical College,	Tamaka, Kolar
Tamaka, Kolar	
Date :	Date :

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION & RESEARCH

SRI DEVARAJ URS MEDICAL COLLEGE

Tamaka, Kolar

INSTITUTIONAL ETHICS COMMITTEE

Members

1. **Dr. D.E.Gangadhar Rao, (Chairman)** Prof. & HOD of Zoology, Govt. Women's College, Kolar
2. **Dr. Sujatha.M.P, (Member Secretary),** Prof. Department of Anesthesia, SDUMC
3. Mr. Gopinath Paper Reporter, Samyukth Karnataka
4. Mr. G. K. Varada Reddy Advocate, Kolar
5. Dr. Hariprasad S, Prof. Dept, of Orthopedics, SDUMC
6. Dr. Abhinandana R Asst. Prof. Dept. of Forensic Medicine, SDUMC
7. Dr. Ruth Sneha Chandrakumar Assoc. Prof. Dept. of Psychiatry, SDUMC
8. Dr. Usha G Shenoy, Asst. Prof., Dept. of Allied Health & Basic Sciences SDUAHER
9. Dr. Munilakshmi U Asst. Prof. Dept. of Biochemistry, SDUMC
10. Dr.D.Srinivasan, Assoc. Prof. Dept. of Surgery, SDUMC
11. Dr.Shilpa M D Assoc. Prof. Dept. of Pathology, SDUMC

No. DMC/KLR/IEC/48/ 2023-24 **Date: 10/04/2023**

PRIOR PERMISSION TO START OF STUDY

The Institutional Ethics Committee of Sri Devaraj Urs Medical College, Tamaka, Kolar has examined and unanimously approved the synopsis entitled **"Body Mass Index And Spread Of Local Anaesthetic In Sub Arachnoid Block:An Observational Study"** being investigated by **Dr.Thummala Susmitha & Dr. Kiran N** in the Department of Anaesthesiology at Sri Devaraj Urs Medical College, Tamaka, Kolar. **Permission is granted by the Ethics Committee to start the study.**

Sujatha. M.P
Member Secretary
Member Secretary
Institutional Ethics Committee
Sri Devaraj Urs Medical College
Tamaka, Kolar

Chairman
CHAIRMAN
Institutional Ethics Committee
Sri Devaraj Urs Medical College
Tamaka, Kolar

COPY RIGHT

DECLARATION BY THE CANDIDATE

I hereby declare that the Sri Devaraj Urs Academy of Higher Education and Research Center, Kolar, Karnataka shall have the rights to preserve, use and disseminate this dissertation/thesis in print or electronic format for academic/ research purpose.

Date:

Place: Kolar **Dr. THUMMALA SUSMITHA**

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION & RESEARCH
TAMAKA, KOLAR, KARNATAKA, INDIA 563103

CERTIFICATE OF PLAGIARISM CHECK

Title of the Thesis/Dissertation	**BODY MASS INDEX AND SPREAD OF LOCAL ANAESTHESTIC IN SUB ARACHNOID BLOCK:OBSERVATIONAL STUDY**
Name of the Student	DR. THUMMALA SUSMITHA
Registration Number	22AN1045
Name of the Supervisor / Guide	DR.KIRAN N.
Department	ANAESTHESIOLOGY
Acceptable Maximum Limit (%) of Similarity (PG Dissertation /Ph.D. Thesis)	10 %
Similarity	09%
Software used	TURNITIN
Paper ID	2657369487
ORCID ID	0009-0005-7293-9126
Submission Date	05/05/2025

Signature of Student

Signature of Guide/Supervisor

Professor
Department of Anaesthesiology
PG
SDUMC/SDUAHER
Tamaka, Kolar-563103

Professor and Head
Department of Anaesthesiology
Sri Devaraj Urs Medical College
R.L. Jalappa Hospital & Research Centre
TAMAKA, KOLAR-563 103

HOD Signature

University Librarian

University Library
Learning Resource Centre
SDUAHER, Tamaka
KOLAR-563103

PG Coordinator

PG Coordinator
Sri Devaraj Urs Medical College
Tamaka, Kolar-563103

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	Dr. Thummala Susmitha
Assignment title:	PG Dissertation - 2025
Submission title:	BODY MASS INDEX AND SPREAD OF LOCAL ANAESTHETIC IN S...
File name:	STHETIC_IN_SUB_ARACHNOID_BLOCKm_AN_OBSERVATIONAL_...
File size:	525.07K
Page count:	59
Word count:	9,892
Character count:	49,649
Submission date:	05-May-2025 11:07AM (UTC+0530)
Submission ID:	2657369487

BODY MASS INDEX AND SPREAD OF LOCALANAESTHETIC IN SUB ARACHNOID BLOCK:AN OBSERVATIONAL STUDY

ABSTRACT

Background: Subarachnoid block (SAB), commonly known as spinal anaesthesia, is a widely utilized regional anaesthetic technique for abdominal and lower limbs surgery. The effectiveness and distribution of local anaesthetic agents administered via SAB are influenced by a range of physiological and demographic factors, with body mass index (BMI) being a significant contributor. Elevated BMI, particularly in obese individuals, has been associated with changes in cerebrospinal fluid (CSF) volume and flow dynamics, which can alter the spread, onset, and duration of the anaesthetic effect. These alterations may result in unpredictable anaesthetic responses, underscoring the importance of assessing the role of BMI in determining the characteristics and efficacy of spinal anaesthesia.

Aim: To compare the spread, onset, and recovery characteristics of local anaesthetic in spinal anaesthesia between obese and non-obese patients undergoing elective lower abdominal surgeries.

Material & Methods: A comparative study involving 110 patients aged 18 to 59 years and classified as ASA physical status I-II was conducted at R.L. Jalappa Hospital and Research Center. The participants were stratified into two groups based on body mass index (BMI): Group 1 included patients with BMI <25 kg/m² (n=55), and Group 2 comprised those with BMI ≥25 kg/m² (n=55). Spinal anaesthesia was administered uniformly. Key anaesthetic parameters—including the onset time of sensory and motor blockade, time to achieve

Document Viewer

Turnitin Originality Report

Processed on: 05-May-2025 11:08 IST
ID: 2657369487
Word Count: 9892
Submitted: 2

BODY MASS INDEX AND SPREAD OF LOCAL ANAESTHET... By Dr. Thummala Susmitha

Similarity Index	Similarity by Source	
9%	Internet Sources:	6%
	Publications:	9%
	Student Papers:	2%

include quoted | include bibliography | excluding matches < 14 words | mode: quickview (classic) report | print | refresh | download

1% match (student papers from 11-Mar-2025)
Submitted to Aarupadai Veedu Medical College and Hospital on 2025-03-11

<1% match (Internet from 27-Feb-2022)
https://link.springer.com/article/10.1186/s42077-022-00215-4?code=37494867-fced-494d-b3be-6c65bd38cf61&error=cookies_not_supported

<1% match (Internet from 25-Sep-2022)
https://link.springer.com/chapter/10.1007/978-3-030-81333-8_3?code=928e01bc-fb01-44f8-a196-28ce2a8859ea&error=cookies_not_supported

<1% match (Internet from 05-Feb-2023)
https://www.researchgate.net/publication/5666702_Clinical_Importance_of_Obesity_Versus_the_Metabolic_Syndrome_in_Cardiovascular_Risk

<1% match (Internet from 22-Feb-2023)
https://www.researchgate.net/publication/1160943_Spinal_Ropivacaine_for_Cesarean_Section

<1% match (Internet from 25-Feb-2023)
https://aacc.tums.ac.ir/index.php/aacc/article/view/205

<1% match (publications)
B. Sundaravadivazhagan, Sekar Mohan, Balakrishnaraja Rengaraju, "Recent Developments in Microbiology, Biotechnology and Pharmaceutical Sciences - International Conference on Recent Development in Microbiology, Biotechnology and Pharmaceutical Science", CRC Press, 2025

<1% match (Internet from 15-Dec-2022)
https://www.ncbi.nlm.nih.gov/books/NBK557521/?report=classic

<1% match (Hamzeh Hosseinzadeh, Dawood Aghamohammadi, Marzieh Marahem, Negin Magsumi, Parisa Hosseinzadeh. "Correlation of Body Mass Index and Spread of Spinal block in Herniorrhaphy Patients Under Spinal Anesthesia", Archives of Anesthesia and Critical Care, 2019)
Hamzeh Hosseinzadeh, Dawood Aghamohammadi, Marzieh Marahem, Negin Magsumi, Parisa Hosseinzadeh. "Correlation of Body Mass Index and Spread of Spinal block in Herniorrhaphy Patients Under Spinal Anesthesia", Archives of Anesthesia and Critical Care, 2019

<1% match (Internet from 21-Jun-2023)
http://iosrjournals.org

<1% match ("Euroanaesthesia 2004: Joint Meeting of the European Society of Anaesthesiologists and European Academy of Anaesthesiology Lisbon, Portugal, 5-8 June 2004", European Journal of Anaesthesiology, 09/14/2005)
"Euroanaesthesia 2004: Joint Meeting of the European Society of Anaesthesiologists and European Academy of Anaesthesiology Lisbon, Portugal, 5-8 June 2004", European Journal of Anaesthesiology, 09/14/2005

<1% match (S. Shellikeri, Neha. "Malignancy in Neck Masses", Rajiv Gandhi University of Health Sciences (India), 2023)
S. Shellikeri, Neha. "Malignancy in Neck Masses", Rajiv Gandhi University of Health Sciences (India), 2023

<1% match (Internet from 01-May-2016)
http://www.wjgnet.com

<1% match ()
Mohamed Thaiyub Khan, M A. "A Comparative Study of Intrathecal Dexmedetomidineand Buprenorphine as Adjuvant to Bupivacaine in Spinal Anaesthesia", 2015

<1% match ("EUROANAESTHESIA 2006: Annual Meeting of the European Society of Anaesthesiology, Madrid, Spain, June 3-6, 2006", European Journal of Anaesthesiology, 06/2006)
"EUROANAESTHESIA 2006: Annual Meeting of the European Society of Anaesthesiology, Madrid, Spain, June 3-6, 2006", European Journal of Anaesthesiology, 06/2006

<1% match (Supriya. "Comparative Study of Endothelial Cell Loss Using Specular Microscopy Following Small Incision Cataract Surgery Versus Phacoemulsification", Rajiv Gandhi University of Health Sciences (India), 2023)
Supriya. "Comparative Study of Endothelial Cell Loss Using Specular Microscopy Following Small Incision Cataract Surgery Versus Phacoemulsification", Rajiv Gandhi University of Health Sciences (India), 2023

<1% match (Internet from 12-Nov-2021)
https://pubmed.ncbi.nlm.nih.gov/22577905/

<1% match (J.M. Boon. "Lumbar puncture: Anatomical review of a clinical skill", Clinical Anatomy, 2004)
J.M. Boon. "Lumbar puncture: Anatomical review of a clinical skill", Clinical Anatomy, 2004

Professor
Department of Anaesthesiology
B.L. Talama Hospital & RC
SDUAHER
Tamaka, Kolar-563103

University Library
Learning Resource Centre
SDUAHER, Tamaka
KOLAR-563103

<1% match (Internet from 03-May-2025)
https://openanesthesiajournal.com/contents/volumes/V19/e25a96458358705/e25896458358705.pdf

<1% match (Katlinge, Praveen Kumar. "A Comparative Study Between Isobaric Levobupivacaine and Isobaric Levobupivacaine with Fentanyl in Patients Posted for Lower Abdominal and Lower Limb Surgeries Under Spinal Anaesthesia", Rajiv Gandhi University of Health Sciences (India), 2023)
Katlinge, Praveen Kumar. "A Comparative Study Between Isobaric Levobupivacaine and Isobaric Levobupivacaine with Fentanyl in Patients Posted for Lower Abdominal and Lower Limb Surgeries Under Spinal Anaesthesia", Rajiv Gandhi University of Health Sciences (India), 2023

<1% match (Gulec, D., B. Karsli, F. Ertugrul, Z. Bigat, and N. Kayacan. "Intrathecal bupivacaine or levobupivacaine: Which should be used for elderly patients?", Journal of International Medical Research, 2014.)
Gulec, D., B. Karsli, F. Ertugrul, Z. Bigat, and N. Kayacan. "Intrathecal bupivacaine or levobupivacaine: Which should be used for elderly patients?", Journal of International Medical Research, 2014.

<1% match (Hites, M., and F. S. Taccone. "Optimization of antibiotic therapy in the obese, critically ill patient", Réanimation, 2015.)
Hites, M., and F. S. Taccone. "Optimization of antibiotic therapy in the obese, critically ill patient", Réanimation, 2015.

<1% match (Manju Bala, Pravesh Kumar, Monica Chhikara, Deepika Seelwal, Preeti Gehlaut. "Correlation of Vertebral Column Length and Abdominal Circumference with Subarachnoid Block Characteristics of Hyperbaric Ropivacaine for Infraumbilical Surgeries: A Single-arm Interventional Study", JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH, 2024)
Manju Bala, Pravesh Kumar, Monica Chhikara, Deepika Seelwal, Preeti Gehlaut. "Correlation of Vertebral Column Length and Abdominal Circumference with Subarachnoid Block Characteristics of Hyperbaric Ropivacaine for Infraumbilical Surgeries: A Single-arm Interventional Study", JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH, 2024

<1% match (Internet from 26-Jul-2024)
https://brightideas.houstontx.gov/ideas/what-would-you-expect-to-find-in-a-person-experiencing-respi-hgos

<1% match (publications)
Edouard Battegay, George L. Bakris, Gregory Y.H. Lip. "Hypertension - Principles and Practice", CRC Press, 2019

<1% match (Internet from 01-Oct-2021)
https://jemds.com/latest-articles.php?at_id=9273

<1% match (Internet from 02-Nov-2024)
https://peerj.com/articles/18074/

<1% match (Internet from 16-May-2013)
http://publications.milliman.com

<1% match (Chauhan, Rajeev. "A Comparison of Propofol and Desflurane to Assess Quality of Surgical Field During Endoscopic Sinus Surgery", Postgraduate Institute of Medical Education and Research, Chandigarh (India), 2024)
Chauhan, Rajeev. "A Comparison of Propofol and Desflurane to Assess Quality of Surgical Field During Endoscopic Sinus Surgery", Postgraduate Institute of Medical Education and Research, Chandigarh (India), 2024

