"COMPARING THE EFFECT OF EPIDURAL ANAESTHESIA AND ULTRASOUND GUIDED HERNIA BLOCK ON HAEMODYNAMIC CHANGES IN GERIATRIC PATIENTS UNDERGOING INGUINAL HERNIA REPAIR USING ROPIVACAINE– A ONE YEAR RANDOMISED CONTROL TRIAL"

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ABBREVIATIONS

ASA	-	American society of Anesthesiologists
ASIS	-	Anterior Superior Iliac Spine
BMI	-	Body mass index
CI	-	Confidence interval
CPOT	-	Critical Care Pain Observation Tool
cm	-	Centimeter
DBP	-	Diastolic Blood Pressure
ED	-	Effective dose
EOM	-	External Oblique muscle
GN	-	Genitofemoral nerve
HR	-	Heart Rate
II-IH nerve	-	Ilioinguinal-Iliohypogastric nerve
IOM	-	Internal oblique muscle
kg	-	Kilogram
L	-	Lumbar sensory dermatomal level
LA	-	Local Anaesthetic
MAP	-	Mean Arterial Pressure
MHz	-	Mega hertz
min	-	Minute

ml	-	Milliliter
SBP	-	Systolic Blood Pressure
SD	-	Standard deviation
T	-	Thoracic sensory dermatomal level
TAM	-	transversus abdominus muscle
US	-	Ultrasound
USG	-	Ultrasonography
VAS	-	Visual Analogue Score
yrs	-	Years

ABSTRACT

TITLE: "COMPARING THE EFFECT OF EPIDURAL ANAESTHESIA AND ULTRASOUND GUIDED HERNIA BLOCK ON HAEMODYNAMIC CHANGES IN GERIATRIC PATIENTS UNDERGOING INGUINAL HERNIA REPAIR USING ROPIVACAINE– A ONE YEAR RANDOMISED CONTROL TRIAL"

Background: Geriatric patients undergoing inguinal hernia repair face heightened risks due to age-related comorbidities and haemodynamic instability. Choosing the optimal anaesthetic technique is crucial to minimize these risks.

Objectives: The aim is to study the haemodynamic changes in hernia block and epidural anaesthesia in geriatric patients undergoing inguinal hernia repair and to compare the effectiveness and peri-operative comfort of Hernia block and epidural anaesthesia.

Methods: Study involved sixty patients aged 60 years and above, ASA grade II onwards undergoing open inguinal hernia repair. In Group E, patients received epidural anaesthesia and group H received hernia block (ilioinguinal-iliohypogaatric nerve block and genitofemoral nerve block). Perioperative hemodynamics, comfort scale, time for first rescue analgesia were recorded.

Results: The Hernia Block group initially had higher systolic blood pressure (p = 0.0489), persisting for 20 minutes, while Epidural Anesthesia group had consistently lower mean arterial pressure (p-values: 0.0383, 0.0177, 0.0048, 0.0209, and 0.0199 at 0, 5, 10, 15, and 50 minutes, respectively). Additionally, the Hernia Block Group had significantly higher CPOT scores at 20, 30, and 40 minutes (p-values: 0.0228, 0.0228, and 0.0132, respectively).

Conclusion: In conclusion, the inguinal field block appears as the more stable choice, particularly considering the prevalent burden of comorbidities in this population.

Key words: Inguinal hernia block. Ilioinguinal-iliohypogastric nerve block, genitofemoral nerve block

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHS

LIST OF PHOTOGRAPHS

INTRODUCTION

The selection of Anesthetic technique for Inguinal hernia should depend on patient general health condition, age, the skill of the anesthesiologist, clinical situation, and the most current scientific evidence. [1] The options encompass local infiltration, regional anaesthesia (such as peripheral nerve blocks, like inguinal hernia block, spinal anaesthesia, and epidural anaesthesia), and general anesthesia. [2] Regional, entails administering anesthetic medication to specific areas. These techniques numb targeted regions, offering notable pain control, and muscle relaxation during surgery. They're particularly beneficial for avoiding general anesthesia in many cases, and mitigating systemic effects. In contrast, general anesthesia achieves unconsciousness and pain alleviation via intravenous medications and inhaled anesthetics. It's commonly employed for inguinal hernia repair, especially in complex cases, or when other anesthesia options may not suffice. Each anesthesia type presents distinct advantages and considerations, emphasizing the importance of personalized selection based on patient factors and procedural requirements. Currently, no agreement exists regarding the best method for anesthesia. [3]

Hernia surgeries in the elderly frequently rely on Spinal anesthesia. However, it's crucial to consider age-related changes in cardiovascular function and sympathetic activity. As individuals age, there's a natural decline in cardiovascular reserve, which means the heart may not respond as efficiently to stressors like surgery. Additionally, alterations in sympathetic activity can affect blood pressure regulation and overall cardiovascular stability during the procedure. These factors emphasize the importance of careful monitoring and management during hernia surgery in geriatric patients. Additionally, the intraoperative management of hernia surgery in elderly patients becomes more complex when considering the concurrent existence of conditions such as hypertension, diabetes mellitus, and ischemic heart disease. These conditions can significantly influence cardiovascular function, exacerbating the challenges faced during surgery. [4, 5]

Epidural anesthesia presents a favorable edge over spinal anesthesia due to its capacity to minimize hemodynamic fluctuations. Unlike spinal anesthesia, which may induce more abrupt changes in blood pressure, epidural anesthesia typically results in smoother transitions, offering greater haemodynamic stability throughout the procedure. Furthermore, epidural anesthesia enables the provision of postoperative analgesia. This extended pain relief not only ensures patient comfort during the immediate postoperative period, but also contributes to enhanced recovery outcomes. Thus, epidural anesthesia serves as a versatile option, providing both intraoperative hemodynamic control and effective postoperative pain relief, thereby optimizing the overall perioperative experience for patients undergoing hernia surgery. [6]

The latest research findings are steering away from the conventional practices associated solely with spinal anesthesia (SA). Instead, there's a rising passion in embracing the broader concept of localized anesthesia [7]. The hernia block, also known as the inguinal field block, is a regional anesthesia technique specifically designed to anesthetize the area surrounding the inguinal canal where hernias occur. It targets three primary nerves belonging to dermatomes T12-L1: the genitofemoral nerve, the iliohypogastric nerve, and the ilioinguinal nerve. These nerves play a crucial role in providing sensation to the inguinal region, including the groin, inner thigh, and lower abdomen. [8] An important benefit of the inguinal field block is its capacity to deliver effective anesthesia while reducing the necessity for general anesthesia or sedation. This is especially advantageous for patients who might not be appropriate candidates for systemic anesthesia due to underlying health conditions or other considerations. Additionally, the inguinal field block can serve as component of a multifaceted pain management approach, whereby local anesthesia is combined with other analgesic techniques to provide comprehensive alleviation of pain during, and after surgical procedures. By reducing the reliance on opioid medications, this approach can help minimize the potential for adverse effects associated with opioid usage and facilitate faster recovery times. [(7)]

Utilizing ropivacaine for hernia block offers several advantages, particularly in maintaining patient hemodynamics and reducing cardiotoxicity compared to other local anesthetics. Ropivacaine also demonstrates superior differentiation between motor and sensory block, resulting in a more favorable balance of sensory anesthesia over motor blockade. This property not only enhances patient comfort by minimizing motor impairment but also contributes to faster postoperative recovery and ambulation. Moreover, its ability to provide postoperative analgesia further aids in pain management, promoting quicker recovery and facilitating ambulation post-surgery. [(9)]

Despite these benefits, research evaluating the effects of ropivacaine, particularly in its plain form, in the geriatric population remains limited. Therefore, while ropivacaine holds promise for hernia block in older patients, further investigation is warranted to fully elucidate its safety and efficacy profile in this demography. Such research endeavors would offer valuable insights for maximizing anesthesia protocols and improving surgical results for elderly individuals undergoing hernia repair. In line with the definition set forth in the National Policy for Older

Persons, we have identified the geriatric age group as individuals aged 60 years and above. [10, 11, 12]

Following an extensive literature review, no studies have been identified that compare the hemodynamic effects of epidural anesthesia with hernia block using ropivacaine in geriatric individuals receiving inguinal hernia surgery. Consequently, there exists a gap in current research, prompting us to undertake a comparative analysis of these two anesthesia techniques.