BODY MASS INDEX AND SPREAD OF LOCALANAESTHETIC IN SUB ARACHNOID BLOCK:AN OBSERVATIONAL STUDY

ABSTRACT Background: Subarachnoid block (SAB), commonly known as spinal anaesthesia, is a widely utilized regional anaesthetic technique for abdomen and lower limbs surgery. The effectiveness and distribution of local anaesthetic agents administered via SAB are influenced by a range of physiological and demographic factors, with body mass index (BMI) being a significant contributor. Elevated BMI, particularly in obese individuals, has been associated with changes in cerebrospinal fluid (CSF) volume and flow dynamics, which can alter the spread, onset, and duration of the anaesthetic effect. These alterations may result in unpredictable anaesthetic responses, underscoring the importance of assessing the role of BMI in determining the characteristics and efficacy of spinal anaesthesia. Aim: To compare the spread, onset, and recovery characteristics of local anaesthetic in spinal anaesthesia between obese and non-obese patients undergoing elective lower abdominal surgeries. Material & Methods: A comparative study involving 110 patients aged 18 to 59 years and classified as ASA physical status I–II was conducted at R.L. Jalappa Hospital and Research Centre. The participants were stratified into two groups based on body mass index (BMI): Group 1 included patients with BMI <25 kg/m² (n=55), and Group 2 comprised those with BMI >25 kg/m² (n=55). Spinal anaesthesia was administered uniformly. Key anaesthetic parameters—including the onset time of sensory and motor blockade, time to achieve I maximum block height, and duration of block recovery—were systematically recorded. Data analysis was performed using SPSS version 26.0, with statistical significance set at a p-value less than 0.05. Results: Obese patients (Group 2) demonstrated a significantly longer onset time and duration for both sensory and motor blocks compared to non-obese patients ($p<0.05$). However, there was no significant difference in the duration of surgery or anaesthesia between the two groups. Conclusion: BMI significantly influences the pharmacodynamics of spinal anaesthesia. Obese patients exhibit delayed onset and prolonged duration of spinal block, highlighting the need for individualized anaesthetic dosing and monitoring to enhance patient safety and efficacy of spinal anaesthesia in higher BMI populations. Keywords: Spinal anaesthesia, Subarachnoid block, Body mass index, Obesity, Sensory block, Motor block, Anaesthetic spread II INTRODUCTION Spinal anaesthesia, often referred to as a subarachnoid block (SAB), is a commonly employed regional anaesthesia method for a range of surgical procedures. It is especially prevalent in surgeries involving the lower abdomen, pelvis, and lower limbs.1,2 "Numerous physiological and demographic parameters, including age, weight, height, body mass index (BMI), and the patient's position after the injection, influence the properties and efficacy of spinal anesthesia. BMI is one of these variables that has drawn more attention lately, especially in light of the worldwide obesity epidemic and its possible impact on the distribution and results of anesthesia."3,4 "Obesity has been linked to an increased cephaloid (upward) spread of local anaesthetic agents in the subarachnoid space, which can result in a higher level of sensory blockade and a longer duration of anaesthesia."5 This effect is mainly due to a reduced cerebrospinal fluid (CSF) volume in obese individuals, caused by the accumulation of epidural fat and the expansion of the epidural venous plexus. The reduction in CSF volume may allow the anaesthetic to spread more extensively, influencing both the onset and duration of spinal anaesthesia. These physiological changes present a challenge for anaesthesiologists when determining the appropriate dose of local anaesthetic, as improper dosing could lead to complications such as high spinal block, excessive hypotension, and respiratory depression.5 Additionally, the distribution and metabolism of local anaesthetic drugs may vary between obese and non-obese participants, potentially affecting the pharmacokinetics and pharmacodynamics of spinal anaesthesia. Increased intra-abdominal pressure in obese individuals can also influence cerebrospinal fluid (CSF) dynamics, further impacting the spread of anaesthesia. Recognizing these differences is essential for optimizing anaesthetic management and ensuring patient safety, especially for individuals with a high BMI.6,7 Given these

ACKNOWLEDGEMENT

*First and foremost, I thank the **"Lord Almighty"** for showering his blessings and giving me the strength during my post-graduation and providing me everything that I required in completing my dissertation.*

I would like to acknowledge all those who have supported me, not only to complete my dissertation, but helped me throughout my post-graduation course.

*I attribute the success of my dissertation and owe immense gratitude to my mentor and guide **Dr. KIRAN. N,** Professor, Department of Anaesthesiology, for being very helpful throughout the study, whose valuable guidance has helped me patch this dissertation and make it a complete dissertation book. His suggestions and his instructions have served as the major contribution towards the completion of this study. His dedication, keen interest, professional knowledge and overwhelming attitude to help students had been solely and mainly responsible for completing my work.*

*I wish to express my sincere thanks to **Dr. RAVI M** Professor, Department of Anaesthesiology for his constant and continuous support. He has conveyed a spirit of adventure in regard to research and scholarship and an excitement in regard to teaching. Without his guidance and persistent help this dissertation would not have been possible.*

*My heartfelt thanks to **Dr. SURESH KUMAR. N** Professor and HOD, Department of Anaesthesiology for his immense support and guidance for teaching and also helping me for completion of my dissertation*

It gives me immense pleasure to extend my sincere thanks to Professors ***Dr. SUJATHA M P, Dr. LAVANYA K, Dr.VISHNUVARDHAN*** *and Associate Professor* ***Dr. SUMANTH T*** *for providing valuable suggestions and motivation throughout the course.*

I am extremely thankful to my Assistant Professor ***Dr. ABHINAYA MANEM, Dr. AMULYA*** *for their constant help and guidance throughout the course. They were a source of encouragement, support and for patient perusal to which I am deeply obliged.*

My heartfelt thanks to senior residents ***Dr. RAHUL K, Dr.YASHWANTH, Dr. ANUSHRI, Dr. HUCHAPPA*** *and my seniors* ***Dr. K DINESH, Dr. SHRUTHI S P, Dr. SUSHMITHA S, Dr. USHASREE, Dr. ARUNSETH C, Dr. S M KUSHAL, Dr. NABI, Dr. RUKMINI K , Dr. HARINI DEV, Dr.REVATHI , Dr. SHOBBANA Dr. HARITHA P,*** *for their practical tips, advice and constant encouragement.I thank my* ***JUNIORS*** *for providing useful tips and clues in completing this vast work.*

My sincere thanks to my colleagues and dearest friends ***Dr.SIRI, Dr.HIMAJA, Dr.SADVI PRAJWAL,Dr.REDDY SRI, Dr.MEGHANA, Dr.NAMRATHA,Dr. BHARATH CJ , Dr.DINESH T, Dr.RATAN, Dr.AKHIL, Dr.TARUN*** *for their co-operation and help in carrying out this study.*

I extend my sincere thanks to all the ***SURGEONS*** *who played an important role during the study.*

I am also thankful to all the ***OT, ICU*** *and* ***Paramedical Staff*** *for their valuable help while performing the study.*

Thanks to my beloved ***PARENTS Smt. MIDHUNA SREE*** *and* ***Sri.T JAYARAM NAIDU*** *and my dearest* ***SISTER TEJASWINI .T*** *for giving me constant support, encouragement and unconditional love throughout my life.*

*Thanks to my **GRAND FATHER prof.VENKATIAH NAIDU POLINENI, METARNAL UNCLE KRISHNA MOHAN POLINENI and L. RAJENDRA NAIDU** for showing me my purpose and role in life .*

*My special thanks to my friends **Dr.VISWANI, Dr.MAHEEJA, Dr.LAVANYA, Dr.UDAYINI, Dr.HARINI, Dr.BHAVITHA , Dr.VARSHA***

*Last but not the least, I express my special thanks to all my **PATIENTS** and their families, who in the final conclusion are the best teachers and without whom this study would have been impossible.*

Date: **Dr.THUMMALA SUSMITHA**

Place: Kolar

TABLE OF CONTENTS

ABBREVIATIONS

ASA	American Society of Anesthesiologists
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
BRI	Body Roundness Index
BUN	Blood Urea Nitrogen
CBC	Complete Blood Count
CI	Confidence Interval
CNS	Central Nervous System
CO	Central Obesity
CRP	C-Reactive Protein
CSF	Cerebrospinal Fluid
CT	Computed Tomography
DEXA	Dual-Energy X-ray Absorptiometry
ECG	Electrocardiogram
ED50	Median Effective Dose
ED95	Dose Required for 95% Efficacy
HbA1C	Hemoglobin A1C
IBW	Ideal Body Weight
LBM	Lean Body Mass
LBW	Lean Body Weight

LFTs	Liver Function Tests
MAP	Mean Arterial Pressure
MBP	Mean Blood Pressure
MHO	Metabolically Healthy Obese
MONW	Metabolically Obese Normal Weight
MRI	Magnetic Resonance Imaging
NCO	Non-Central Obesity
NIH	National Institutes of Health
NO	Non-Obese
O	Obese
OR	Odds Ratio
PD	Pharmacodynamics
PEFR	Peak Expiratory Flow Rate
PK	Pharmacokinetics
SAB	Subarachnoid Block
TBW	Total Body Weight
TSH	Thyroid Stimulating Hormone
Vd	Volume of Distribution

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Background: Subarachnoid block (SAB), commonly known as spinal anaesthesia, is a widely utilized regional anaesthetic technique for abdomen and lower limbs surgery. The effectiveness and distribution of local anaesthetic agents administered via SAB are influenced by a range of physiological and demographic factors, with body mass index (BMI) being a significant contributor. Elevated BMI, particularly in obese individuals, has been associated with changes in cerebrospinal fluid (CSF) volume and flow dynamics, which can alter the spread, onset, and duration of the anaesthetic effect. These alterations may result in unpredictable anaesthetic responses, underscoring the importance of assessing the role of BMI in determining the characteristics and efficacy of spinal anaesthesia.

Aim: To compare the spread, onset, and recovery characteristics of local anaesthetic in spinal anaesthesia between obese and non-obese patients undergoing elective lower abdominal surgeries.

Material & Methods: A comparative study involving 110 patients aged 18 to 59 years and classified as ASA physical status I–II was conducted at R.L. Jalappa Hospital and Research Centre. The participants were stratified into two groups based on body mass index (BMI): Group 1 included patients with BMI <25 kg/m² (n=55), and Group 2 comprised those with BMI >25 kg/m² (n=55). Spinal anaesthesia was administered uniformly. Key anaesthetic parameters—including the onset time of sensory and motor blockade, time to achieve maximum block height, and duration of block recovery—were systematically recorded. Data analysis was performed using SPSS version 26.0, with statistical significance set at a p-value less than 0.05.

Results: Obese patients (Group 2) demonstrated a significantly longer onset time and duration for both sensory and motor blocks compared to non-obese patients ($p<0.05$). However, there was no significant difference in the duration of surgery or anaesthesia between the two groups.

Conclusion: BMI significantly influences the pharmacodynamics of spinal anaesthesia. Obese patients exhibit delayed onset and prolonged duration of spinal block, highlighting the need for individualized anaesthetic dosing and monitoring to enhance patient safety and efficacy of spinal anaesthesia in higher BMI populations.

Keywords: Spinal anaesthesia, Subarachnoid block, Body mass index, Obesity, Sensory block, Motor block, Anaesthetic spread

INTRODUCTION

INTRODUCTION

Spinal anaesthesia, often referred to as a subarachnoid block (SAB), is a commonly employed regional anaesthesia method for a range of surgical procedures. It is especially prevalent in surgeries involving the lower abdomen, pelvis, and lower limbs.[1,2] "Numerous physiological and demographic parameters, including age, weight, height, body mass index (BMI), and the patient's position after the injection, influence the properties and efficacy of spinal anesthesia. BMI is one of these variables that has drawn more attention lately, especially in light of the worldwide obesity epidemic and its possible impact on the distribution and results of anesthesia."[3,4]

"Obesity has been linked to an increased cephaloid (upward) spread of local anaesthetic agents in the subarachnoid space, which can result in a higher level of sensory blockade and a longer duration of anaesthesia."[5] This effect is mainly due to a reduced cerebrospinal fluid (CSF) volume in obese individuals, caused by the accumulation of epidural fat and the expansion of the epidural venous plexus. The reduction in CSF volume may allow the anaesthetic to spread more extensively, influencing both the onset and duration of spinal anaesthesia. These physiological changes present a challenge for anaesthesiologists when determining the appropriate dose of local anaesthetic, as improper dosing could lead to complications such as high spinal block, excessive hypotension, and respiratory depression.[5]

Additionally, the distribution and metabolism of local anaesthetic drugs may vary between obese and non-obese participants, potentially affecting the pharmacokinetics

and pharmacodynamics of spinal anaesthesia. Increased intra-abdominal pressure in obese individuals can also influence cerebrospinal fluid (CSF) dynamics, further impacting the spread of anaesthesia. Recognizing these differences is essential for optimizing anaesthetic management and ensuring patient safety, especially for individuals with a high BMI.[6,7]

Given these considerations, our study aims to investigate the correlation between BMI, the sensory level achieved, and the duration of subarachnoid block in both obese and non-obese individuals. By analyzing these relationships, we seek to provide valuable insights into the effects of BMI on spinal anaesthesia, potentially contributing to better dose adjustments and improved anaesthetic strategies for obese patients. With the growing obesity epidemic, it is essential to refine spinal anaesthesia techniques to accommodate variations in body habitus and enhance patient outcomes.

"Present study aimed to compare the spread of given local anaesthetic by sub arachnoid block in the patients undergoing lower abdomen surgeries in both obese and non obese patients".

AIMS & OBJECTIVES

AIMS & OBJECTIVES

"To compare the spread of given local anaesthetic by sub arachnoid block in the patients undergoing lower abdomen surgeries in both obese and non-obese patients."

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Anaesthetic medications are injected directly into the intrathecal or subarachnoid region, which includes cerebrospinal fluid (CSF), in a specific technique recognized as spinal anesthesia. The brain and spinal cord are cushioned and nourished by this transparent, clean fluid. Adults normally have a total CSF volume of 130–140 mL, with constant turnover and circulation. Every day, the body generates around 500 milliliters of CSF to maintain its vital processes.

To enable accurate distribution of anesthetic drugs into the intrathecal (subarachnoid) area, spinal anesthesia administration necessitates appropriate patient placement and a comprehensive grasp of neuraxial anatomy. Five lumbar, twelve thoracic, seven cervical, and five fused sacral vertebrae make up the human spine. The spinal cord is housed in a hollow spinal canal formed by the sequential stacking of these vertebrae joined by articulating joints and ligaments. Via lateral apertures between neighboring vertebrae, spinal nerves leave the canal. The conus extends somewhat lower in pediatric individuals and frequently stops around L3. The conus location ranges from the middle third of T12 to the upper third of L3, with the average for adults being in the lower third of L1. There are no discernible variations in this variance according to age or sex; it follows a normal distribution. The dural sac, which contains cerebrospinal fluid, typically extends down to the S2/S3 level.

“The L3/L4 or L4/L5 intervertebral spaces are the suggested locations for spinal needle insertion in order to reduce the risk of spinal cord injury. Because of anatomical heterogeneity, using greater interspaces elevates the risk of damage to

spinal cord, especially in obese individuals. The needle must pass through several layers of tissue during spinal anesthesia, with the precise structures varying depending on the method used."[8,9]

Accurately determining the degree of neural blockage during spinal anesthesia requires knowledge of dermatomal anatomy. The efficacy of anesthesia for particular surgical procedures depends on the degree of sensory blockage. To avoid pain from peritoneal tension, especially during uterine manipulation, anesthetic coverage must reach the T4 dermatome.

Indication

For a variety of surgeries below the neck, "neuraxial anesthesia considered as primary or supplemental anesthetic approach. Particularly for treatments below the umbilicus, spinal anesthetic is suitable since it is commonly used for surgeries affecting the lower belly, pelvis, perineum, and lower extremities".

Patient counseling is crucial before administration. In order to ensure that patients are aware of the treatment, its indications, and what to anticipate during placement, informed permission must be acquired. In order to reduce anxiety, conversations should address the advantages, disadvantages, and substitute anesthetic possibilities. Patients should be informed that until the block is removed, spinal anesthesia will temporarily limit their range of motion in their lower extremities. Short-duration operations are the best candidates for spinal anesthesia. General anesthesia is frequently chosen for lengthy procedures or those that might impair respiratory

function. A more seamless perioperative experience and better patient outcomes are facilitated by appropriate patient selection and communication.