This proposed comparison seeks to elucidate potential differences in hemodynamic stability, efficacy of postoperative analgesia, and overall perioperative outcomes between epidural anesthesia and hernia block using ropivacaine in elderly individuals undergoing inguinal hernia repair.

AIM AND OBJECTIVES

PRIMARY OBJECTIVE:

- To compare the haemodynamic changes in hernia block and epidural anaesthesia in geriatric patients undergoing inguinal hernia repair.

SECONDARY OBJECTIVE:

- To assess the peri-operative comfort of epidural anesthetic and hernia block, using the Critical Care Pain Observation Tool.

REVIEW OF LITERATURE

1. Pertti Pere and Jukka Harju investigated the viability of three different anesthetic methods for open inguinal hernia surgery in a study conducted in 2016. With the theory that LAI would permit speedier discharge than SPIN and TIVA, the study sought to assess the effectiveness of local anesthetic infiltration (LAI), subarachnoid anesthesia (SPIN), and total intravenous anesthesia (TIVA). A total of 156 patients (ASA 1-3) participated in the experiment. Participants were randomized to receive either TIVA (propofol + remifentanil), SPIN (bupivacaine + fentanyl), or LAI (lidocaine + ropivacaine). Prior to and following surgery, bladders were scanned, and postoperative days 1, 7, and 90 were used for interviews.

   The findings showed that the LAI group had a longer surgery (median 40 minut es) than the SPIN (35 minutes, P =.003) and TIVA (33 minutes, P <.001) group Compared to the LAI group, these patients spent more time in the operatingroom (P <.001), even though their procedure took less time in the TIV A group.

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   The LAI group had the shortest time until discharge preparedness (93 minutes), which was considerably less than the TIVA (147 minutes) and SPIN (190 minut es) groups (P <.001).Thirty-two LAI patients and four SPIN patients required

IV fentanyl, whereas thirty two LAI patients needed further lidocaine infiltratio. 34 TIVA, 5 LAI, and 5 SPIN patients required ephedrine. Furthermore, in order to finish their surgeries, three LAI patients and one SPIN patient needed TIVA, and another SPIN patient needed LAI. Urinary retention was not seen in any cases, and three months after surgery, 26% of patients experienced discomfort in the scar area; however, this was unrelated to the type of anesthetic utilized. (**13**)

2. In 2020, Lin Li, Yi Pang, et al. carried out a review and analysis comparing the effectiveness of general anesthesia (GA) with spinal anesthesia (SA) in the treatment of adult inguinal hernias. They located relevant research using the databases of PubMed, Embase, ScienceDirect, Cochrane Library, and Scopus. They then examined the results, examining variables like length of hospital stay, pain levels, patient satisfaction, and complications following surgery. A total of 2593 participants from six randomized controlled trials and five cohort studies were included in the analysis. The findings indicated that SA was linked to a longer surgical duration, especially for laparoscopic repairs. For both open and laparoscopic repairs however, SA was preferred due to postoperative pain at 4 and 12 hours (standard mean difference [SMD]: 1.58; 95%CI: 0.55, 2.61 and SMD: 0.99, 95%CI: 0.37, 1.60, respectively). SA was favored by patient satisfaction, which had borderline significance (SMD: -0.32, 95%CI: -0.70, 0.06). Seromas, wound infections, recurrences, shoulder soreness, and scrotal edema were among the major consequences that were similar in SA and GA. SA was more likely to experience headaches (RR: 0.33, 95%CI: 0.12, 0.92) and postoperative urine retention (RR: 0.44, 95%CI: 0.23, 0.86) after surgery. Particularly in open herniorrhaphy, there was a tendency for a decreased

incidence of postoperative nausea and vomiting in SA as compared to GA (RR: 2.12, 95%CI: 0.95, 4.73). [3]

3. Bin Yang, Ming-Juan Liang, and associates carried out a study in 2008 to examine the safety and effectiveness of local anesthetic in comparison to epidural anesthesia for tension-free inguinal hernia repair. 269 participants participated in the trial and were split into two groups at random: 123 had local anesthetic and 126 got epidural anesthesia. The results of the retrospective analysis of clinical data showed that, in comparison to the epidural anesthesia group, the local anesthesia group had considerably shorter operation times, faster ambulation times, shorter hospital stays, and reduced hospitalization expenditures ($P < 0.05$). The two groups did not differ significantly in terms of pain scores, operation-related problems, postoperative recovery, or intraoperative usage of supplementary sedatives. On the other hand, the local anesthesia group had a considerably decreased rate of postoperative anesthetic problems ($P < 0.05$). In each group, one instance of recurrence was recorded during the postoperative follow-up period. The research findings indicate that the use of local anesthetic for tension-free inguinal hernia repair is a straightforward, secure, cost-effective, and efficient method that outperforms epidural anesthesia. [14]

4. The effectiveness of ilioinguinal-iliohypogastric nerve block (IINB and IHNB) with tumescent anesthesia was compared to spinal anesthetic in single-sided inguinal hernia surgeries in a study by Mustafa Kaçmaz and Hacı Bolat, which was published in 2020. Finding out if local anesthetic with IINB and IHNB may be a good substitute for spinal anesthesia was the main goal. 75 patients,

categorized as ASA I-III and ranging in age from 18 to 75, were enrolled in the trial prospectively and at random. The results indicated a statistically significant difference in the duration of surgery, with Group 1 (spinal anesthesia) having a shorter duration (30.14 ± 8.2 minutes) compared to Group 2 (IINB and IHNB) (35.51 ± 9.39 minutes) ($p < 0.001$). However, the time to first mobilization was significantly shorter in Group 2 (2.70 ± 1.53 minutes) compared to Group 1 (5.71 ± 1.7 minutes) ($p < 0.001$). The mean length of hospital stay was also significantly shorter in Group 2 (14.23 ± 5.40 hours) than in Group 1 (26.00 ± 6.43 hours) ($p < 0.001$). During the 24-hour postoperative follow-up, a higher percentage of patients in Group 1 required analgesia (91.4%) compared to Group 2 (45.7%) ($p < 0.005$). Additionally, patient satisfaction and the incidence of urinary retention were significantly better in Group 2 ($p < 0.005$). In neither group were there any instances of postoperative bleeding or hematoma development. Group 2 experienced a substantially longer sensory block onset time (9.66 ± 1.41 minutes) than Group 1 (9.03 ± 0.98 minutes) ($p < 0.005$). The study found that for unilateral inguinal hernia repairs, IINB and IHNB administered under local anesthesia are preferable to spinal anesthesia. These benefits include a shorter length of hospital stay, quicker mobilization, less need for postoperative analgesics, and increased patient satisfaction. [15]

5. A study done by Chakraborty A, Khemka Rakhi et al in 2016 on Truncal blocks guided by ultrasound elaborated that the advent of portable ultrasound machines in operating theaters has brought about a shift in the practice of regional anesthesia, moving away from traditional landmark-based techniques to performing regional blocks under direct visualization using ultrasound. Subsequent years witnessed the development of newer regional anesthesia

techniques targeting the trunk, hence termed truncal blocks. A distinctive aspect of ultrasound-guided truncal blocks is unlike that of peripheral nerve blocks, they do not require identification of specific nerves or plexuses. Instead, local anesthesia (LA) is injected into a specific muscle plane, where the injectate diffuses and reaches the target nerves. This straightforward mechanism has simplified the administration of nerve blocks, making them more accessible and adaptable. They conclude with saying Ultrasound-guided regional anesthesia techniques have demonstrated superior safety and efficacy compared to traditional landmark-based approaches. While the journey initially focused on imaging known landmarks, current research suggests a shift towards an era where ultrasound becomes indispensable in regional anesthesia practice. Many techniques may only be feasible with ultrasound assistance, with truncal blocks serving as early examples of this trend. The transversus abdominis plane block, rectus sheath block, hernia block, and quadratus lumborum block in the abdomen, as well as the pectoral nerves (Pecs) blocks 1 and 2, serratus anterior plane block, and intercostal nerve block, are a few of the noteworthy recent techniques. A comprehensive understanding of regional anatomy remains essential, alongside considerations of ergonomics, such as positioning, side selection, and equipment choice. Adhering to these guidelines can make using ultrasound a fun and instructive experience for anesthesiologists. [16]

6. Seyed Hamid Reza Faiz, Nader D. Nader, and associates investigated the effectiveness of transversus abdominis plane (TAP) block versus ultrasound-guided ilioinguinal/iliohypogastric (IINB) nerve block for analgesia after open

inguinal hernia repair in a clinical experiment conducted in 2019. In the post anesthesia care unit, 90 patients were randomly randomized to undergo either IINB (n = 45) or TAP block (n = 45) with 15 mL of 0.2% bupivacaine administered under ultrasound supervision. The Numerical Rating Scale (NRS) was used to measure pain immediately after the block as well as at 4, 8, 12, and 24 hours later. Furthermore, NRS ratings were noted at 24-, 36-, and 48-hours following surgery, both during rest and movement. A Likert-based questionnaire was used to assess the satisfaction of patients with their analgesics. The findings showed that, both at rest and during movement, the NRS values in the IINB group were consistently lower than those in the TAP block group. The difference in dynamic pain levels was statistically significant (P=0.017). In addition, the IINB group's mean score for analgesic satisfaction was substantially greater (2.43) than the TAP block group's (1.84%, P=0.001). The two groups' postoperative opioid needs did not significantly differ from one another. The study found that after open inguinal hernia repair, IINB, when given under ultrasound guidance, offers better pain control and higher patient satisfaction than TAP block. [17]

7. Susan M Nimmo studied the advantages and results following epidural analgesia in 2004. It offers several established advantages such as pain relief and dampening the stress response. Although its impact on postoperative mortality hasn't been definitely proven, when integrated into a comprehensive perioperative care regimen, it has been demonstrated to enhance the quality of patient recovery and decrease the occurrence of severe complications. Moreover, epidurals are expected to provide superior pain relief, a primary concern for patients, as evidenced by numerous significant trials. [18]

8. In a study conducted by Urvashi Yadav, Deepika Doneria and colleagues, in 2023, for postoperative pain management in patients undergoing inguinal hernia surgery, the analgesic efficacy of single-shot epidural block and ultrasound-assisted transversus abdominis plane (TAP) block was compared. The study included 40 patients of either gender, classified as ASA I and II, who were split into two groups at random: Group T underwent a TAP block with 20 ml of 0.25% bupivacaine under ultrasound supervision, while Group E received a single-shot epidural. Postoperative pain was measured at fifteen, thirty, sixty, 120 minutes and 72 hours after the block using the visual analog scale (VAS). When a patient requested rescue analgesia or had a VAS score of 4 or above, it was given. The VAS scores at the designated time periods were the primary outcomes, and patient satisfaction, the length of analgesia, and the total amount of rescue analgesia needed were the secondary results. The findings showed that at 2, 6, 12, and 24 hours postoperatively, the epidural group's VAS pain scores were significantly lower than those of the TAP group ($p<0.0001$). Group E also had a substantially longer mean duration of analgesia (576.75 ± 96.64 minutes) than Group T (276.75 ± 105.56 minutes). Group T also consumed significantly more analgesics overall over a 24-hour period. Group E also had significantly higher patient satisfaction scores, having an average value of 5.55 ± 0.6 as opposed to Group T's 4.75 ± 0.72. The results of the study show that in terms of postoperative pain control, a single-shot epidural block works better than a TAP blockade. This leads to longer-lasting analgesia, lower analgesic use, and better patient satisfaction. [(19)]
9. When outpatients underwent inguinal herniorrhaphy with local anesthetic infiltration, Yifeng Ding and Paul E. White's 1995 study sought to determine the

effects of an ilioinguinal-hypogastric nerve block (IHNB) with 0.25% bupivacaine on postoperative analgesic requirements and recovery. An IHNB containing either saline or bupivacaine was randomly assigned to thirty healthy males who were scheduled for elective unilateral inguinal herniorrhaphy. Before injecting 30 ml of bupivacaine or saline at the anterior superior iliac spine, each participant received 2 mg of midazolam and 25 μg of fentanyl intravenously. Next, 1% lidocaine was injected into the incision site. A propofol infusion with a variable rate was used to control sedation during the procedure. The intraoperative doses of fentanyl, propofol, and lidocaine did not change significantly between the two groups, according to the study. Nevertheless, thirty minutes after arriving at the post-anesthesia care unit (PACU), the bupivacaine group reported reduced pain levels ($P < 0.05$). Patients who received bupivacaine needed less oral analgesic medicine after discharge (46% vs. 85%), despite similar timeframes to ambulation and readiness for release between the groups. According to the study's findings, using IHNB with 0.25% bupivacaine during inguinal herniorrhaphy supervised anesthetic treatment significantly minimized discomfort in the PACU and the requirement for oral analgesics after discharge. [20]

10. In children having inguinal hernia surgery, the effectiveness of including a genitofemoral nerve block into the usual ilioinguinal and iliohypogastric (IG-IH) nerve block was assessed in a research conducted in 2005 by N. Sasaoka, M. Kawaguchi, and colleagues. The genitofemoral nerve and other sensory innervations of the inguinal region may not be completely covered by the IG-IH nerve block, which is frequently utilized for pain management during these surgeries. The purpose of the trial was to determine whether adding a genitofemoral nerve block would improve analgesia. Ninety-eight children were divided into two groups at random: Group I received only the IG-IH nerve block, whereas Group II received both the IG-IH and genitofemoral nerve blocks. Systolic arterial pressure (SAP) and heart rate (HR) were measured by the researchers at several intervals: prior to surgery (control), during skin incision, during sac traction, and following operation. Complications and postoperative analgesic needs were monitored until discharge. The findings demonstrated that during sac traction, Group I had significantly higher HR and SAP than Group II ($P<0.05$), and elevated HR episodes were more often in Group I (29% vs. 12%, $P<0.05$). At other times, however, there were no appreciable variations in SAP and HR, nor in the groups' rates of complications or postoperative analgesic requirements. The results of the trial demonstrated modest therapeutic gain, even while the inclusion of a genitofemoral nerve block increased analgesia during sac traction and provided no significant postoperative benefit. [21]