Subarachnoid space

"The dura mater, arachnoid mater, and pia mater are the three protective layers that surround the brain and spinal cord. The outermost layer, known as the dura mater, is a thick layer of connective tissue. The arachnoid mater, a thin, impermeable membrane, is located underneath it. The pia mater, the deepest layer, is a vascular membrane that envelops the brain and spinal cord tightly."[10]

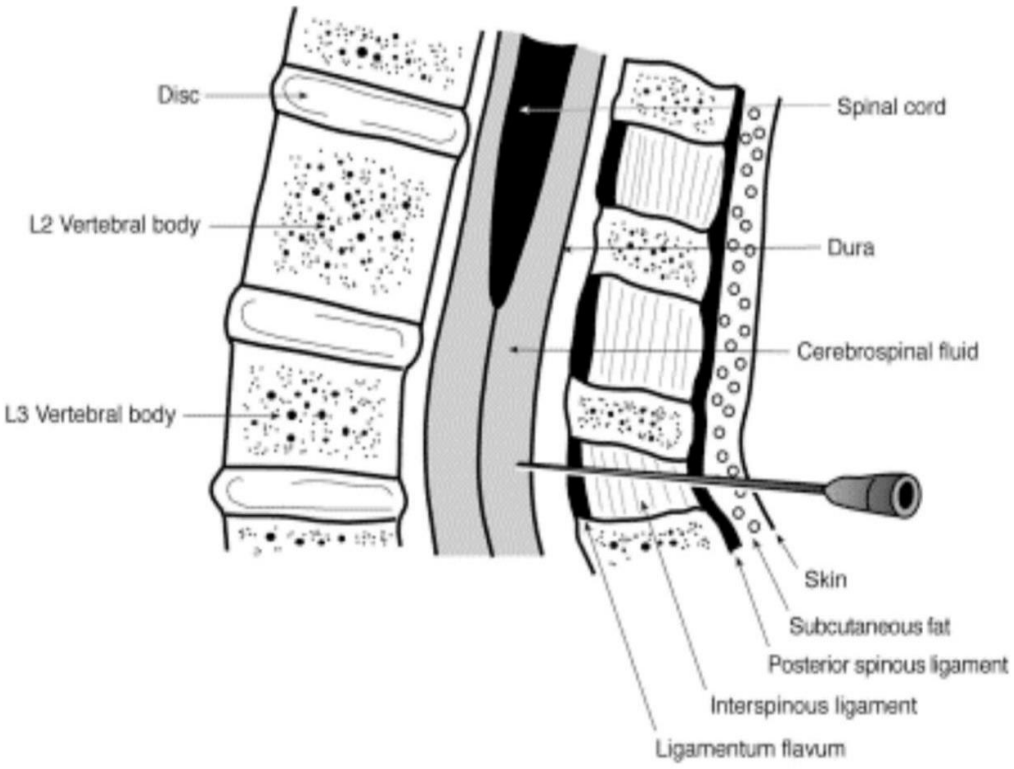

Figure 1: Subarachnoid block

Three clinically relevant areas are defined by these layers. "The epidural space is a projected space in the brain between the dura mater and the skull, however it is a real space in the spinal cord. The subdural space is located between the dura mater and arachnoid mater, whereas the subarachnoid space, which lies between the arachnoid and pia mater, contains cisterns, major blood arteries, and cerebrospinal fluid (CSF). The cisterns, which vary in size according to the structure of the brain and spinal cord, are larger CSF-filled pockets created when the arachnoid and pia mater separate. These areas are essential for cushioning, CSF circulation, and central nervous system protection."

Structure and function

The subarachnoid space is located between the arachnoid mater on the exterior and the pia mater on the inside. It is characterized by a network of tiny, fragile connective tissue known as trabeculae, which link these two layers and give the area its unique spiderweb-like appearance. Cerebrospinal fluid (CSF) can flow through the subarachnoid trabeculae's curtain-like structure with holes, which serve as supporting pillars between the pia and arachnoid mater. Major cerebral blood arteries, in addition to trabeculae, pierce the nerve tissue in this area.[11]

Throughout the central nervous system, the subarachnoid space's depth varies. "It surrounds neurovascular systems, such as the cranial and spinal nerves, in sleeve-like extensions, and ends where the pia and arachnoid mater unite with the perineurium of the nerves. The arteries and veins of the central nervous system are also enclosed in this region until they penetrate the nerve tissue and divide into arterioles and venules. The pia mater adheres firmly to the brain's surface, following the contours of the gyri

and sulci, whereas the arachnoid mater crosses across the cortical sulci to create triangular holes filled with CSF." The arachnoid and pia mater are not close together at some points where the structure of the brain causes it to naturally slip away from the skull. Subarachnoid cisterns, which are naturally expanded CSF-filled expansions, are the result of this. These cisterns have important clinical significance and are essential for the transmission of cranial nerves and intracranial arteries.[12,13]

In terms of function, CSF moves via the ventricular system and subarachnoid area. With 150 mL in circulation at any given time, the choroid plexus secretes CSF mostly at a rate of 0.3 mL/min. The remaining volume is found in the subarachnoid space, whereas 25 mL is found in the ventricular system. Less CSF is also produced by the ependymal lining of the ventricles and the dura mater of the spinal nerve roots. CSF leaves the lateral ventricles and passes through the foramen of Monro to the third ventricle before continuing on via the cerebral aqueduct to the fourth ventricle. It then travels inferiorly around the spinal cord and superiorly over the cerebral cortex after entering the subarachnoid space through the Luschka and Magendie foramina. [14,15]

Obesity

"The excessive or aberrant buildup of fat or adipose tissue in the body is known as obesity, leading to significant health risks such as diabetes mellitus, cardiovascular disease, hypertension, and hyperlipidemia. Over the past 50 years, obesity has emerged as a major public health epidemic and is currently the second most common cause of preventable death after smoking. Its etiology is complex and multifactorial, requiring comprehensive and often lifelong treatment strategies. Even a modest

weight loss of 5% to 10% can substantially improve health outcomes, quality of life, and reduce the economic burden on both individuals and healthcare systems."[16–20]

Pathophysiology

Obesity is a complicated illness that is associated with several health issues, such as diabetes, sleep apnea, fatty liver disease, cardiovascular disease, and some types of cancer. Its pathogenesis includes metabolic, hormonal, and genetic elements that contribute to insulin resistance, systemic inflammation, and elevated cardiovascular risk. One of the main hereditary causes of obesity has been shown to be the FTO gene, although leptin resistance impairs the control of hunger normally. The release of adipokines and free fatty acids by adipose tissue is crucial since these substances worsen inflammation and metabolic disorders. Through changes in the renin-angiotensin system, increased blood pressure, and fatty acid buildup in the heart, obesity also affects cardiovascular function. "Furthermore, the distribution of body fat, have a major impact on overall morbidity and cardiometabolic risk."[21–25]

To distinguish between people with varied risks, the idea of metabolic obesity subtypes was established. Metabolically obese normal weight (MONW) is a condition in which certain people with normal BMI have metabolic problems that are usually seen in obese people. In contrast, those who are metabolically healthy obese (MHO) do not have insulin resistance or dyslipidemia, although they do have a BMI of greater than 30 kg/m^2.[26,27]

Because of their prothrombotic and pro-inflammatory properties, adipocytes raise the risk of stroke. Adipocytes are the primary source of adipokines, which are cytokines

that impact glucose and lipid metabolism and lead to persistent low-grade inflammation. In obesity, inflammation is exacerbated by macrophages that invade adipose tissue and generate more adipokines. Metabolic dysfunction is made worse by visceral obese individuals' decreased levels of adiponectin, an adipokine that has anti-inflammatory and insulin-sensitizing properties.[24,28]

Screening and Diagnosis of Obesity

"The **body mass index (BMI)** is the standard screening tool for obesity. It is calculated using the formula":

$$\text{BMI} = \frac{\text{Weight in kilogram}}{\left(\text{Height in meter}\right)^2}$$

BMI classifications:

- **Underweight**: <18.5 kg/m²
- **Normal range**: 18.5–24.9 kg/m²
- **Overweight**: 25–29.9 kg/m²
- **Obese, Class I**: 30–34.9 kg/m²
- **Obese, Class II**: 35–39.9 kg/m²
- **Obese, Class III (Severe/Morbid Obesity)**: ≥40 kg/m²

The WHO and NIH guidelines for Asian individuals define overweight as a BMI between 23 and 24.9 kg/m^2 and obesity as a BMI >25 kg/m^2.

Additional Anthropometric Measurements

- **Waist-to-hip ratio**: A ratio **>1.0 in men** and **>0.8 in women** is significant and suggests central obesity, which is associated with higher cardiovascular risks.

- **Waist circumference**:
  - >102 cm (40 inches) for men
  - >88 cm (35 inches) for women
  - High waist circumference is a strong predictor of metabolic syndrome.

Advanced Diagnostic Studies

For a more precise assessment of body composition and fat distribution, the following tests may be used:

- **Skinfold thickness measurement** (triceps, biceps, subscapular, and suprailiac regions)
- **Bioelectrical impedance analysis (BIA)**
- **Dual-energy X-ray absorptiometry (DEXA scan)**
- **Computed Tomography (CT) and Magnetic Resonance Imaging (MRI)** to assess visceral fat
- **Air displacement plethysmography (BodPod)**
- **Hydrostatic weighing (water displacement method)**

Laboratory and Diagnostic Tests

To assess obesity-related comorbidities, laboratory tests may include:

- Complete blood count (CBC)
- Basic metabolic panel (BMP)

- Renal function tests
- HbA1C
- Liver function tests (LFTs)
- Thyroid function tests (TSH, T3, T4)
- Lipid profile
- Urinalysis
- Vitamin D levels
- C-reactive protein (CRP)

Additional Evaluations for Associated Conditions

- **Electrocardiogram (ECG)** – To evaluate for cardiovascular risk
- **Sleep study (Polysomnography)** – If obstructive sleep apnea is suspected

These diagnostic tools help in assessing obesity-related risks and guiding treatment plans.

Volume of Distribution and Clearance in Obesity

Previously thought to be just an excess of adipose tissue, obesity is now understood to be a disorder associated with dysfunction of several organs. Knowledge of the underlying pathophysiological alterations associated with obesity is necessary to comprehend how it affects the pharmacokinetics (PK) and pharmacodynamics (PD) of anesthetic drugs.[29]

"Total body weight (TBW), lean body weight (LBW), and fat mass all rise in obese people. However, fat mass rises at a far faster pace than LBW, which results in a lower LBW-to-TBW ratio, even if LBW is responsible for 20–40% of the TBW

growth."[30,31] This increase in fat mass expands the volume of distribution for lipophilic drugs. It could make sense to give obese people larger starting doses of a medication because the loading dosage is mostly determined by the central volume of distribution. "However, medication distribution is also influenced by variables such tissue perfusion, cardiac output, and plasma protein binding. Obesity increases cardiac output, which is strongly linked to LBW, but it has no discernible effect on drug binding to albumin or α-acid glycoprotein."[32–34]

Obesity's increased cardiac output improves blood supply to the liver and kidneys, which may have an effect on medication metabolism. Furthermore, distinct fat deposits have varied blood flow distributions; visceral and abdominal fat get less perfusion than subcutaneous fat. Obesity often improves medication clearance, but the precise metabolic route involved determines how it affects metabolism. Obese people have lower clearance rates for drugs metabolized by cytochrome P450 3A4, but those processed by CYP2D6, CYP1A2, CYP2E1, and CYP2C9 have higher clearance rates than non-obese people.[35–39]

Effects of obesity on pharmacokinetics of anesthetic drugs

Changes in volume of distribution (Vd), free-drug availability, and clearance are some of the variables that affect drug pharmacokinetics in obese people. Reduced body water, increased fat and lean body mass, increased cardiac output, and increased total blood volume are the causes of these changes. Furthermore, obese people have lower hepatic blood flow but higher renal blood flow and glomerular filtration rate, which affects medication metabolism and excretion.[40]

"Total body weight (TBW), lean body mass (LBM), body mass index (BMI), or ideal body weight (IBW + 20%) can all be used to determine drug dose in obesity. Because adipose tissue affects many anesthetic medications, their effects might last for a long time." Obese people have a higher Vd for lipophilic medications, such barbiturates and benzodiazepines, which might cause them to be eliminated more slowly. These medications should be dosed according to IBW or LBM when administered infusion, whereas TBW should be used to determine a single intravenous dose.

IBW should be used to determine dosage for muscle relaxants such vecuronium, rocuronium, and cisatracurium. Atracurium and succinylcholine, however, ought to be given in accordance with TBW.

The chosen drug for induction is propofol, a highly lipophilic anesthetic with a quick onset and brief duration. Continuous infusions should be dosed appropriately because its Vd and clearance seem to be proportionate to TBW. Nonetheless, some research indicates that LBM could be a more appropriate weight-based propofol dosage during induction.[41,42]

For **opioids**, **fentanyl and sufentanil** should be dosed according to **TBW**, while **remifentanil** should be based on **IBW**.[43,44]

Due to their heightened sensitivity to general anesthetics, obese individuals, particularly those with sleep apnea, should have their doses of most anesthetic drugs decreased. To reduce hazards and maximize therapeutic effectiveness, careful dosage is necessary.[31]

Various articles;

Kim HJ et al. (2015) evaluated obesity's independent association with spinal anesthesia outcome in a prospective observational research. Furthermore, obese individuals waited longer before reporting self-voiding and postoperative discomfort. These results imply that bupivacaine dose and obesity have separate effects on the results of spinal anesthesia, and that hyperbaric bupivacaine gives obese patients a longer block. To validate these outcomes, more studies with morbidly obese individuals receiving a fixed dosage of bupivacaine are required.[45]

In impact of BMI on sensorimotor block and vasopressor demand during spinal anesthesia, Ngaka TC et al. (2016) conducted research. When measured by temperature at 5 minutes or by touch at 5 or 25 minutes, there were no appreciable variations in the median block height across groups. Group O experienced a delayed return of touch sensation to T10 (152 vs. 132 min) and a longer mean surgical time (49.1 vs. 39.4 min). Supplementing with analgesics was not necessary. These results imply that a 10 mg dosage of bupivacaine is still suitable without the need for reduction, even when morbid obesity causes a little increase in block height and a longer duration of spinal anesthesia.[46]

A research by Karaca B et al. (2016) evaluated the impact of anthropometric measurements on the hemodynamics and features of spinal anesthetic blocks. 54% of patients had hypotension; this condition was more common in individuals who were shorter, had a wider circumference around their abdomen, had a higher BMI, had a lower body surface area, or had a higher waist/hip ratio. Early preparedness against likely side effects like bradycardia and hypotension is made possible by the use of

simple anthropometric measurements to quantify sensory block characteristics and predict the effects of spinal anesthesia.[47]

A research by Lamon AM et al. (2017) evaluated the effect of BMI on high spinal block. High spinal blocks occurred in 0.6% of the 5015 women analyzed (29 cases), and there was a significant correlation between BMI and the likelihood of high block ($p = 0.025$). These results imply that individuals with a BMI of 50 kg/m² are more likely to experience high block at conventional spinal dosages of hyperbaric bupivacaine (≥10.5 mg).[48]

A research by She YJ et al. (2017) evaluated the distribution of spinal anesthesia for cesarean sections and body height. These results show that a larger dose of intrathecal ropivacaine raised the risk of hypotension in shorter individuals relative to taller patients, while height had no effect on reactions to intermediate doses of the drug.[49]

A research by Wang H et al. (2018) evaluated the connection between spinal anesthesia spread and BMI. Both gestational age (OR=1.894, $p<0.001$) and ropivacaine dose (OR=1.453, $p<0.001$) were positively associated with the risk of hypotension. "People in the normal BMI range need similar doses of ropivacaine for spinal anesthesia. However, compared to patients who were not fat, greater dosages were associated with a higher frequency and severity of hypotension in obese patients."[50]

In order to evaluate the relationship between BMI and spinal block spread in patients undergoing spinal anesthesia for herniorrhaphy, Hosseinzadeh H et al. (2019) did a research. Additionally, obese patients recovered from sensory and motor block more

slowly than non-obese patients. The groups' blood pressure trends during surgery also differed. These results suggest a relationship between spinal block time and body mass index (BMI), with obese individuals reporting a longer duration of analgesia and a faster start of maximal motor and sensory block.[51]

Elmeliegy M. et al. (2020) investigated how BMI affected the properties of anesthesia and the need for vasopressors during spinal anesthesia. "The mean blood pressure (MBP) of groups A and B were comparable, however group C did differ significantly from the other two. Vasopressor requirements were much more in group C than in groups A and B, although being comparable. Group C experienced a longer anesthesia regression, which might be advantageous for lengthy surgical operations. Parturients with a BMI < 45 kg/m² responded consistently to a single spinal dose of 12.5 mg hyperbaric bupivacaine; however, individuals with a BMI > 45 kg/m² should exercise caution and modify their dosage."[52]

A research by Poojitha K et al. (2021) evaluated the effect of central adiposity on the transmission of spinal anesthesia. The CO group had two segments more sensory blockage than the NCO group ($p = 0.000$). In the CO group, it took 4 minutes less to obtain maximum sensory blockage and 2 minutes less to reach maximum motor blockade ($p = 0.000$). However, the CO group experienced a 10-minute delay in the reversal of motor blockage, as shown by the time to Bromage scale 0 ($p = 0.001$). These results imply that a more widespread dissemination of spinal anesthesia is linked to central adiposity.[53]

A research by Ekinci NA et al. (2022) evaluated the effect of the body roundness index on spinal anesthetic block. Block regression time to L2, the occurence of

bradycardia and hypotension, and the maximum sensory blockade levels at 15 and 30 minutes were all noted. Maximum sensory blockage at the 15th minute was shown to be independently predicted by body roundness index (BRI), hip circumference, and waist circumference (OR=65.7, p=0.036; OR=0.733, p=0.026; OR=1.065, p=0.047, respectively). Anthropometric factors did not correlate with hypotension after spinal anesthesia. In patients receiving spinal anesthesia, BRI could be a useful technique for anticipating the increased cephalic distribution of local anesthetic.[54]

A research by Gunkaya M et al. (2022) evaluated the impact of BMI and waist size on the degree of spinal anesthesia. There were significant differences between groups I, II, and III in the Bromage scale scores and the time required for the spinal block to reach the T10 level. There were also notable differences in the amount of time needed to reach the maximal upper dermatomal block level, with longer times being linked to higher waist circumferences and BMIs. Additionally, there was statistically significant diversity in waist circumference. These results imply that waist circumference and BMI are independent measures of the prevalence of obesity.[55]

A research by Yadav V et al. (2024) evaluated the impact of BMI and waist-hip ratio on the degree of sensory block in spinal anesthesia. 54% of patients had hypotension, and this condition was more common in individuals with higher BMIs and waist-to-hip ratios. Bradycardia was also more prevalent in participants with larger waist/hip ratios and BMIs. The time it took for the sensory block to reach the T4 dermatome was positively correlated with height, weight, and BMI, and the maximal sensory block level was positively correlated with BMI. Simple anthropometric measures can be used to predict sensory block features and assist forecast the effects of spinal

anesthesia, enabling early preparedness against anticipated adverse outcomes such as bradycardia and hypotension.[2]

MATERIALS & METHODS

MATERIAL & METHOD

Study Design: Comparative study.