11. Kuthiala G, Chaudhary G's review published in 2011 elaborated that Ropivacaine's mechanism of action resembles that of other local anesthetics by reversibly inhibiting entry of sodium ions into nerve fibers. It exhibits lower lipophilicity compared to bupivacaine, resulting in a diminished likelihood of penetrating large myelinated motor fibers and thus inducing a lesser motor blockade. This allows for a higher extent of differentiation between motor and sensory functions, particularly beneficial in scenarios where motor blockade is aimed to be minimized. Moreover, it's lower lipophilic nature is linked to a decreased risk of central nervous system and cardiac-toxicity. Ropivacaine demonstrates excellent tolerance as a regional anesthetic, effectively providing

surgical anesthesia and relieving post-surgery pain. While it may display slightly lower potency than bupivacaine when given epidurally or intrathecally, equivalent dosages have been determined. With its distinct features ropivacaine emerges as a crucial choice. [9]

12. When used for ilioinguinal-iliohypogastric blocks (IIB) during adult inguinal hernia repair, ropivacaine's pharmacokinetics and pharmacodynamics were examined at three different concentrations (2 mg/mL, 5 mg/mL, and 7.5 mg/mL) by Hinnerk Wulf, Frank Worthmann, and associates in 1999. Four groups of eighty male adults were randomly assigned. The patients in Groups 1, 2, and 3 underwent a double-blind IIB with 0.25 mL/kg of ropivacaine at doses of 2 mg/mL, 5 mg/mL, and 7.5 mg/mL, respectively, after general anesthesia was induced. The Control group was given saline. The plasma concentrations of ropivacaine were measured using reversed-phase high-performance liquid chromatography on venous blood samples. Peak plasma concentrations were measured at median times of 30 minutes (range: 15-60), 30 minutes (range: 10-60), and 45 minutes (range: 15-60) for Group 1, Group 2, and Group 3. The values were 0.3 ± 0.15 μg/mL, 0.75 ± 0.45 μg/mL, and 1.57 ± 0.82 μg/mL, respectively. After surgery, 6 of 18 patients in Group 2, 5 of 20 patients in Group 3, and 3 of 19 patients in Group 1 did not need any more analgesics within 24 hours, while all 20 control patients did. Compared to 1.5 hours (range 0.5-24) in Group 1, 2 hours (range 0.5-24) in Group 2, and 2 hours (range 1-24) in Group 3, the Control group experienced a considerably shorter duration to the first analgesic request (median 0.3 hours, range 0-2.8). Furthermore, three patients in Group 3 developed femoral nerve postoperative motor block. According to the study's findings, ropivacaine at a dose of 0.25 mL/kg (5

mg/mL) works well for relieving postoperative pain when combined with general anesthesia. Even the highest dose examined (0.25 mL/kg or 7.5 mg/mL), according to pharmacokinetic studies, did not produce dangerous plasma concentrations, confirming the safety of ropivacaine at these doses for IIB during hernia repair. [22]

13. Age-related changes in neural suppression and hemodynamic effects after epidural anesthesia with 1.0% ropivacaine among individuals getting orthopedic, urological, gynecological, or lower abdominal operations were examined in a 2002 study by Mischa J. G. Simon, Bernadette T. Veering, and colleagues. Three age groups of fifty-four patients were created: Group 1 (18–40 years), Group 2 (41–60 years), and Group 3 (above 61 years). Each patient received 15 mL of 1.0% ropivacaine epidurally after receiving a test dose of 3 mL of 1.0% prilocaine with 5 μg/mL epinephrine. The degree of motor blockage, analgesic level, and hemodynamic variables were measured at regular intervals in the trial. The findings demonstrated that there were significant differences in the upper threshold of analgesia between the age groups, with medians of T8 for Group 1, T6 for Group 2, and T4 for Group 3. Compared to younger patients, older individuals had a more severe motor blockage. Additionally, the oldest age group saw greater rates of bradycardia and hypotension as well as the greatest drop in mean arterial blood pressure within the first hour following an epidural injection, with median drops of 11 mm Hg in Group 1, 16 mm Hg in Group 2, and 29-mm Hg in Group 3. The study found that the clinical effects of 1.0% ropivacaine are considerably influenced by age, with older patients exhibiting more pronounced hemodynamic changes. This

may be because older individuals have a decreased ability for hemodynamic equilibrium and a larger thoracic spread of analgesia. [23]

14. Yuhong Li, PhD, Shengmei Zhu, and colleagues conducted a study in 2006 with the purpose of determining the median effective concentration (EC50) of ropivacaine for motor blockade following epidural administration in patients undergoing minor lower limb surgery or urology. They also wanted to look into the impact of age on motor blockade. Patients with ASA physical status I–II were included in the study and were split into two age groups: Group 1 (those over 70) and Group 2 (those under 70). A 15-mL bolus of epidural ropivacaine, commencing at a concentration of 0.425% and devoid of epinephrine, was administered to each patient. The subsequent concentrations were adjusted at intervals of 0.025% using the up-down sequential allocation approach. A modified Bromage score of 0 was considered to be achieved within 30 minutes of effective motor blockage. The findings indicated an statistically substantial disparity ($P < 0.01$) between the motor blockade EC50 of ropivacaine in the younger group (Group 1) and the older group (Group 2), with the former having a 95% confidence interval of 0.358%-0.409%) and the latter having an EC50 of 0.536% (95% confidence interval, 0.512%-0.556%). The study found that older individuals need a higher concentration of ropivacaine to achieve successful motor blockade, and that age significantly affects the EC50 of ropivacaine for motor blockade with epidural injection. [24]

15. The impact of combining clonidine with ropivacaine for ilioinguinal-iliohypogastric block in patients having inguinal herniorrhaphy under monitored anesthetic care was examined in a study conducted in 2005 by Marc Beaussier, Henri Weickmans, and colleagues. 40 adult patients were randomly randomized

to receive either a preoperative nerve block with 225 mg of ropivacaine (7.5 mg/mL) alone (control group) or the same dose of ropivacaine plus 75 μg of clonidine (clonidine group). Patients were urged to mobilize during the second postoperative hour after being moved to the post anesthesia care unit following surgery. After leaving the unit, they were permitted to take 30 mg of codeine and 500 mg of propacetamol orally as needed. With the use of a 100 mm visual analog scale, pain intensity was measured. In the clonidine group, the median time to the first request for more analgesics was 10 hours, whereas in the control group, it was 9 hours ($P > 0.83$). The clonidine group experienced less pain during movement on the third postoperative day, but there was no significant difference in discomfort at rest across the groups. Within the initial few hours following surgery, however, a greater number of patients (6 out of 20 in the clonidine group) than patients (1 out of 20 in the control group) had orthostatic hypotension ($P < 0.05$). The study came to the conclusion that although ropivacaine plus clonidine for ilioinguinal-iliohypogastric block might lessen pain during movement on the third postoperative day, this possible advantage needs to be carefully balanced against the higher risk of orthostatic hypotension in the first few days following surgery. [25]

BASIC SCIENCES

APPLIED ANATOMY VERTEBRAL COLUMN [26]

An anaesthesiologist requires to have an accurate and in-depth knowledge of the anatomy of vertebral column and its contents for a safe and successful administration of epidural anaesthesia, not only in terms of performance but also in terms of spread of drug in epidural space and level of block achieved.

Vertebral column

Main function of vertebral column is to protect the spinal cord. There are 33 vertebrae in vertebral column which includes

- Cervical - 7
- Thoracic - 12
- Lumbar - 5
- Sacrum - 5 (fused)
- Coccyx - 4 (fused)

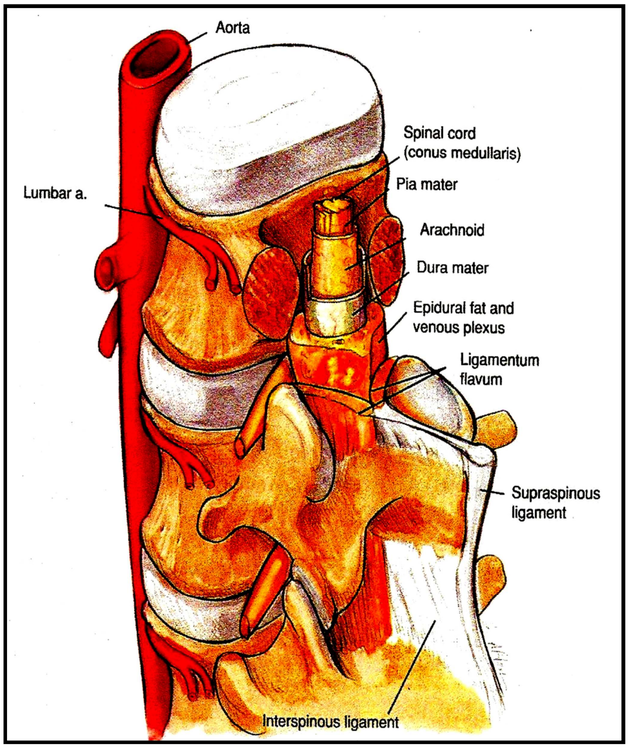
Curves of spine

In adults, curves of vertebral column have significant effect on spread of drugs in subarachnoid space. These curves are:

- Cervical curve - Convexity anterior
- Thoracic curve - Concave anterior
- Lumbar curve - Convexity anteriorly

Cervical (C) five and lumbar (L) five are the highest points of cervical and lumbar curves in supine position and the lowest points of thoracic and sacral are at thoracic (T) five and sacral (S) two respectively.

Figure 1: Vertebral Column



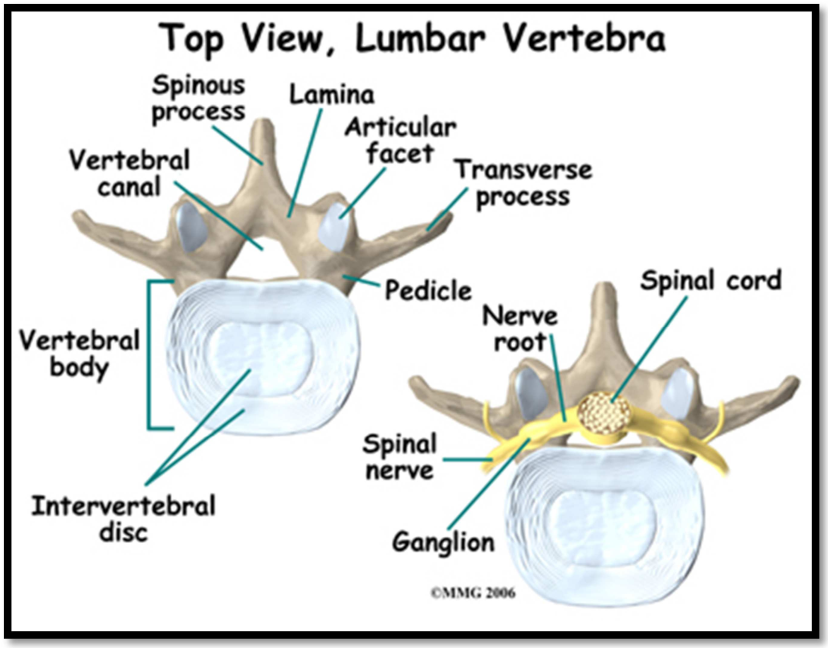
Lumbar vertebrae

A typical lumbar vertebra consists of:

- A kidney shaped body
- Two pedicles directed backwards from the upper part of the body
- Two transverse processes
- Two laminae meeting posteriorly and enclosing the triangular vertebral foramen
- Thick, broad and quadrilateral spinous processes

- Two upper and lower articular processes which prevent rotation but allow limited flexion and extension between contiguous vertebrae

Figure 2: Typical lumbar vertebra



Thoracic vertebrae:

- A heart shaped body
- A small costal demi facet on the superior border of the lateral side of body and a larger demi facet on the inferior surface
- Shallow superior vertebral notches and deeper inferior vertebral notches
- Transverse processes are directed backwards and laterally, carrying a costal facet for articulation with ribs

Vertebral ligaments

The following overlapping ligaments provide stability to the vertebral column and protect the spinal cord:

Supraspinous ligament: This is a strong fibrous cord which connects apices of spinous processes from sacrum to C_5 where it is continued as the ligamentum nuchae. The width depends upon the width of the spinous process – in lumbar region it might be upto 1 cm wide. In elderly people and manual labourers this ligament calcifies thus making the midline approach difficult.

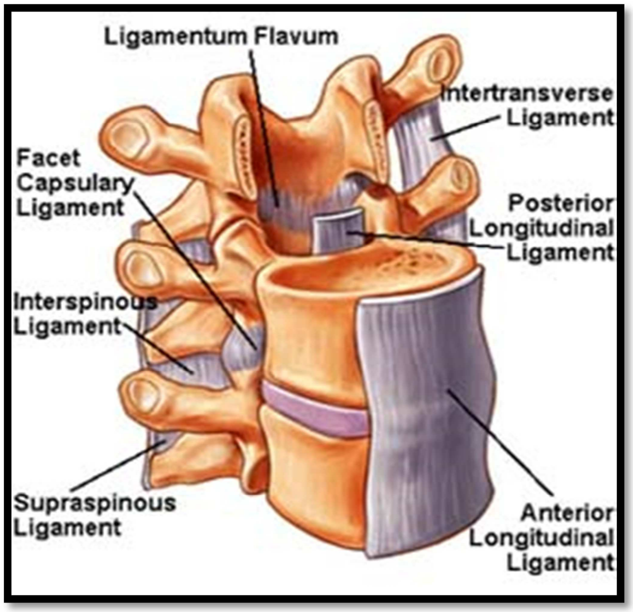
Interspinous ligament: This is a thin membranous ligament running obliquely and connecting spinous processes, blending anteriorly with ligamentum flavum and posteriorly with supraspinous ligament. In the lumbar region, this ligament is rectangular in shape leading to the characteristic and identifiable "loss of resistance" feel to air or saline.

Ligamentum flavum: This ligament comprises of yellow elastic fibres and connects adjacent laminae. Laterally, this ligament begins at the root of articular processes and extends posteriorly and medially to the point where laminae join to form spinous process. It provides the classic springy resistance in the lumbar region.

Longitudinal ligaments: There are two longitudinal ligaments (anterior and posterior) that bind vertebral bodies together.

For epidural anaesthesia, the needle pierces the first three ligaments when midline approach is used, in para median approach only the ligamentum flavum is encountered.