Study Duration: From May 2023 to October 2024.

Study Participants: "This study was conducted on patients undergoing spinal anaesthesia for elective surgical procedures with local anaesthesia at R.L Jalappa Hospital and Research Centre attached to SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR."

Sample size calculation:

Sample size was calculated as per Das *et al*., (2026) and the sample size formula is given below

$$n = \frac{2 \times \left(z_{1-\alpha/2} - z_{1-\beta}\right)^2 \times \sigma^2}{d^2}$$

In the present case, $z_{1-\alpha/2} = 2.58$ at 1 % level of significance

$z_{1-\beta}$ = 1.28 at 90 % power

Where n = minimum required sample size

$z_{1-\alpha/2}$= The critical value (Table value) from a standard normal distribution that the test statistic must exceed in order to show a statistically significant result at 'α' level of significance.

$z_{1-\beta}$= Standard normal table value for the power of the test $(1-\beta)$

σ = Standard deviation of the response variable (obtained from previous study

d = the effect size = the minimum clinically important difference that the investigator wishes to detect.

investigator assumed a minimum difference of 0.5 hrs in mean time of recovery of sensory block required would be clinically important to detect. So, d =0.5

"In the previous study by Hosseinzadeh et al.,[51] 2019, mean time of recovery of sensory block of obese group is 2.5 and that for 2.0 hours and so the difference in the mean time of recovery of sensory block is 0.5 which is considered as minimum difference of clinically important to detect. And so, d= 0.5. SD of two groups were found to be 0.67 and 0.68. Hence, pooled SD computed is 0.675."

ie. $\sigma = 0.675$.

Then the minimum required sample size computed in each group is 54.31 ≅ 55

Thus a total of 2 x 55 = 110 patients is required for the present study

Inclusion Criteria

- Age 18 to 59 years
- Patients requiring spinal anesthesia for undergoing elective lower abdomen surgeries.
- ASA 1 and 2.

Exclusion Criteria

- Neuropathy diseases
- Skin infection in location
- Hypovolumia, circulatory shock
- Allergy to bupivacaine
- Diabetes mellitus
- Coagulopathy, sepsis
- Pregnant patients

Sampling Procedure:

- The study will be started after Institutional Ethical Clearance (IEC) and Clinical Trials Registry – India (CTRI)
- Detailed history of the patient was taken.
- Complete physical examination was done.
- Routine investigations were checked.
- Group 1 - Non Obese Group (BMI <25kg/m^2)

- Group 2 - Obese Group (BMI>25kg/m^2)

Parameters to be observed

- Body mass index to be calculated by taking weight and height of the patient in pre anaesthestic evaluation.
- Bromage scale to be observed after giving spinal anaesthesia to know the level of block reached.
- After giving spinal anaesthesia sensory level achived should check by pinch or pin prick method.

STATISTICAL ANALYSIS

All the data were collected in proforma and entered in excel sheet. The data were analysed using SPSS v26.0 operating on windows 10. The data were summarised as mean with standard deviation and frequency with percentage. The data were represented in tables and figures, bar diagram and pie chart. The mean difference were compared between the group using unpaired t-test and categorical data using chi-square test. For all statistical purpose a p-value of <0.05 was considered statistically significant.

RESULTS

RESULTS

A total of 110 individuals were enrolled in the study, including 55 instances in groups 1 and 2. Groups 1 and 2 are non-obese (BMI <25 kg/m2) and obese (BMI >25 kg/m2), respectively.

Table 1: Mean age comparison between the groups

	Group 1		Group 2		p-value
	Mean	SD	Mean	SD	
Age	45.7	11.9	39.4	11.1	0.25

No significant difference in mean age.

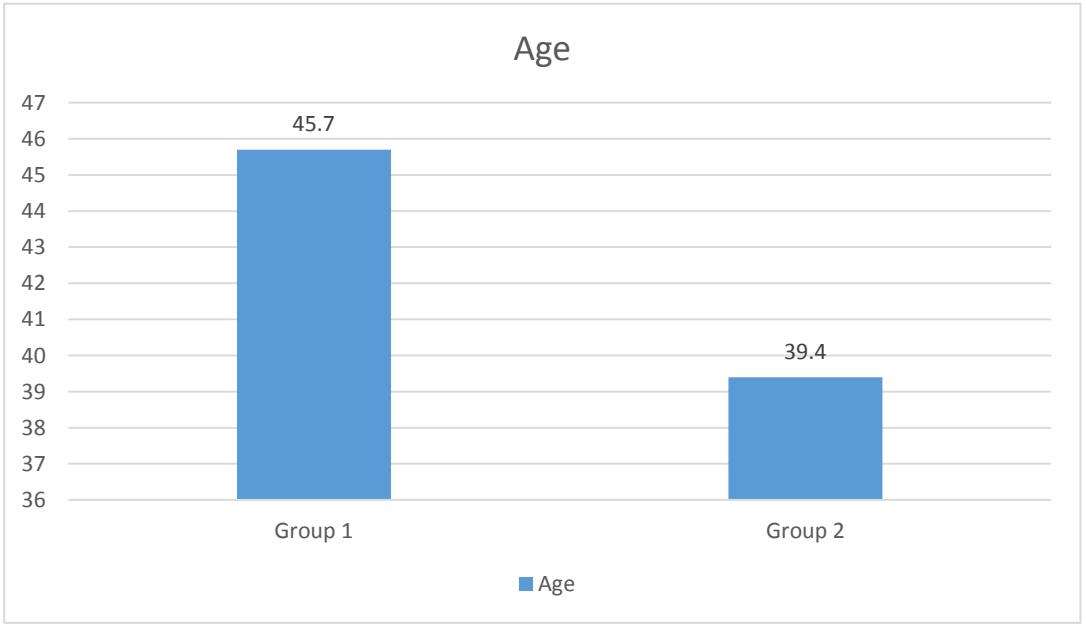

Figure 2: Mean age comparison between the groups

Table 2: Distribution according to gender between the groups

		Group 1		Group 2	
		Count	N %	Count	N %
Gender	Female	13	23.6%	27	49.1%
	Male	42	76.4%	28	50.9%

Gender distribution was comparable between the group, however there is male preponderance in both the groups.

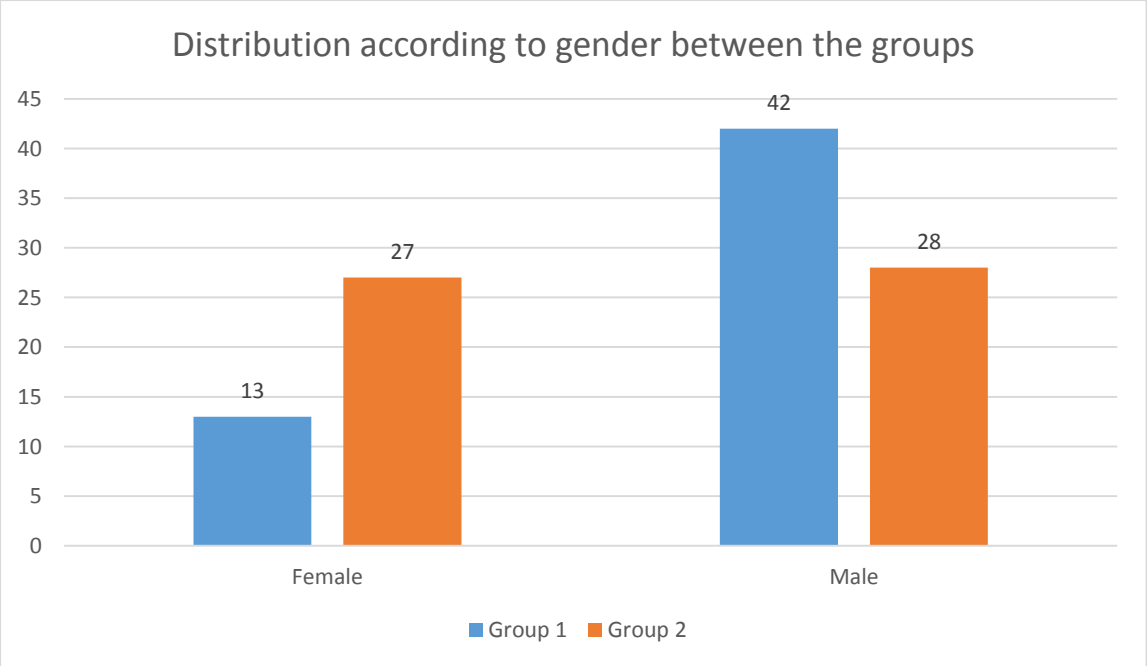

Figure 3: Distribution according to gender between the groups

Table 3: Distribution according to ASA grade between the groups

		Group 1		Group 2	
		Count	N %	Count	N %
ASA	1	28	50.9%	29	52.7%
	2	27	49.1%	23	41.8%
	3	0	0.0%	3	5.5%

Also patients were comparable with ASA grade distribution between the group with majority were in grade 1 and 2.

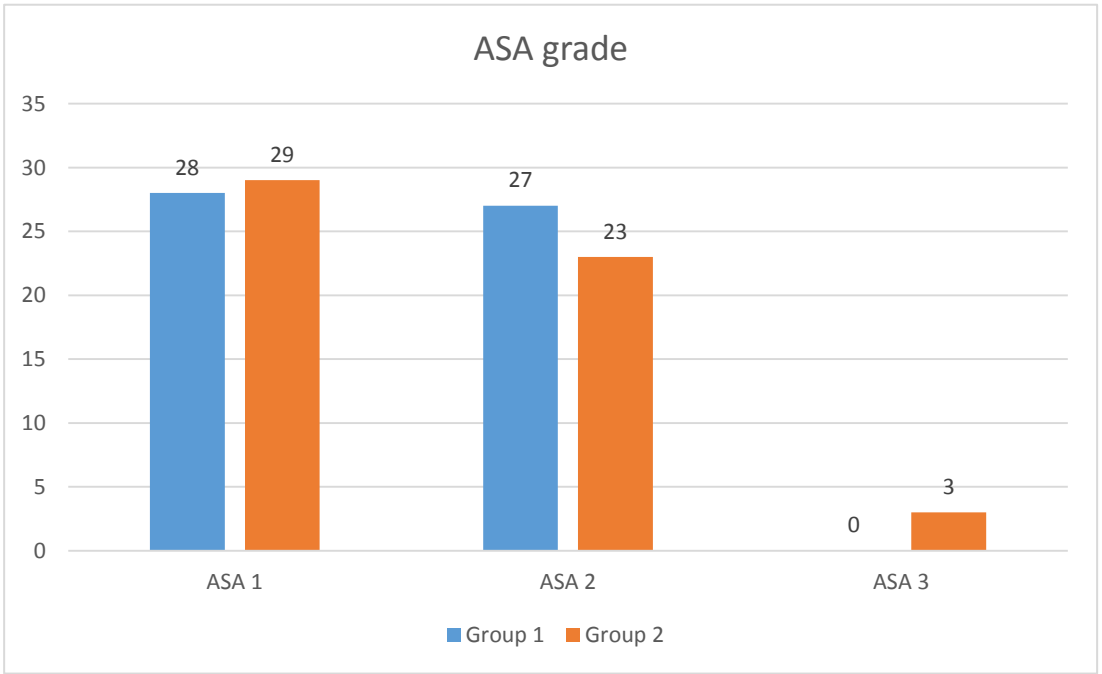

Figure 4: ASA grade

Table 4: Comparison of physical parameters between the groups

	Group 1		Group 2		p-value
	Mean	SD	Mean	SD	
Weight (kg)	60.3	10.1	82.0	11.9	0.05*
Height (cms)	161.1	21.5	158.7	7.5	0.44
BMI (kg/m^2)	22.9	6.5	32.7	4.8	0.05*

The mean weight and BMI was found to be significantly higher in group 2 patients compared to group 1 patients.($p<0.05$)

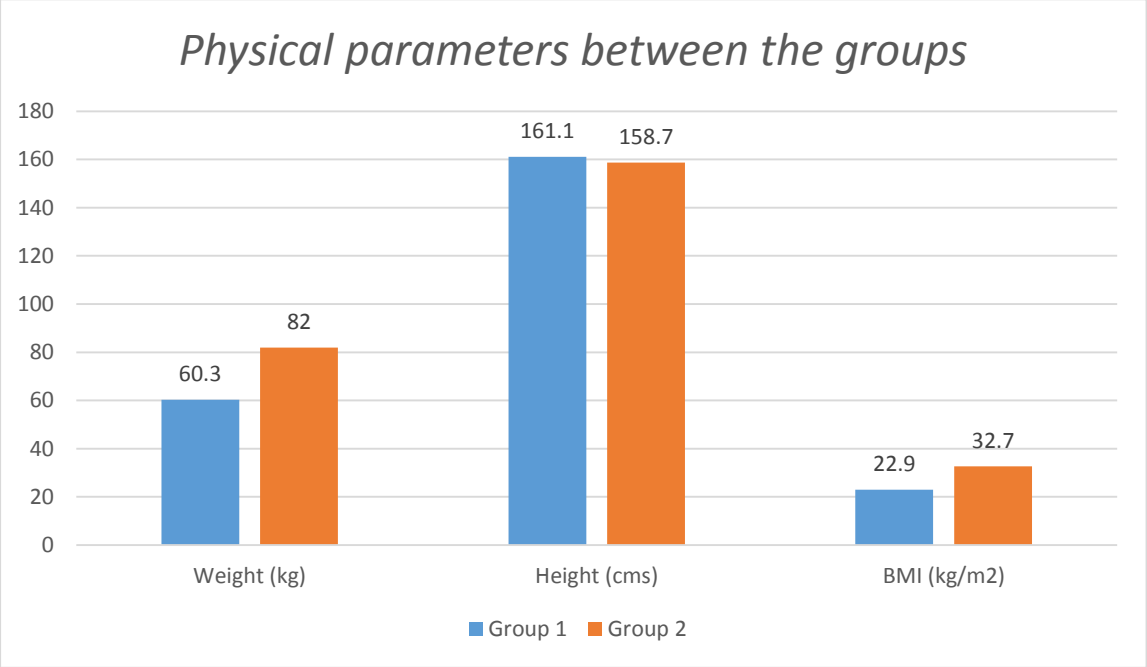

Figure 5: Physical parameters

Table 5: Comparison of the duration of surgery and anesthesia between the groups

	Group 1		Group 2		p-value
	Mean	SD	Mean	SD	
Duration of surgery (min)	87.9	46.1	87.5	42.5	0.91
Duration of anaesthesia (min)	108.0	41.5	123.1	47.5	0.08

There is no significant difference in mean duration of surgery and duration of anesthesia between the group.($p>0.05$)

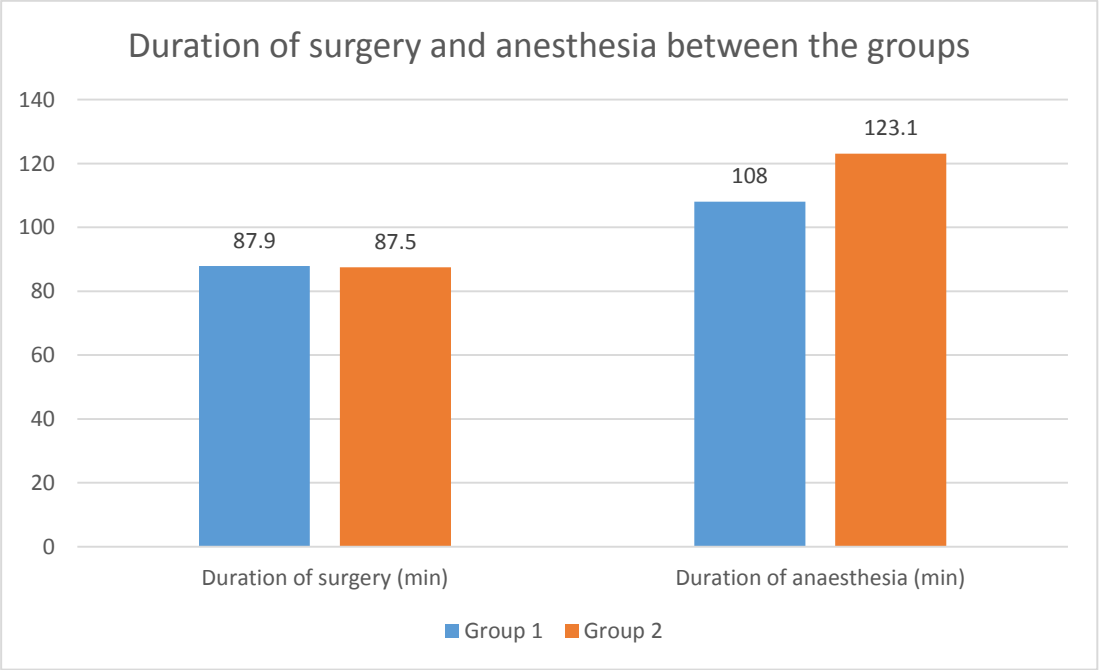

Figure 6: Duration of surgery and anesthesia between the groups

Table 6: Comparison of the time to onset and time to maximum sensory block between the groups

	Group 1		Group 2		p-value
	Mean	SD	Mean	SD	
Time to onset of sensory block (min)	1.5	.8	2.8	1.7	0.01*
Time to maximum sensory block (min)	2.5	1.0	3.7	1.7	0.01*

Compared to group 1 patients, who needed 1.5 and 2.5 minutes, respectively, group 2 patients needed 2.8 and 3.7 minutes, respectively, for the start and maximum of sensory block. ($p<0.05$)

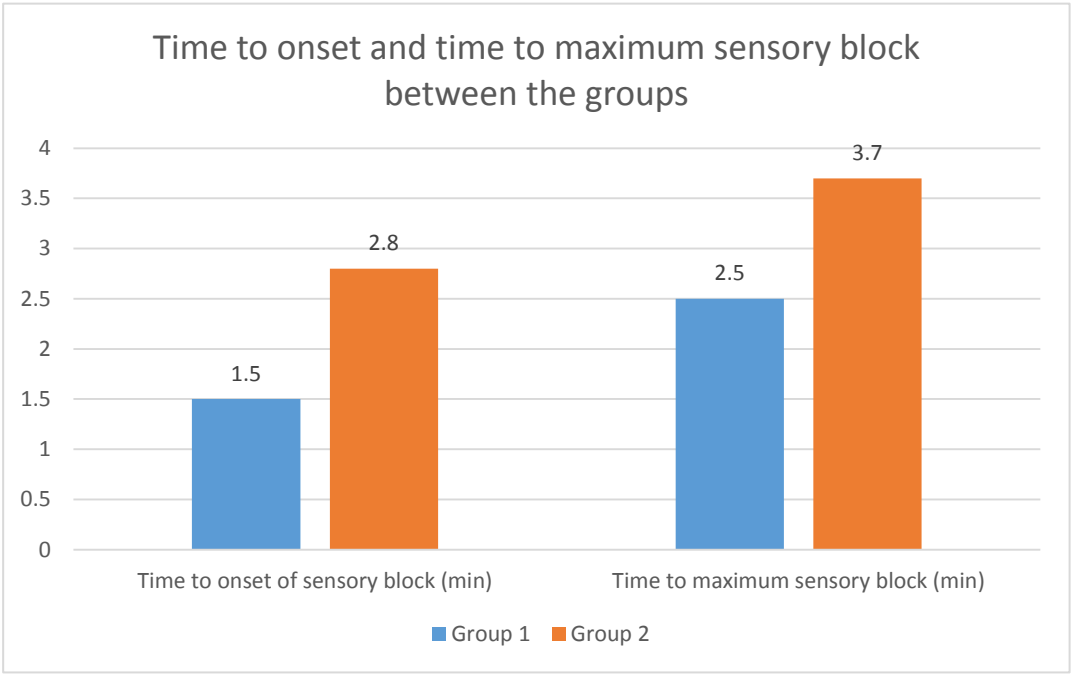

Figure 7: Time to onset and time to maximum sensory block between the groups

Table 7: Comparison of the time to onset and time to maximum motor block between the groups

	Group 1		Group 2		p-value
	Mean	SD	Mean	SD	
Time to onset of motor block (min)	2.1	1.0	2.9	1.5	0.01*
Time to maximum motor block (min)	2.5	1.2	3.4	1.6	0.01*

those in group 2 had significantly longer times to start and maximal motor block (2.9 and 3.4 minutes, respectively) than those in group 1 (2.1 and 2.5 minutes, respectively). ($p<0.05$)

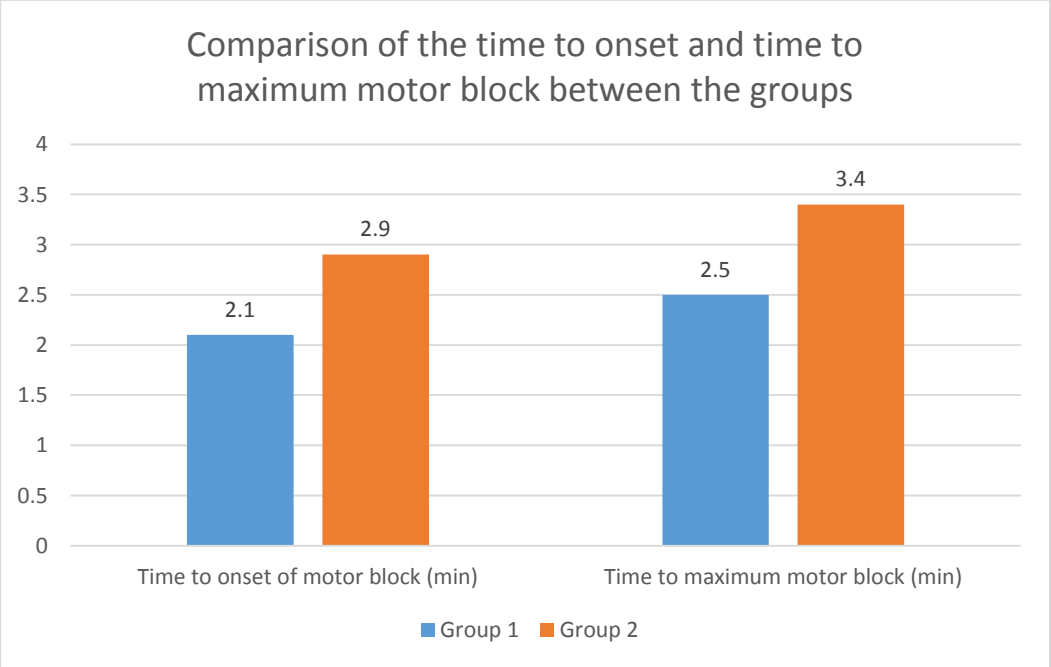

Figure 8: Comparison of the time to onset and time to maximum motor block between the groups

Table 8: Comparison of time for recovery from sensory and motor block between the group

	Group 1		Group 2		p-value
	Mean	SD	Mean	SD	
Time for recovery from sensory block (hr)	2.3	.6	2.6	.8	0.05*
Time for recovery from motor block (hour)	2.6	.5	2.9	.7	0.01*

There is significant longer time for recovery from sensory and motor block in group 2 (2.6hr and 2.9hr respectively) patients compared to group 1 patients (2.3hr and 2.6hr respectively).($p<0.05$)

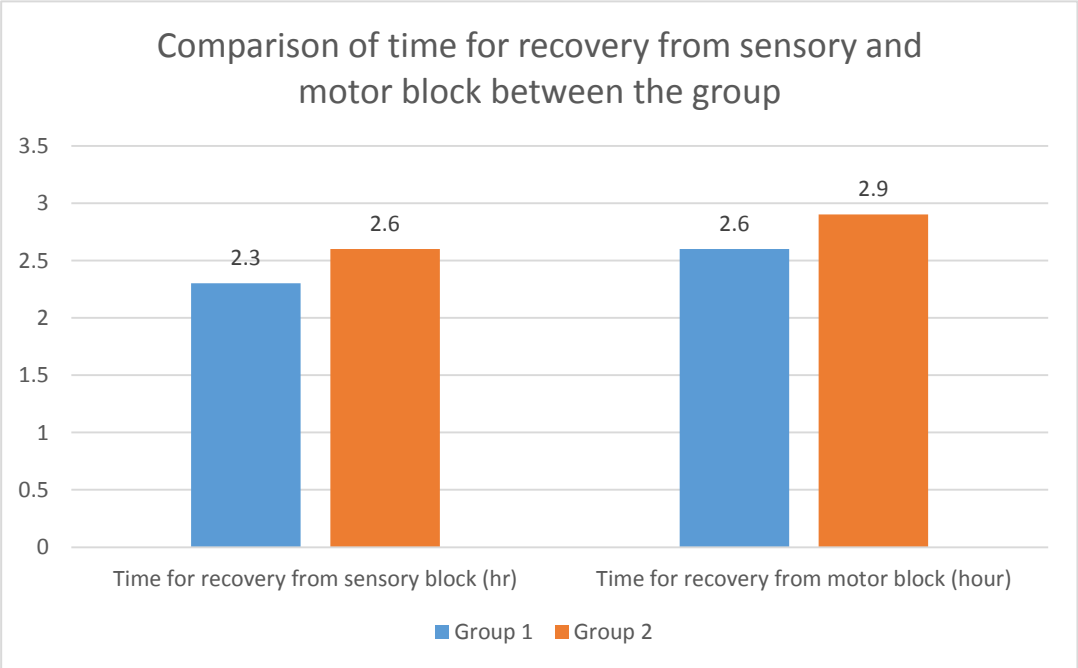

Figure 9: Comparison of time for recovery from sensory and motor block between the group

DISCUSSION

DISCUSSION

BMI has become a major focus in clinical research due to the global increase in obesity and its potential effects on the distribution and outcomes of anaesthesia. Obesity has been associated with an increased cephalad spread of local anaesthetic agents within the subarachnoid space, largely due to a reduced cerebrospinal fluid (CSF) volume in obese individuals, which results from the accumulation of epidural fat and venous engorgement. As a result, anaesthetic agents may reach higher spinal levels, raising the risk of complications such as high spinal block, hypotension, and respiratory depression. These anatomical and physiological changes make dose titration more challenging in obese patients, highlighting the need for a better understanding of spinal anaesthesia pharmacokinetics in this population.

The onset and duration of anesthesia are also impacted by the altered pharmacodynamics associated with obesity, which include elevated intra-abdominal pressure and modifications in drug distribution. These factors must be carefully considered during anaesthetic planning to ensure both safety and effectiveness. Additionally, the spread of spinal anaesthesia is influenced by cerebrospinal fluid (CSF) dynamics and patient positioning, which can differ significantly between obese and non-obese individuals.

This study aims to compare the spread and duration of spinal anaesthesia in obese versus non-obese patients undergoing lower abdominal surgeries. By analyzing the relationship between BMI, sensory blockade level, and duration of anaesthesia, the study seeks to optimize anaesthetic dosing strategies tailored to patient body habitus.

With the growing prevalence of obesity, refining spinal anaesthesia techniques is essential to improve perioperative care and outcomes in diverse patient populations.

"Present study included total of 110 patients with 55 cases in group 1 and 55 cases in group 2. Group 1 - Non Obese Group (BMI <25kg/m^2) & Group 2 - Obese Group (BMI>25kg/m^2). The mean age between the groups were comparable with mean age of 45.7yr in group 1 and 39.4yrs in group 2.($p>0.05$) Gender distribution was comparable between the group, however there is male preponderance in both the groups. Also patients were comparable with ASA grade distribution between the group with majority were in grade 1 and 2. The mean weight and BMI was found to be significantly higher in group 2 patients compared to group 1 patients.($p<0.05$) There is no significant difference in mean duration of surgery and duration of anesthesia between the group."($p>0.05$)

In a similar research by Want H et al., the groups' mean height and age were similar. When compared to the control group, the obese group's mean weight and BMI were shown to be considerably greater.[50]

Body weight, height, and BMI varied considerably between the groups in the research by Hosseinzadeh H et al. Additionally, the length of the anesthesia and the procedure were similar.[51] The study by Gunkaya M et al. also found that while there were no significant differences between the groups in terms of age, gender, or ASA risk class, there were significant disparities in waist circumference and BMI.[55] In a related research by Kim HJ et al., the distribution of the obese and non-obese by age group and gender was similar. The obese group had a considerably higher mean weight and BMI. The group's tourniquet time, surgical length, and ASA grade were similar.[45]

“There is significant longer time required for the onset of sensory block and time to maximum sensory block in group 2 (2.8mins and 3.7mins respectively) compared to group 1 patients (1.5mins and 2.5mins respectively).($p<0.05$) Similarly, significant longer time to onset motor block and time to maximum motor block in group 2 (2.9mins and 3.4mins respectively) patients compared to group 1 patients (2.1mins and 2.5mins respectively).”($p<0.05$)

In the research by Wang H et al., after receiving a 15 mg dosage of ropivacaine, During spinal anesthesia, Group L experienced more mean arterial pressure (MAP) fluctuations, a higher incidence of hypotension, and a greater requirement for ephedrine dosages. The risk of hypotension was strongly correlated with both gestational age (OR=1.894, $p<0.001$) and ropivacaine dosage (OR=1.453, $p<0.001$). For spinal anesthesia, people with normal BMIs require comparable dosages of ropivacaine. However, compared to patients who were not fat, greater dosages were associated with a higher frequency and severity of hypotension in obese patients.[50]

According to a research by Poojitha K et al., the CO group needed 4 minutes less to obtain maximum sensory blockage and 2 minutes less to accomplish maximum motor blockade ($p = 0.000$). However, the CO group experienced a 10-minute delay in the reversal of motor blockage, as shown by the time to Bromage scale 0 ($p = 0.001$). These results imply that a more widespread dissemination of spinal anesthesia is linked to central adiposity.[53]

There is significant longer time for recovery from sensory and motor block in group 2 (2.6hr and 2.9hr respectively) patients compared to group 1 patients (2.3hr and 2.6hr respectively).($p<0.05$)

Similar to the current study by Kim HJ et al., the results indicate that hyperbaric bupivacaine gives fat people a longer block and that the effects of bupivacaine dose and obesity separately affect the results of spinal anesthesia. To validate these outcomes, more studies with morbidly obese individuals receiving a fixed dosage of bupivacaine are required.[45]

In the study by Gunkaya M et al., the amount of time needed to reach the maximal upper dermatomal block level varied greatly, with longer times being linked to higher waist circumferences and BMIs. Furthermore, the variation in waist circumference was statistically significant. These findings suggest that BMI and waist circumference are separate indicators of the prevalence of obesity.[55] Yadav V. et al., as reported in The time it took for the sensory block to reach the T4 dermatome was positively correlated with height, weight, and BMI, and the maximal sensory block level was positively correlated with BMI. Simple anthropometric measures can be used to predict sensory block features and assist forecast the effects of spinal anesthesia, enabling early preparedness against anticipated adverse outcomes such as bradycardia and hypotension.[2]

Recommendations

1. **Individualized Dosing for Obese Patients:** Given the significantly longer onset and recovery times of both sensory and motor blocks observed in patients with higher BMI, it is advisable to consider BMI as a key parameter when determining the dose and concentration of local anaesthetic agents for subarachnoid block. Tailored dosing may help achieve optimal anaesthetic effect while minimizing complications.