Figure 3: Vertebral ligaments



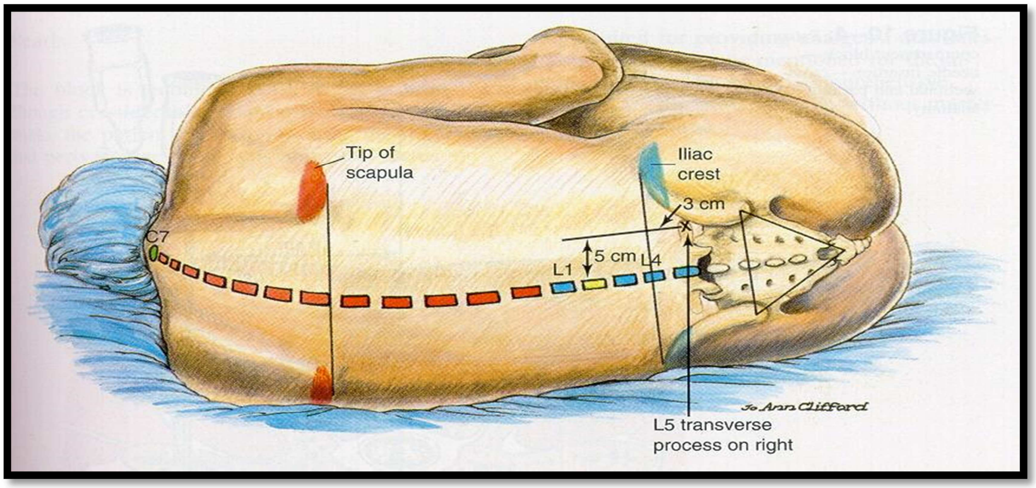
Intervertebral Discs [27]

These are the principle connecting links between vertebral bodies. They form about 25% of the length of the spine. They consist of two parts - The outer fibrous part called the *annulus fibrosus* (made up of fibrous tissue) and the inner softer core, the *nucleus pulposus*. The discs serve as shock absorbers and lend flexibility to the vertebral column.

Topographical Line of Tuffier

This is a horizontal line across the back between the crests of the iliac bone passing over the spine of the 4th lumbar vertebra in the upright position. In a patient lying in the lateral position, it may also pass through L4 and L5 interspaces. The superior iliac crest is used to identify the L4 and L5 interspace during epidural anaesthesia.

Figure 4: Topographical line of Tuffier



Vertebral canal:

The vertebral canal is anatomically bound by:

- **Anteriorly:** The vertebral bodies and intervertebral discs.
- **Posteriorly:** The laminae and the ligamentum flavum.
- **Laterally:** The pedicles and the laminae.

The contents of vertebral canal are as follows:

- Spinal cord
- Spinal nerve roots
- Meninges
- Cerebrospinal fluid
- Vessels
- Fat
- Loose areolar tissue

Spinal cord

The average length of the spinal cord in males is 45 centimetres (cms) and in females it is 42 cms. The average weight is approximately 30 gm.

The spinal cord is a continuation of the medulla oblongata below the level of foramen magnum. It tapers off into a conical extremity known as conus medullaris. Filum terminale descends to the back of first segment of coccyx from the apex of conus medullaris.

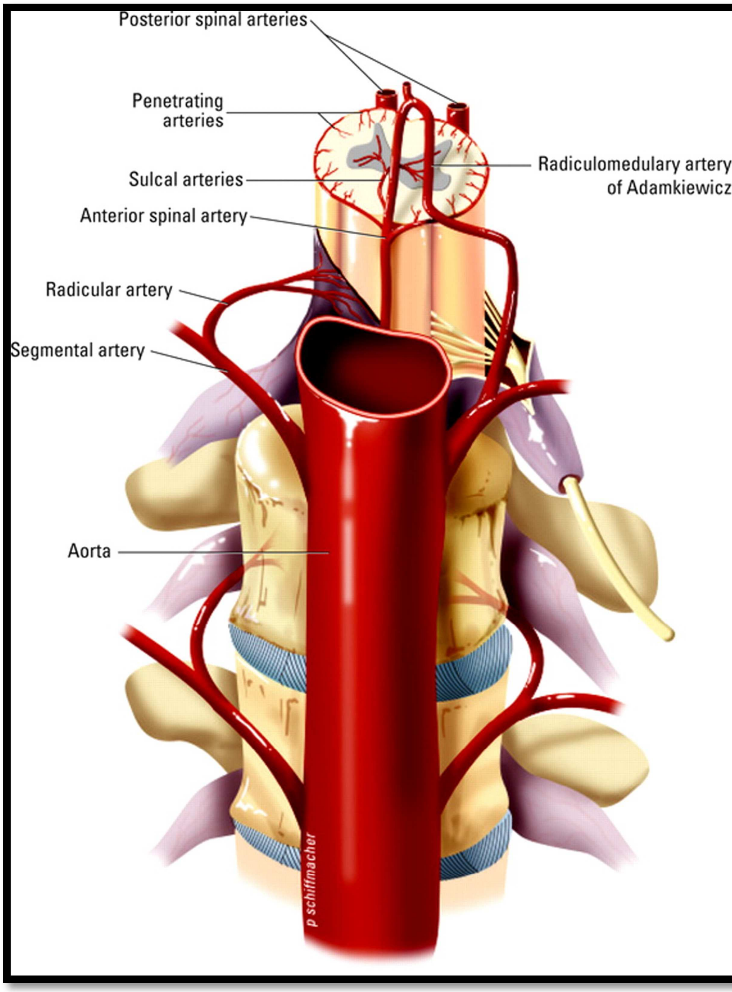
At birth, the Spinal cord ends at the level of lower border of lumbar (L) three vertebra and in adults, it is as follows;

- Lower border of L1 - in 50% of the population
- Upper border of L2 - in 40% of the population
- Upper border of L3 - in 3% of the popultion

From the spinal cord arise 31 pairs of spinal nerves, each made of a ventral and a dorsal root. These anterior and posterior roots after crossing the subarachnoid space, pass through the dura and extradural space independently and unite at the level of intervertebral foramen to form spinal nerve trunks, which further divide into anterior and posterior primary divisions.

The amount of white matter declines progressively from the cervical region down to the lumbar region. The gray matter is greatly increased in both, lumbar and cervical enlargement.

Figure 5: Blood supply of spinal cord



Blood Supply of Spinal Cord:

The spinal cord receives its blood supply from anterior and posterior spinal arteries. The anterior spinal artery is a single vessel lying in front of the anterior median fissure. It is formed by two small arteries, one given off from each vertebral artery at the level of the foramen magnum. It receives small communications from the intercostal and lumbar arteries; to provide the extra blood supply needed in the cervical, thoracic and lumbar enlargements.

There are two posterior spinal arteries-one on each side. They are derived from the vertebral artery, or more often from a primary branch of each vertebral artery. They supply the posterior one-third of the spinal cord. This supply is augmented by the spinal branches of vertebral, ascending cervical, posterior intercostals, lumbar and lateral sacral arteries, which pass through the intervertebral foramina.

Venous drainage is through a plexus of anterior and posterior veins in the neck, azygous veins in the thorax, lumbar veins in the abdomen, and lateral sacral veins in the pelvis. There is no anastomosis between the anterior and posterior spinal arteries.

The longest of the feeder arteries is the radicularis magna (artery of Adamkiewicz), which supplies the anterior spinal artery in the area of the lumbar enlargement of the cord. It enters by way of a single intervertebral foramen (78% of the time on the left) between the T8 and L3 foramina.

Meninges

The spinal cord is covered by three membranes from inward to outward. They are the pia mater, the arachnoid mater and the dura mater. The dural sac is the continuation of meningeal layer of the cranial dura mater. It is a circular sac or sleeve surrounding the spinal cord. Above, it is attached firmly to the circumference of the foramen magnum.

Duramater

It is the outermost membrane, the fibres of which run longitudinally. Although continuous, it can be described in two parts: the cranial and the spinal. The cranial dura consists of two layers: outer endosteal layer, which lines the skull, and an inner meningeal layer, which invests the brain and folds inward to form the falx cerebri and tentorium cerebelli.