2. **Preoperative BMI Assessment:** Routine preoperative evaluation should include BMI measurement, as it is a crucial predictor of altered anaesthetic spread and pharmacodynamics. Identifying obese patients preoperatively can guide anaesthetic planning and resource allocation.

3. **Prolonged Onset Anticipation:** Clinicians should anticipate delayed onset of both sensory and motor blocks in obese patients. This knowledge can prevent premature surgical starts and reduce intraoperative anaesthetic supplementation, thereby improving patient safety and surgical conditions.

4. **Extended Monitoring for Recovery:** Since obese patients demonstrated prolonged recovery times from spinal anaesthesia, extended postoperative monitoring is recommended. This is particularly important to manage delayed motor function return and ensure safe ambulation and discharge, especially in day-care settings.

5. **Caution Against Standard Dosing in Obese Patients:** Standard spinal anaesthetic doses may result in unpredictable or excessive spread in obese individuals due to reduced CSF volume. Anaesthesiologists should exercise caution and consider lower or adjusted dosing protocols for high-BMI patients to prevent high spinal blocks and associated complications.

6. **Further Research and Protocol Development:** Larger multicentric studies are encouraged to develop BMI-based dosing guidelines for subarachnoid blocks. Incorporating patient-specific variables into standard protocols will enhance the safety and effectiveness of regional anaesthesia in the obese population.

SUMMARY

SUMMARY

- There were 110 patients in the current research, with 55 instances in groups 1 and 2. Groups 1 and 2 are non-obese (BMI <25 kg/m2) and obese (BMI >25 kg/m2), respectively.
- The groups' mean ages were similar between group 45.7 years (group 1) 39.4 years (group 2). ($p>0.05$)
- Although there is a male majority in both groups, the gender distribution was comparable. Additionally, the patients' ASA grade distribution was consistent throughout the sample, with the majority falling into grades 1 and 2.
- The mean length of anesthesia and operation does not significantly differ across the groups. ($p>0.05$)
- "Compared to group 1 patients, who needed 1.5 and 2.5 minutes, respectively, group 2 patients needed 2.8 and 3.7 minutes, respectively, for the start and maximum of sensory block." ($p<0.05$)
- Patients in group 2 had a noticeably longer time to beginning motor block and time to maximal motor block (2.9 and 3.4 minutes, respectively) than patients in group 1 (2.1 and 2.5 minutes, respectively). ($p<0.05$)
- Patients in group 2 took much longer to recover from sensory and motor block (2.6 and 2.9 hours, respectively) than patients in group 1 (2.3 and 2.6 hours, respectively). ($p<0.05$)

CONCLUSION

CONCLUSION

The findings showed that obesity had a substantial impact on the dynamics of spinal anesthesia, even when the length of the surgery and anesthesia did not differ considerably. Compared to non-obese patients (Group 1), obese patients (Group 2) showed a substantially delayed start of both sensory and motor blocks, as well as a longer time to attain maximal block levels. Furthermore, the fat group's recovery from sensory and motor block took longer, suggesting that the local anesthetic had a longer-lasting impact.

These results imply that elevated BMI modifies the pharmacodynamics and dissemination of local anesthetics in the subarachnoid area. Obesity-related physiological and anatomical alterations, such as altered CSF fluid dynamics or increased epidural fat, may be the cause of the delayed onset and prolonged duration seen in obese individuals.

In conclusion, the start, peak, and recovery aspects of subarachnoid block are considerably influenced by body mass index. This highlights how crucial it is to take BMI into account when preoperatively planning procedures in order to guarantee the best possible dosage and monitoring, improving the safety and efficacy of spinal anesthesia in obese patients.

BIBLIOGRAPHY

REFERENCE

1. Gupta K, Rastogi B, Gupta PK, Rastogi A, Jain M, Singh VP. Subarachnoid block with Taylor's approach for surgery of lower half of the body and lower limbs: A clinical teaching study. Anesth essays Res. 2012;6(1):38–41.
2. Yadav V, Singh P, Mili J. Effect of waist hip ratio and body mass index on sensory block level of spinal anaesthesia and haemodynamic changes during caesarean section. J Popul Ther Clin Pharmacol. 2024;31(7):715–25.
3. Doelakeh ES, Chandak A. Risk Factors in Administering Spinal Anesthesia: A Comprehensive Review. Cureus. 2023 Dec;15(12):e49886.
4. Demilie AE, Denu ZA, Bizuneh YB, Gebremedhn EG. Incidence and factors associated with failed spinal anaesthesia among patients undergoing surgery: a multi- center prospective observational study. BMC Anesthesiol. 2024;24(1):129.
5. Ciftci T, Kepekci AB, Yavasca HP, Daskaya H, İnal V. The Levels and Duration of Sensory and Motor Blockades of Spinal Anesthesia in Obese Patients That Underwent Urological Operations in the Lithotomy Position. Biomed Res Int. 2015;2015:453939.
6. Taylor CR, Dominguez JE, Habib AS. Obesity And Obstetric Anesthesia: Current Insights. Local Reg Anesth. 2019;12:111–24.
7. Wilson A, Longhi J, Goldman C, McNatt S. Intra-abdominal pressure and the morbidly obese patients: the effect of body mass index. J Trauma. 2010;69(1):78–83.
8. Broadbent CR, Maxwell WB, Ferrie R, Wilson DJ, Gawne-Cain M, Russell R. Ability of anaesthetists to identify a marked lumbar interspace. Anaesthesia. 2000;55(11):1122–6.

9. Saifuddin A, Burnett SJ, White J. The variation of position of the conus medullaris in an adult population. A magnetic resonance imaging study. Spine (Phila Pa 1976). 1998;23(13):1452–6.
10. Ghannam JY, Al Kharazi KA. Neuroanatomy, Cranial Meninges. In Treasure Island (FL); 2025.
11. Mortazavi MM, Quadri SA, Khan MA, Gustin A, Suriya SS, Hassanzadeh T, et al. Subarachnoid Trabeculae: A Comprehensive Review of Their Embryology, Histology, Morphology, and Surgical Significance. World Neurosurg. 2018;111:279–90.
12. Altafulla J, Bordes S, Jenkins S, Litvack Z, Iwanaga J, Loukas M, et al. The Basal Subarachnoid Cisterns: Surgical and Anatomical Considerations. World Neurosurg. 2019;129:190–9.
13. Yasargil MG, Kasdaglis K, Jain KK, Weber HP. Anatomical observations of the subarachnoid cisterns of the brain during surgery. J Neurosurg. 1976;44(3):298–302.
14. Brinker T, Stopa E, Morrison J, Klinge P. A new look at cerebrospinal fluid circulation. Fluids Barriers CNS. 2014;11:10.
15. Khasawneh AH, Garling RJ, Harris CA. Cerebrospinal fluid circulation: What do we know and how do we know it? Brain Circ. 2018;4(1):14–8.
16. Akinkuotu AC, Hamilton JK, Birken C, Toulany A, Strom M, Noseworthy R, et al. Evolution and Outcomes of a Canadian Pediatric Bariatric Surgery Program. J Pediatr Surg. 2019;54(5):1049–53.
17. Holly JMP, Biernacka K, Perks CM. Systemic Metabolism, Its Regulators, and Cancer: Past Mistakes and Future Potential. Front Endocrinol (Lausanne). 2019;10:65.

18. Gowd V, Xie L, Zheng X, Chen W. Dietary fibers as emerging nutritional factors against diabetes: focus on the involvement of gut microbiota. Crit Rev Biotechnol. 2019;39(4):524–40.
19. Kozlov AI. [Carbohydrate-related nutritional and genetic risks of obesity for indigenous northerners]. Vopr Pitan. 2019;88(1):5–16.
20. Saalbach A, Anderegg U. Thy-1: more than a marker for mesenchymal stromal cells. FASEB J. 2019;33(6):6689–96.
21. Sparrow D, Borkan GA, Gerzof SG, Wisniewski C, Silbert CK. Relationship of fat distribution to glucose tolerance. Results of computed tomography in male participants of the Normative Aging Study. Diabetes. 1986;35(4):411–5.
22. Fujioka S, Matsuzawa Y, Tokunaga K, Tarui S. Contribution of intra-abdominal fat accumulation to the impairment of glucose and lipid metabolism in human obesity. Metabolism. 1987;36(1):54–9.
23. Després JP, Nadeau A, Tremblay A, Ferland M, Moorjani S, Lupien PJ, et al. Role of deep abdominal fat in the association between regional adipose tissue distribution and glucose tolerance in obese women. Diabetes. 1989;38(3):304–9.
24. Ferrante AWJ. Obesity-induced inflammation: a metabolic dialogue in the language of inflammation. J Intern Med. 2007;262(4):408–14.
25. Ruderman NB, Berchtold P, Schneider S. Obesity-associated disorders in normal-weight individuals: some speculations. Int J Obes. 1982;6 Suppl 1:151–7.
26. Bonora E, Kiechl S, Willeit J, Oberhollenzer F, Egger G, Meigs JB, et al. Insulin resistance as estimated by homeostasis model assessment predicts incident symptomatic cardiovascular disease in caucasian subjects from the general population: the Bruneck study. Diabetes Care. 2007;30(2):318–24.

27. Karelis AD, St-Pierre DH, Conus F, Rabasa-Lhoret R, Poehlman ET. Metabolic and body composition factors in subgroups of obesity: what do we know? J Clin Endocrinol Metab. 2004;89(6):2569–75.

28. Neels JG, Olefsky JM. Inflamed fat: what starts the fire? J Clin Invest. 2006;116(1):33–5.

29. Ingrande J, Lemmens HJ. Anesthetic Pharmacology and the Morbidly Obese Patient. Curr Anesthesiol Rep. 2013;3(1):10–7.

30. Shi S, Klotz U. Age-related changes in pharmacokinetics. Curr Drug Metab. 2011;12(7):601–10.

31. Casati A, Putzu M. Anesthesia in the obese patient: pharmacokinetic considerations. J Clin Anesth. 2005 Mar;17(2):134–45.

32. Abernethy DR, Greenblatt DJ, Divoll M, Smith RB, Shader RI. The influence of obesity on the pharmacokinetics of oral alprazolam and triazolam. Clin Pharmacokinet. 1984;9(2):177–83.

33. Benedek IH, Fiske WD 3rd, Griffen WO, Bell RM, Blouin RA, McNamara PJ. Serum alpha 1-acid glycoprotein and the binding of drugs in obesity. Br J Clin Pharmacol. 1983;16(6):751–4.

34. Collis T, Devereux RB, Roman MJ, de Simone G, Yeh J, Howard B V, et al. Relations of stroke volume and cardiac output to body composition: the strong heart study. Circulation. 2001;103(6):820–5.

35. Stokholm KH, Brøchner-Mortensen J, Hoilund-Carlsen PF. Increased glomerular filtration rate and adrenocortical function in obese women. Int J Obes. 1980;4(1):57–63.

36. Brill MJE, Diepstraten J, van Rongen A, van Kralingen S, van den Anker JN, Knibbe CAJ. Impact of obesity on drug metabolism and elimination in adults

and children. Clin Pharmacokinet. 2012;51(5):277–304.

37. Kotlyar M, Carson SW. Effects of obesity on the cytochrome P450 enzyme system. Int J Clin Pharmacol Ther. 1999 Jan;37(1):8–19.

38. Larsen OA, Lassen NA, Quaade F. Blood flow through human adipose tissue determined with radioactive xenon. Acta Physiol Scand. 1966 Mar;66(3):337–45.

39. Virtanen KA, Lönnroth P, Parkkola R, Peltoniemi P, Asola M, Viljanen T, et al. Glucose uptake and perfusion in subcutaneous and visceral adipose tissue during insulin stimulation in nonobese and obese humans. J Clin Endocrinol Metab. 2002;87(8):3902–10.

40. Leykin Y, Miotto L, Pellis T. Pharmacokinetic considerations in the obese. Best Pract Res Clin Anaesthesiol. 2011;25(1):27–36.

41. Ingrande J, Brodsky JB, Lemmens HJM. Lean body weight scalar for the anesthetic induction dose of propofol in morbidly obese subjects. Anesth Analg. 2011;113(1):57–62.

42. Ingrande J, Lemmens HJM. Dose adjustment of anaesthetics in the morbidly obese. Br J Anaesth. 2010;105(suppl_1):i16–23.

43. De Baerdemaeker LEC, Jacobs S, Den Blauwen NMM, Pattyn P, Herregods LLG, Mortier EP, et al. Postoperative results after desflurane or sevoflurane combined with remifentanil in morbidly obese patients. Obes Surg. 2006;16(6):728–33.

44. Egan TD, Huizinga B, Gupta SK, Jaarsma RL, Sperry RJ, Yee JB, et al. Remifentanil pharmacokinetics in obese versus lean patients. Anesthesiology. 1998;89(3):562–73.

45. Kim HJ, Kim WH, Lim HW, Kim JA, Kim DK, Shin BS, et al. Obesity is

independently associated with spinal anesthesia outcomes: a prospective observational study. PLoS One. 2015;10(4):e0124264.

46. Ngaka TC, Coetzee JF, Dyer RA. The influence of body mass index on sensorimotor block and vasopressor requirement during spinal anesthesia for elective cesarean delivery. Anesth Analg. 2016;123(6):1527–34.

47. Karaca Baysal P, Gölboyu BE, Ekinci M, Güden M, Ahiskalioğlu A, Çelik EC. Effects of anthropometric measurements on spinal anaesthesia block characteristics and hemodynamics. Medeni Med J. 2016;31(1).

48. Lamon AM, Einhorn LM, Cooter M, Habib AS. The impact of body mass index on the risk of high spinal block in parturients undergoing cesarean delivery: a retrospective cohort study. J Anesth. 2017;31:552–8.

49. She Y, Zheng X, Zhao B, Zeng M, Tan Y, Song X. Body height and the spread of spinal anaesthesia for caesarean section: a prospective controlled trial. Acta Anaesthesiol Scand. 2017;61(7):824–31.

50. Wang HZ, Chen HW, Fan YT, Jing YL, Song XR, She YJ. Relationship Between Body Mass Index and Spread of Spinal Anesthsia in Pregnant Women: A Randomized Controlled Trial. Med Sci Monit. 2018;24:6144–50.