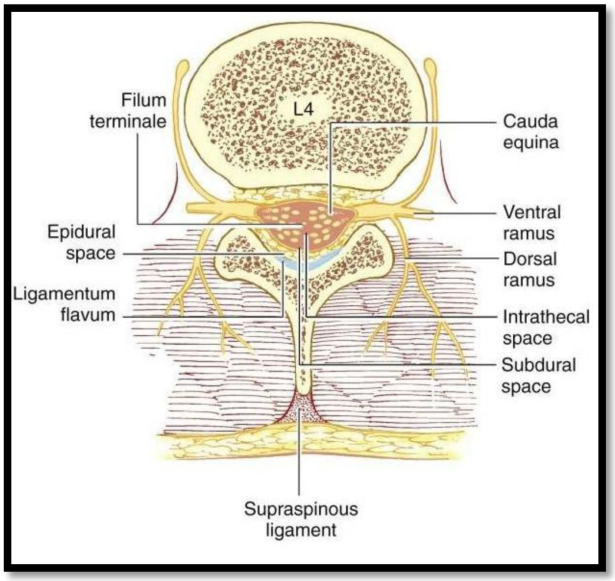
Arachnoid Mater

The arachnoid mater is a delicate non-vascular membrane applied closely to the dura mater. The lower extent of dural sac is as follows;

Below this, the dura continues as the filum terminale. The subarachnoid space is the space between the arachnoid and pia mater. This space is occupied by the cranial and spinal nerves by the cobweb trabeculae. The space is annular in the cranial and thoracic vertebrae and is about three mm deep. Below the first lumbar vertebrae it is circular in shape.

EPIDURAL SPACE [28]

Figure 6: Epidural Space



Boundaries of the epidural space

The epidural space is bounded by:

Superior: by foramen magnum, where periosteal and spinal layers of duramater fuse.

Inferior: by sacrococcygeal membrane and sacral hiatus.

Anterior: by the posterior longitudinal ligament, vertebral bodies and discs

Posterior: by ligamentum flavum, periosteum of anterior surface of laminae and connecting ligaments.

Lateral: by periosteum of pedicles and intervertebral foramina.

Rarely, a fold of duramater divides the space into ventral and dorso – medial compartments leading to patchy or unilateral analgesia or missed segments.

Shape and size: These are largely determined by the shape of the lumbar vertebral canal and the position and size of the dural sac within it.

Cervical: 1.5 mm

Upper thoracic: 2.5 – 3 mm

Lower thoracic: 4-5 mm

Lumbar: 5-6 mm

Types of epidural space

The epidural space can be categorized into cervical, thoracic, lumbar and sacral epidural spaces. These spaces can be defined according to their margins. At the cervical epidural space, there is a fusion of the spinal and periosteal layers of dura mater at the foramen magnum to the lower margin of the 7th cervical vertebra. While the thoracic epidural space is formed by the lower margin of C_7 to the upper margin of L_1, the lumbar epidural space is formed by the lower margin of L_1 vertebra to the upper margin of S_1 vertebra. The sacral epidural space is formed by the upper margin of S_1 to sacrococcygeal membrane and sacral hiatus.

Contents of the epidural space:

Contains semi liquid fat, lymphatics, arteries, loose areolar tissue, spinal nerve roots, and a very rich plexus of veins.

Fat

The epidural space is filled with semi fluid, lobulated fat tissue. Fat cells are also abundant in the dura that forms the sleeves around spinal nerve roots but they are not embedded within the laminae that form the dura mater of the dural sac. The fat in the epidural space buffers the pulsatile movements of the dural sac and protects the nerve structure, creating a reservoir of lipophilic substances. This facilitates the movement of the dural sac over the periosteum of the spinal column during flexion and extension. The areolar tissue of this space has a very rich blood supply with small capillaries forming a network in its substance. Drugs stored in fat, inside dural sleeves, could have a greater impact on nerve roots than drugs stored in epidural fat, given that the concentration of fat is proportionally higher inside nerve root sleeves than in the epidural space, and that the distance between nerves and fat is shorter. Similarly, changes in fat content and distribution caused by different pathologies may alter the absorption and distribution of drugs injected in the epidural space. The maximum amount of fat is present posteriorly, where it assumes triangular capsular shapes and is linked to the midline of the ligamentum flavum by a vascular pedicle. Drugs with high lipid solubility like bupivacaine have a high affinity for fatty tissue, and thus remain in epidural fat for a longer time thus leaving a small quantity of the drug to interact with nerve roots at any time. Uptake of local anaesthetic by fat competes with its vascular and neural uptake.

Lymphatics

The lymphatics of the epidural space are mostly found in the region of the dural roots where they remove foreign materials including microorganisms from the subarachnoid and epidural spaces.

Vertebral venous plexus

The internal vertebral venous plexus consists of four interconnecting longitudinal vessels, two anterior and two posterior. The external vertebral plexus (EVP) in contrast, lies peripheral to the vertebrae and is made of the anterior and posterior external vertebral plexuses. The EVP is situated anterior to the vertebral bodies and in relation to the laminae, spinous processes, transverse processes and articular processes respectively. These veins communicate with the segmental veins of the neck, the intercostal, azygous and lumbar veins. With the veins of bones of the vertebral column, the internal and external vertebral plexuses form Batson's plexus. These veins are predominantly in the antero-lateral part of the epidural space, and ultimately drain into the azygous system of veins. As the whole system is valveless, increased intrathoracic or intra-abdominal pressure (e.g. ascites, pregnancy, tumours etc.) can lead to major congestion and vessel enlargement within the spinal canal. The epidural venous plexus is surrounded by sparse quantity of fat.

The anterior epidural space is entirely occupied by a rich venous plexus (valveless system of veins). The plexus communicates with the intracranial sigmoid sinus, basilar venous sinus, basi vertebral vein, occipital vein, and the azygous system. The plexus is linked to the abdominal and thoracic veins by the intervertebral foramina and through this connection transmit intraabdominal and intrathoracic pressure to the epidural space. The venous plexus is also connected to the iliac veins through the sacral venous plexus. Obstruction of the inferior vena cava, advanced pregnancy or intra-abdominal tumours can cause distension of the venous plexus leading to an increased risk of being traumatized during needle and/or catheter placement in the epidural space. These veins are more prominent along the lateral wall of the vertebral canal, usually out of reach of a correctly placed needle by midline approach. The dose and rate of local anaesthetic should also be reduced in any case of increased intraabdominal pressure / inferior vena cava obstruction as the resultant engorgement of the venous plexus would reduce the effective volume of the epidural space. The injected drug may therefore spread rapidly upwards or downwards along the epidural space.

Epidural arteries

The epidural arteries located in the lumbar region of the vertebral column are branches of the ilio-lumbar arteries. These arteries are found in the lateral region of the space and therefore accidental puncture is uncommon by midline approach.

Spinal arteries:

As already discussed, the spinal cord is supplied by one anterior spinal and two posterior spinal arteries. The spinal branches of the subclavian, aortic and iliac arteries cross the epidural space on their way to sub arachnoid space. The largest of them, the artery of Adamkiewicz supplies the anterior spinal artery at the lumbar level. This artery enters the epidural space between T_8 – L_3 levels and any damage to it would cause ischaemia of entire lumbar region of the cord. In general, anterior spinal artery is more susceptible due to it being unpaired.