51. Hosseinzadeh H, Aghamohammadi D, Marahem M, Magsumi N, Hosseinzadeh P. Correlation of Body Mass Index and Spread of Spinal block in Herniorrhaphy Patients Under Spinal Anesthesia. Arch Anesth Crit Care. 2019;5(1):4–6.

52. Elmeliegy M. Effect of body mass index on anesthesia characteristics and vasopressor requirements during spinal anesthesia for elective cesarean section. Open J Anesthesiol. 2020;10(4):157–69.

53. Kamath SS. Effect of Central Obesity on Spread of Spinal Anesthesia. Int J Pharm Res. 2021;13(2).

54. Ekinci NA, Tutar MS, Kozanhan B. Effects of Body Roundness Index on Spinal Anesthesia Block Characteristics. Dünya Sağlık ve Tabiat Bilim Derg. 2022;5(2):67–75.

55. Günkaya M, Arar C, Mordeniz C, Baran O, Topçu B. Effect of waist circumference and body mass index on the level of spinal anesthesia. Ain-Shams J Anesthesiol. 2022;14(1):19.

ANNEXURE

ANNEXURE

PROFORMA

STUDY: BODY MASS INDEX AND SPREAD OF LOCAL ANAESTHETIC IN SUB ARACHNOID BLOCK:A COMPARITIVE STUDY

Investigators: Dr.KIRAN/

Dr THUMMALA SUSMITHA

1. Name of the patient: 2. Age/Sex: 3. Ward:

4. IP No: 5. ASA grade:

6.Height: 7.Weight: 8.BMI:

- **Diagnosis:**

- **Surgery:**

1.PATIENT PARAMETERS

PARAMETERS	OBESE PATIENTS(n=55)	NORMAL WEIGHT PATIENTS(n=55)
AGE(years)		
WEIGHT(kg)		
HEIGHT(cm)		
Duration of surgery(min)		
Duration of anaesthesia(min)		

2.BLOCKADE CHARACTERISTICS

	OBESE PATIENTS(n=55)	NORMAL WEIGHT PATIENTS(n=55)
Time to onset of sensory block(min)		
Time to maximum sensory block(min)		
Time for recovery from sensory block(hour)		
Time to onset of motor block(min)		
Time to maximum motor block(min)		
Time for recovery from motor block(hour)		

PATIENT INFORMATION SHEET

Study: BODY MASS INDEX AND SPREAD OF LOCAL ANAESTHETIC IN SUB ARACHNOID BLOCK:AN COMPARITIVE STUDY

Investigators:Dr. Kiran.N/ Dr Thummala susmitha

Study location: R.L.Jalappa Hospital and Research Center attached to Sri Devaraj Medical College, Tamaka, Kolar.

Details – In this study patients undergoing elective spinal anaesthesia will be divided into two groups

Group 1 - obese group (BMI > 25kg/m^2)

Group 2- non obese group(BMI<25kg/m^2)

This study aims to compare spread of given Local Anaesthetic by subarachnoid block in patients undergoing lower abdominal surgeries depending on their body mass index, patient and the attenders will be completely explained about the procedure.One group with obese patients and other group with non obese group is equally divided and after giving spinal anaesthesia motor block and sensory blockade parameters are compared and recorded .There will be no risk involved in the study as it is an observational study.Participant will not have any financial expenses and will not get any monetary benefits for participating in the study

Please read the information and discuss it with your family members. You can ask any question regarding the study. If you agree to participate in the study, then relevant information and history will be taken. This information collected will be used only for dissertation and publication.

All information collected from you will be kept confidential and will not be disclosed to any outsider. Your identity will not be revealed. There is no compulsion to agree to this study. The care you will get will not change if you don't wish to participate. You are required to sign/ provide a thumb impression only if you voluntarily agree to participate in this study.

For further information contact

Dr Thummala susmitha

Post graduate in Anaesthesiology, SDUMC Kolar

Mobile no: 9550576434

ರೋಗಿಯ ಮಾಹಿತಿ ಹಾಳೆ

ಅಧ್ಯ ಯನ : ಬಾಡಿ ಮಾಸ್ ಇಂಡೆಕಮತ್ತುಸಬಲರ್ಕಿನಾಡ ಬಾಾ ಕ್ಷ ಲ್ಲಾ ಲೋಕ್ಲ್ ಅನೆಸ್ಥೆ ಟಿಕ್ಸ ನ ಹರಡುವಿಕೆ : ತೌಲ್ಲನಿಕ್ ಅಧ್ಯ ಯನ .

ಪರಿಶೋಧ್ಯ ; ಡಾ. ರ್ಕರಣ್ .ಎನ್/ಡಾ. ತ್ತಮಮ ಲ ಸುಶ್ಮಮ ತಾ

ಅಧ್ಯ ಯನ ಸೆ ಳ : ಶ್ಮ ರ ೋ ದೇವರಾಜ್ ಅರಸ್ ಮೆಡಿಕ್ಲ್ ಕಾಲೇಜ್ ಹಂದಿಕಂಡಂತೆ

ಆರ್. ಎಲ್ ಜಾಲಪಪ ಆಸಪ ತೆರ ಮತ್ತು ಸಂಶೋಧ್ನಾ ಕಂದ್ರ

ವಿವರ ಗಳು : ಎಲೆರ್ಕಿ ವೆ ಸ್ಥಪ ್ಯೆನಲ್ ಅನೆಸ್ಥೆ ಸಿಯ ಕೆ ಿ ಒಳಪಟ್ ಿರೋಗಿಗಳನ್ನನಎರಡು ಗುಪು ಗಳನಾನ ಗಿ ವಿಭಾಜಿಸಲಪ ಟಿ ದೆ

ಗುಂಪು-೧ –ಸ್ಥೆ ಲ ಕಾಯ (ಬಿ.ಎಂ.ಐ .> 25kg/M

ಗುಂಪು -೨ – ಸ್ಥೆ ಲ ಕಾಯ ಅಲಾ ದ್ವರು (ಬಿ.ಎಂ.ಐ . < 25KgM2)

ಅಧ್ಯ ಯನ:

ಬಿ.ಎಂ.ಐ ಮೇಲೆ ಅವಲಂಬಿತರಾಗಿರುವ ಲೋಯರ್ ಅಬಾಾ ಮಿನಲ್ ಸರ್ ಿರೋಸ್ ಗೆ ಒಳಗಾಗಿರುವ ರೋಗಿಗಳನ್ನನ ಸುಬಾರ್ಕಿನೈಡ್ ಬಾಾ ಕ್ಷ ನಲ್ಲಾ ಕಟಿ ರುವ ಲೋಕ್ಲ್ ಅನೆಸ್ಥೆ ಸಿಯ್ ಹರಡು ವಿಕ

ರೋಗಿಗಳು ಮತ್ತು ಅವರ ಮೇಲ್ಲಿ ಚಾರಕ್ರಿಗೆ ಅದ್ರ ನಿವಿಹಣೆಯನ್ನನ ಪೂರ್ತಿಯಾಗಿ ವಿಸ್ತು ರವಾಗಿ ರ್ತಳಿಸಿ ದ್ದಾ ರೆ. ಸ್ಥೆ ಲ ಕಾಯದ್ ಯದ್ ಒಂದು ಗುಂಪಿನ ರೋಗಿಗಳನ್ನನ, ಸ್ಥೆ ಲಕಾಯ ರಲಾ ದ್ವರನ್ನನ ಸಮವಾಗಿ ವಿಭಜಿಸಿ ಮತ್ತು ಸ್ಥಪ ್ಯೆನಲ್ ಅನೆಸ್ಥೆ ಸಿಯ ಕಟ್ಟಿ ಮೋಟ್ರ್ ಬಾಾ ಕ್ಷ ಸೇನ್ ರಿ ಬಾಾ ಕೆಡ ಪರಮಿರ್ತಗಳನನ ಹೋಲ್ಲಸಿ ಅದ್ನ್ನ ದ್ದಖಲು ಮಾಡಲಾಗಿದೆ. ಇದು ಒಂದು ಅವಲೋಕ್ಷ ಅಧ್ಯಯನವಾಗಿರುವುದ್ರಿಂದ್ ಇದ್ರಲ್ಲಾ ಯಾವುದೇ ಅಪಾಯ ವಿರುವುದಿಲಾ . ಈ ಅಧ್ಯ ಯನದ್ಲಾ ಭಾಗವಹಿಸುವವರಿಗೆ ಯಾವುದೇ ರಿೋರ್ತ ಹಣದ್ ವೆಚ್ಚ ವಿರುವುದಿಲಾ ಮತ್ತು ಯಾವುದೇ ಹಣದ್ ಪರ ಯೋರ್ನ ವಿರುವುದಿಲಾ . ದ್ಯವಿಟ್ಟಿ ಎಲಾಾ ವಿಷಯಗಳನ್ನನ ಓದಿ ನಿಮಮ ಕುಟ್ಟಂಬದ್ವರಡನೆ ವಿಚಾರಿಸಿ ವಿಚಾರ ವಿನಿಮಯ ಮಾಡಿಕಳಿ. ಈ ಅಧ್ಯಯನದ್ ಬಗೆ ನಿೋವು ಯಾವುದೇ ಪರ ಶ್ನನ ಗಳನ್ನನ ಕಳಬಹುದು . ನಿೋವು ಇದ್ರಲ್ ಭಾಗವಹಿಸುವುದ್ರಲ್ಲಾ ಒಪಿಪ ಗೆ ಯಾದ್ರೆ ಸಂಬಂಧ್ ವಿಷಯಗಳನ್ನನ ಮತ್ತು ಅದ್ರ ಚ್ರಿತರ ಯನ್ನನ ತೆಗೆದುಕಳು ಿ ತಾು ರೆ . ಈ ವಿಷಯನ್ನನ ಪರ ಕ್ಟೆ ಗಾಗಿ ಮತ್ತು ಉಪನಾಯ ಸಕಾ ಿ ಗಿ ಬಳಸುತೆವೆ.

ನಿಮಿಮ ಂದ್ ಪಡೆದ್ ವಿವರಗಳನ್ನನ ಗೌಪಯ ವಾಗಿ ಇಟಿ್ ರುತಾು ರೆ. ಅಲಾ ದೆ ಇದ್ನ್ನ ಬೇರೆ ಯಾರೇ

ಹರಗಿನವರಿಗೆ ಕಡುವುದಿಲಾ.ನಿಮಿಮ ವೈಯುರ್ಕು ಕ್ ಗುರುತನ್ನನ ರ್ತಳಿಸುವುದಿಲಾ . ಇದ್ನ್ನ ಈ ಸಂಸ್ಥೆಯ ನೈರ್ತಕ್ ಹಣೆ ಹರ್ತು ರುವವರು ಆಗಾಗ ವಿಮಶ್ಮಿಸುತಾು ರೆ . ನಿೋವು ಅವರನ್ನನ ಸುಲಭವಾಗಿ ಭೇಟಿಯಾಗಬಹುದು. ಈ ಅಧ್ಯ ಯನಕೆ್ ಒಪಿಪ ಗೆಗೆ ಯಾವುದೇ ರಿೋರ್ತ ಒತು ಡವಿಲಾ.

ನಿೋವು ನಿಮಿಮ ಸಹಿ ಅಥವಾ ಹೆಬೆ್ ಟಿ್ ನ ಗುರುತನ್ನನ ಕಡುವುದು. ವೈಯುಕಾ್ ಗಿ ಒಪಿಪ ಮಾತರ ಸಹಿ

ಮಾಡಬಹುದು.

ಮಿಕ್್ ಬೇರೆ ಏನಾದ್ರೂ ವಿಷಯ ಬೇಕಾದ್ಾ ಲ್ಲಾ ಸಂಪರ್ಕಿಸಿ

ಡಾ. ತ್ತಮಿಮ ಲ ಸುಶ್ಮಿಮ ತಾ

ಅನೆಸ್ಥೆ ಸಿಯಾದ್ಲ್ಲಾ ಸ್ತನ ತಕೋತು ರ ಪದ್ವಿ ಎಸ.ದಿ.ಯು ಎಂ. ಸಿ ಕೋಲಾರ

ಮ: :9550576434

INFORMED CONSENT FORM

BODY MASS INDEX AND SPREAD OF LOCAL ANAESTHETIC IN SUBARACHNOID BLOCK:AN COMPARITIVE STUDY

Date:

I, _____ aged _____,after being explained about the purpose of the study and the risks and complications of the procedure.

hereby give my valid written informed consent without any force or prejudice for using BODY MASS INDEX AND SPREAD OF LOCAL ANAESTHETIC IN SUB ARACHNOID BLOCK: AN OBSERVATIONAL STUDY. The nature and risks involved have been explained to me to my satisfaction. I have explained in detail about the study being conducted. I have read the patient information sheet and I have had the opportunity to ask any question. Any question that I have asked, have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research. I hereby give consent to provide my history, undergo physical examination, undergo the procedure, undergo investigations and provide its results and documents etc. to the doctor / institute etc. All the data may be published or used for any dissertation/publication. I will not hold the doctors / institute etc. responsible for any untoward consequences during the procedure / study. I am aware that there won't be any monetary benefits for taking part in this study.

A copy of this Informed Consent Form and Patient Information Sheet has been provided to the participant

(Signature & Name of Pt. Attendant) (Signature/Thumb impression & Name of Patient/Guardian) (Relation with patient)

Witness 1:

Witness 2:

(Signature &Name of principal investigator /doctor)

ವಿಷಯದ ಒಪ್ಪಿಗೆಯ ಪತ್ರ

ಬಾಡಿ ಮಾಸ್ ಇಂಡೆಕ್ಸ್ ಮತ್ತು ಸಬಅರ್ಕಿನಾಡ ಬಾಾ ಕ್ಷ ಲ್ಲಾ ಲೋಕ್ಲ್ ಅನೆಸ್ಥೆ ಟಿಕ್ಸ ನ ಹರಡುವಿಕೆ : ತೌಲ್ಲನಿಕ್ ಅಧ್ಯ ಯನ

ದಿನಾಂಕ್:

ನಾನ್ನ ..... ವಯಸ್ಸು ..... ಈ ಒಂದು ಪರ ರ್ಕರಯೆಯಲ್ಲಾ ನಾನ್ನ ನನನ ಪೂಣಿ ಒಪಿಪ ಗೆಯನ್ನನ ಲ್ಲಖಿತ ರೂಪದ್ಲಾ ಯಾವುದೇ ಒತು ಡಕೆ ಳಗಾಗದೆ, ಪಕ್ಷಪಾತವಿಲಾ ದೆ, ಪೂವಾಿಗರ ಹ ಪಿೋಡಿತರಾಗದೆ ರ್ತಲ್ಲಸಿರುತು ಿೋನೆ.
ಬಾಡಿ ಮಾಸ್ ಇಂಡೆಕ್ಸ್ ಮತ್ತು ಸಬಅರ್ಕಿನಾಡ ಬಾಾ ಕ್ಷ ಲ್ಲಾ ಲೋಕ್ಲ್ ಅನೆಸ್ಥೆ ಟಿಕ್ಸ ನ ಹರಡುವಿಕೆ : ತೌಲ್ಲನಿಕ್ ಅಧ್ಯ ಯನ
ನನಗೆ ಇದ್ರ ಸಿ ಭಾವ ಮತ್ತು ದುಷಪ ರಿಣಾಮಗಳನ್ನನ ಪೂರ್ತಿಯಾಗಿ ನನಗೆ ಸಮಾಧಾನ ವಾಗುವ ರಿೋರ್ತಯಲ್ಲಾ ವಿವರಿಸಿದ್ದಾ ರೆ. ಈ ಅಧ್ಯ ಯನದ್ ಬಗೆಿಯೂ ವಿವರಿಸಿದ್ದಾ ರೆ. ನಾನ್ನ ಸಹ ರೋಗಿಯ ವಿಷಯ ಸ್ಥಚಿಯನ್ನನ ಓದಿದೆಾ ಿೋನೆ. ನನಗೆ ಪರ ಶ್ನನ ಕಳುವುದ್ಕೆ ಅವಕಾಶ ವಿತ್ತು .ನಾನ್ನ ಏನೇ ಪರ ಶ್ನನ
ಕಳಿದ್ರೂ ಅದ್ಕೆಿ ಸಮಾಧಾನದ್ ಉತು ರ ಸಿಗುರ್ತು ತ್ತು . ನಾನ್ನ ಸಿ ಯಂ ಇಚ್ಛಚ ಯಂದ್ ಈ ಪರಿಶೋಧ್ನೆಯಲ್ಲಾ ಪಾಲೆ ಳಿ ಲು ಇಚಿಚ ಸಿದೆಾ ಿೋನೆ. ನಾನ್ನ ನನನ ರೋಗಕೆಿ ಸಂಬಂಧ್ ಪಪ ಟ್ಿ ಚ್ರಿತೆರ ಯನ್ನನ ಕಡಲು, ಭೌರ್ತಕ್ ಪರಿೋಕೆಿ ಗೆಕೆ ಳಗಾಗಲು ಇಷಿ ಪಟಿಿ ದೆಾ ಿೋನೆ. ಅವರ ಭೌರ್ತಕ್
ಪರಿೋಕೆಿ ಗೆ, ತನಿಖೆಗೆ ಎಲಾಾ ರಿೋರ್ತಯ ನಿವಿಹಣೆ ಗೆಕೆ ಳಗಾಗಲು ಮತ್ತು ಇದ್ರ ಫಲ್ಲತಾಂಶ ಮತ್ತು ಎಲಾಾ ದ್ಸು ವೇಜುಗಳನ್ನನ ವೈಧ್ಯ ರಿಗಾಗಲ್ಲೋ ಸಂಸ್ಥೆ ಗಾಗಲ್ಲೋ ಕಡಲು ಸಿದ್ಧ ವಾಗಿದೆಾ ಿೋನೆ

ಎಲಾಾ ಮಾಹಿರ್ತಗನ್ನನ ಉಪಯೋಗಿಸಿಕಳಿ ಲು , ಮತ್ತು ಪರ ಕ್ಟಿಸಲು ಅಲಾ ದೆ ಅಧ್ಯ ಯನಕೆಿ ಉಪನಾಯ ಸಕೆಿ ಬಳಸಲು ಅನಿಿ ಿೋಕ್ರಿಸಿದೆಾ ಿೋನೆ. ನಾನ್ನ ಯಾವುದೇ ರಿೋರ್ತ ವೈಧ್ಯ ರನಾನ ಗಲ್ಲೋ, ಸಂಸ್ಥೆ ಯನಾನ ಯನಾನ ಗಲ್ಲೋ ಅನ್ನಚಿತ ಮತ್ತು ರೋಗಿಯ ಪ ರಿಣಾಮಕೆಿ ದೂಡಿಸುವುದಿಲಾ ನಾನೇ
ವಾಬಾಾ ರಿ.ಈ ಅಧ್ಯ ಯನದ್ ಯಾವುದೇ ರಿೋರ್ತ ಹಣದ್ ಲಾಭದ್ದಯಕ್ ಪರ ಸರ್ಕು ಯೇ ಇಲಾ. ಎಂಬುದು ಮದ್ಲೇ ನನನ ಅರಿವಿಗೆ ಬಂದಿದೆ.

ಈ ಒಪಿಪ ಗೆಯ ಮಾಹಿರ್ತ ಪರ ರ್ತಯನ್ನನ ಮತ್ತು ರೋಗಿಯ ವಿಷಯ ಸ್ಥಚಿಯನ್ನನ ಭಾಗವಿಸುವವರಿಗೆ

ಕಟಿ ರುತು ೋನ.

(ಸಹಿ ಮತ್ತು ರೋಗಿಯ/ಮೇಲ್ಲಿ ಚಾರಕ್ರ ಹೆಸರು) *(ಸಹಿ /ಹೆಬ್ಬೆ*

ರಳ ಗುರುತ್ತ ಮತ್ತು ರೋಗಿಯ ಹೆಸರು /ಪೋಷಕ್ರು)

ರೋಗಿಯೋದ್ನೆ ಸಂಬಂಧ್)

ಸಾಕ್ಷಿ- 1

ಸಾಕ್ಷಿ- 2

ಆವಿಷ್ಕೆ ರ ರ/ ವೈಧ್ಯ ರ ಹೆಸರು ಮತ್ತು ಸಹಿ

MASTER CHART

MASTERCHART

SL No.	Group	Age	Gender	ASA	Weight (kg)	Height (cms)	BMI (kg/m2)	Duration of surgery(min)	Duration of anaesthesia(min)	Time to onset of sensory block(min)	Time to maximum sensory block(min)	Time for recovery from sensory block(hr)	Time to onset of motor block(min)	Time to maximum motor block(min)	Time for recovery from motor block(hour)
1	Non-Obese	59	M	2	60	170	20.8	30	90	2	5	2	3	4	2
2	Non-Obese	63	M	2	62	166	22.5	30	120	2	4	2.5	3	4	2.5
3	Non-Obese	59	M	2	60	170	20.8	60	120	2	5	2	5	8	1.5
4	Non-Obese	56	M	1	62	165	22.8	120	150	1	2	2	3	3	2.1
5	Non-Obese	60	M	2	68	165	25	45	60	0.5	1	1.5	1	2	1.5
6	Non-Obese	52	M	1	55	157	22.3	2	120	2	3	2	1	2	2
7	Non-Obese	60	M	1	53	150	23.6	120	130	1	3	2.5	1	2	3
8	Non-Obese	24	F	2	41	150	18.2	30	60	0.5	1	2	0.5	1	2
9	Non-Obese	60	M	2	63	163	23.7	120	150	2	2.5	2.5	2	2	2.7
10	Non-Obese	30	F	2	68	172	23	40	50	1	2	2	1	1.5	2
11	Non-Obese	47	F	1	44	15	19.6	120	130	1	3	2.6	1	2	3
12	Non-Obese	48	F	2	64	158	25.6	150	130	2	3	2.1	2	2	2.5
13	Non-Obese	24	M	1	66	165	24.2	70	80	1	2	2.5	2	2	3
14	Non-Obese	49	F	1	53	153	22.6	120	140	2	4	2	3	4	2.5
15	Non-Obese	27	M	1	65	176	21	30	40	1	2	2	2	2	2.5
16	Non-Obese	50	M	2	69	165	25.3	50	60	1	2	2	2	2	2.5
17	Non-Obese	35	M	1	67	164	67	80	90	2	2.5	3	1	2	3
18	Non-Obese	27	M	1	68	172	23	130	140	1	2	2	2	2	2.5
19	Non-Obese	46	M	1	55	165	20.2	30	50	2	2.5	1.3	2	3	1.5

20	Non-Obese	36	M	2	68	170	23.5	45	60	1	2	1.5	2	2	2
21	Non-Obese	33	M	2	68	170	23.5	50	60	2	2.5	2	2	2	2.1
22	Non-Obese	55	M	2	68	170	23.5	80	90	1	2	2	2	2	2.5
23	Non-Obese	41	F	1	58	151	25.4	180	190	1	2	2	2	2	2.5
24	Non-Obese	40	F	2	55	161	21.2	190	200	1	2	2	2	2	2.5
25	Non-Obese	59	M	2	58	160	22.7	120	130	1	1	2	2	2	2.1
26	Non-Obese	52	M	2	65	173	21.7	90	100	1	2	2	2	2	2.5
27	Non-Obese	51	M	2	72	177	23	80	90	1	2	2	2	2	2.5
28	Non-Obese	46	F	1	57	148	25	120	140	1.5	2	3	2	2	3
29	Non-Obese	64	F	2	70	168	24.8	60	80	2	3	2.5	2	2	3
30	Non-Obese	54	F	1	48	152	20.8	60	80	2	2.5	3	2	2	3
31	Non-Obese	55	F	1	50	142	24.8	180	190	1.5	2.5	3	2	2	3
32	Non-Obese	45	M	2	72	168	25.5	70	90	2	2	1.6	2	2	2
33	Non-Obese	59	M	2	56	164	20.8	60	80	1	2	3	2	2	3
34	Non-Obese	59	M	1	44	163	16	160	170	1	1.5	1.6	1	2	3
35	Non-Obese	49	M	2	60	168	21.3	60	70	1	2	2	2	2	2.5
36	Non-Obese	43	M	1	62	160	24.2	40	50	2	2.5	2.5	1	2	2.5
37	Non-Obese	52	M	1	70	169	24.5	180	190	2	3	2.6	2	2	3
38	Non-Obese	20	M	1	50	170	17.3	140	150	1	2	2.5	2	2	3.5
39	Non-Obese	54	M	1	47	162	17.9	60	70	1	2	2	2	2	2.5
40	Non-Obese	44	M	2	50	152	21.6	60	70	2	3	2	1	2	2.5
41	Non-Obese	62	M	1	67	168	23.7	120	130	1	2	2	2	2	2.5
42	Non-Obese	57	M	1	82	173	21.4	120	130	1	2	2	2	2	2.5
43	Non-Obese	45	F	2	45	160	17.6	140	180	4.8	6.1	4	4.5	5.5	3.5
44	Non-	4	M	1	70	170	24.2	10	12	2	3.	3	4	4	3.

	Obese	2						0	0		5				5
45	Non-Obese	21	M	2	52	164	19.3	80	100	3	3.5	3	4.5	4	3.5
46	Non-Obese	45	M	2	67	170	23.2	60	100	4	4.4	4	4.1	4	3.5
47	Non-Obese	32	F	2	50	165	18.4	30	120	3	3.5	4	5.1	5.5	3.5
48	Non-Obese	54	M	1	47	162	17.9	60	70	1	2	2	2	2	2.5
49	Non-Obese	44	M	2	50	152	21.6	60	70	2	3	2	1	2	2.5
50	Non-Obese	62	M	1	67	168	23.7	120	130	1	2	2	2	2	2.5
51	Non-Obese	57	M	1	82	173	21.4	120	130	1	2	2	2	2	2.5
52	Non-Obese	54	M	1	47	162	17.9	60	70	1	2	2	2	2	2.5
53	Non-Obese	44	M	2	50	152	21.6	60	70	2	3	2	1	2	2.5
54	Non-Obese	62	M	1	67	168	23.7	120	130	1	2	2	2	2	2.5
55	Non-Obese	57	M	1	82	173	21.4	120	130	1	2	2	2	2	2.5
56	Obese	34	F	2	82	160	32	120	200	2	3	2	2	3	2.2
57	Obese	24	M	1	72	162	27.4	140	150	3	3.5	2.9	2	3	3
58	Obese	33	F	2	58	145	27.6	45	55	1	2	2	2	2	2.5
59	Obese	56	M	2	70	150	31.1	60	70	1	2	2	2	2	2.5
60	Obese	45	F	1	70	163	26.3	180	190	2	4	3	3	3	3.5
61	Obese	24	F	2	74	150	32.9	90	100	1	2	2	2	2	2.5
62	Obese	65	M	2	85	164	31.6	45	90	1	1.5	2	2	2.5	2.5
63	Obese	28	M	1	74	165	27.2	45	90	2	4	2	5	6	1.5
64	Obese	26	M	1	82	165	30.1	150	180	3	5	3.5	2	5	3
65	Obese	34	F	2	105	157	42.6	30	60	5	7	1.5	4	4	2
66	Obese	23	M	1	69	160	27	60	80	1	2	1.5	1.5	2	2.5
67	Obese	36	F	1	74	156	30.4	80	100	2	3	2	2	2	2.5
68	Obese	23	F	1	88	166	31.9	30	40	2	3	1.5	2	2	2

69	Obese	35	F	2	83	160	32.4	90	100	1	2	2	2	2	2.5
70	Obese	46	M	1	72	162	27.4	80	90	1	2	2	2	2	2.5
71	Obese	39	F	1	100	160	39.1	150	180	3	4	2.5	4	5	2.1
72	Obese	40	F	2	65	154	27.4	120	150	2	2.5	3	1	1	2.5
73	Obese	49	M	2	82	162	31.2	45	60	2	2.5	2	1	2	2
74	Obese	29	F	1	61	150	27.1	40	60	1.8	2	2.5	1	2	2
75	Obese	30	M	1	96	180	29.6	150	170	1	2	3	2	2	2.7
76	Obese	33	M	1	68	149	30.6	60	70	2	2	3	2	3	3
77	Obese	35	M	1	72	150	32	45	60	2	4	2	3	4	2.5
78	Obese	28	F	2	106	154	44.7	120	140	3	4	3	3	3	2.7
79	Obese	46	F	1	80	174	29.8	170	180	2	3	2	2	2	2.5
80	Obese	43	M	2	75	164	27.9	180	200	1	3	3	2	2	3.5
81	Obese	24	F	2	75	162	28.6	40	45	2	2	1.5	1	2	2
82	Obese	37	F	2	70	159	27.7	120	130	3	3	2.5	3	3	2.5
83	Obese	44	F	1	64	150	28.4	130	150	2	2.4	4	2	2	3.5
84	Obese	62	M	2	84	173	28.1	130	140	1	2	2	2	2	2.5
85	Obese	45	F	1	80	153	34.2	100	120	1	1.3	2.6	2	2	3.5
86	Obese	52	F	2	90	150	40	60	150	2	2.3	2.5	2	2	2.1
87	Obese	48	M	1	80	150	35.6	120	200	3	3.5	4	1.5	2.5	4
88	Obese	40	M	1	80	160	31.6	90	160	3	4	3.5	2	2.5	3.5
89	Obese	54	F	2	75	158	30	100	150	2	3.5	2.1	2	2.5	3.5
90	Obese	32	F	1	72	160	29.3	60	160	3	3	2	1.5	1.5	2.2
91	Obese	40	M	2	67	152	29	50	100	4	4.4	2.1	4	4	3.5
92	Obese	25	M	1	100	160	39.1	100	200	2	3.5	4	3	3.6	4
93	Obese	2	M	1	73	162	27.8	12	15	1.	3.	4	2	3.	4

		1						0	0	8	5			6	
94	Obese	23	M	2	98	168	34.7	40	100	6	6.1	2.1	6	6	2.7
95	Obese	48	F	1	82	142	40.7	56	90	6	7	3.5	5	5.5	4
96	Obese	32	M	1	92	154	38.8	95	180	5	6.1	2.1	3	3.1	3.5
97	Obese	25	M	1	102	162	38.9	54	100	2	3.5	3.5	3	3.6	4
98	Obese	36	F	1	97	160	37.9	55	100	6	7	3.5	5	5.5	4
99	Obese	54	M	3	78	161	30.5	35	60	5	5	1.6	5	5.5	2.1
100	Obese	29	M	1	90	170	31.1	60	120	3	3.5	2.6	4	4	3.5
101	Obese	30	F	2	89	167	31.9	70	120	4.8	5	3.5	4.5	5.5	4
102	Obese	50	F	2	92	149	41.4	50	100	2	3.5	2.1	3	4	3.5
103	Obese	42	M	3	100	158	40.1	80	100	6	6.1	2.1	5.3	5.5	2.7
104	Obese	56	F	1	76	152	32.9	50	120	5	6.1	2.1	5	5.5	3.5
105	Obese	38	M	1	82	162	31.2	60	100	8	8	1.5	8	8	2.1
106	Obese	54	M	2	95	150	41.3	120	160	3	6.1	4	3	4	4
107	Obese	53	F	3	90	165	33.1	45	60	6	7	1.6	5.1	6	3.5
108	Obese	42	F	1	90	154	37.9	120	200	3	4.3	4	4.5	5.5	4
109	Obese	38	M	2	95	164	33.5	160	180	2	3	3.5	3	4	3.5
110	Obese	32	M	2	89	160	34.8	120	160	4.8	2.6	3.5	5	5.5	4