Pharmacokinetics Of Epidural Blockade

Epidural anaesthesia results from the interaction of local anaesthetics with nerve structures located within the epidural space. Local anaesthetics can reach the sites of action along various distribution pathways. Uptake into extra neural tissues like epidural fat and systemic absorption compete with neural tissue distribution thereby affecting the clinical potency and duration of action. Therefore, epidural doses of local anaesthetics are much higher than spinal doses.

Specifically, drugs may

1) Exit the intervertebral foramina to reach the paraspinous muscle space,
2) drugs may diffuse into epidural fat,
3) drugs may diffuse into ligaments and finally,
4) drugs may diffuse across the spinal meninges.

The only mechanism by which drugs redistribute from the epidural space to the spinal cord is diffusion through the spinal meninges and the cellular arachnoid mater is the principal meningeal barrier to diffusion accounting for 95% of the resistance to meningeal permeability.

Meningeal permeability is not the only determinant of a drug spinal cord bioavailability after epidural administration. Drugs can partition into various environments in the epidural space and be unavailable for transfer across the spinal meninges.

Lipid soluble drugs have a tendency to get sequestrated into epidural fatty tissue. The dura mater is an important site of drug clearance especially in humans where dura mater is a highly vascular structure. As lipid soluble molecules traverse capillaries more readily than do more hydrophilic molecules, lipid soluble drugs may be cleared by this mechanism more readily than less lipid soluble drugs.

Meninges contain multiple enzyme systems, which are capable of drug metabolism. In addition, the meninges express enzymes capable of metabolizing neurotransmitters, including epinephrine, norepinephrine, acetylcholine and neuropeptides. After epidural administration, local anaesthetics need to cross the spinal meninges to reach their site of action

Epidurally administered drugs that reach the CSF, can also diffuse back across the meninges into the epidural space, but this happens only when the drug concentration in the epidural space falls below that in the CSF. Diffusion is dependent mainly on the drug's physiochemical properties, particularly, lipid solubility.

Physiological Effects of Epidural Blockade

The physiological responses to epidural anaesthesia are mainly due to sympathetic blockade accompanied by sensory and motor blockade to various degrees. Some of the most important (but not all) physiological effects of epidural blockade can be discussed in relation to either sympathetic blockade of vasoconstrictor fibres (below T_4) and/or of cardiac sympathetic fibres. Major sympathetic blockade can be avoided by trying to keep the block level around or below T_{10}. Lower abdominal, urologic, gynaecological and lower limb surgeries can be carried out satisfactorily with acceptable sympathetic blockade.

Zone of differential blockade:

Erlanger and Gasser showed that action of local anaesthetics on nerve fibres is by "differential conduction blockade". The nerve fibres are of three types viz A, B, C

A minimum length of myelinated nerve fibres should come in contact with local anaesthetic for conduction blockade. In myelinated fibres, the blockade occurs at nodes of Ranvier and three consecutive nodes need to be blocked for impulse conduction to be completely interrupted.

All types of nerve fibres are affected by local anaesthetics. but within any one fibre type, there is tendency for smaller, slower conducting fibres to be more readily blocked than larger, faster conducting fibres. Between fibre types however, these rules do not hold good. Myelinated preganglionic B fibres which have a faster conduction time are about three times more sensitive to local anaesthetics than the slower non-myelinated post ganglionic C fibres.

Sensory $A\alpha$ fibres appear to be more sensitive to blockade than motor A_β fibres, although of the same conduction velocity, this may be because sensory fibres conduct at a higher frequency. It has been suggested that this selectivity for sensory fibres exhibited by Bupivacaine and Ropivacaine is a function of frequency dependent block.

Sensory

In intradural block sympathetic fibres are blocked two or three segments higher than sensory fibres. In extradural block, the relationship is complex. Level of sympathetic block is the same as (or lower than) sensory with epidural blockade. Sympathetic block will be greater when more concentrated solutions are used or when adrenaline added, as this has similar effect.

Motor

In intradural block, the difference between sensory and motor block is slight (two segments). In extradural block, the difference in levels is greater, depending on nature of local anaesthetic solution.

Factors Influencing Height and Distribution of Local Anaesthetic: [29]

Patient characteristics:

- Age: Study done by Bromage shows a correlation between age and dose, an increase in dose from age 4-18 years followed by a gradual decrease from 19 years onwards.
- Height: A simple thumb rule is to use 1ml per segment for height of 150 cm and then add 0.1 ml per segment for each 5 cm over 150 cm.
- Weight: Under normal circumstances, there is not much correlation between spread of analgesia and the weight. However, in morbidly obese patients a given dose of local anaesthetics can cause a higher than normal block due to compression of epidural space due to increased intra-abdominal pressure.
- Intra-abdominal pressure: epidural venous engorgement in pregnancy, obesity, tumours can cause a higher blockade with a given dose due to narrower epidural space
- Posture: In sitting position there is slight propensity of the drug to spread caudally and higher doses may be required.
- Gender

Technique of injection:

- Site of injection: Rapid onset and denser blockade is seen when the point of injection was nearer to nerve roots. Lumbar epidural injection has a better cephalad spread than caudal epidurals.
- Direction of bevel
- Rate of injection: A rapid injection of local anaesthetic produces a rapid but incomplete and more extensive block. Injection rate of 0.3 – 0.75 ml/sec results in most reliable block.

Characteristics Of Anaesthetic Solution:

- Amount: Earlier epidural anaesthesia was considered to be equivalent to multiple paravertebral blocks and the tendency was to give a large volume of diluted drug. However, studies by Bromage showed that increasing dosage linearly increases the degree of sensory blockade.
- Concentration: An increase in the drug concentration increases the density of motor blockade.
- Density
- Temperature
- Use of adjuvants

Effects Of Epidural Anaesthesia on Various Organ Systems: [29]

Cardiovascular System:

The action of epidural anaesthesia on cardiovascular system depends on the level of block:

1. If the level of block is below T_4 there is dilation of resistance and capacitance vessels due to loss of sympathetic tone. This causes a fall in BP. However, if there is a blockade of cardiac efferent sympathetic fibres from T_1 to T_4 there is a loss of chronotropic and inotropic drive resulting in a fall in cardiac output.
2. The activation arterial or Bainbridge reflex causing bradycardia -The lowering of blood pressure in the right atrium consequent to diminished venous return [Bainbridge (1874-1921) effect]
3. The operation of Mary's law causing tachycardia.
4. Depression of vascular smooth muscle and β adrenergic blockade of myocardium with fall in cardiac output.

Block not extending above T4 is not always associated with fall of blood pressure in fit young adults. However, elderly may suffer significant hypotension when moderate volumes are injected into the epidural space.

Slowing heart rate is caused if any of the anterior roots carrying sympathetic cardiac accelerator fibres are blocked (T_1– T_4). Activation of Bainbridge reflex may further contribute to bradycardia which is more frequent than tachycardia.

Theories of causation of fall in blood pressure

1. Diminished cardiac output consequent on reduction of venous return to heart due to failure of peripheral pump – calf muscles.
2. Dilatation of posterior arteriolar capillaries and small venules due to paralysis of vasoconstrictors. Compensatory vasoconstriction takes place in areas not anaesthetized via carotid sinus reflexes. In high spinal blocks, majority of

vasoconstrictor fibres including those to arm (T2-T10), are paralyzed, hence low blood pressure.

3. Paralysis of sympathetic nerve supply to heart T_1-T_4. Bradycardia may give rise to fall in cardiac output.
4. Paralysis of sympathetic nerve supply to adrenal glands splanchnic nerves, with consequent catecholamine depletion.
5. Absorption of drug into circulation. Seen more commonly with epidural blockade due to the larger volume of drug used.
6. Pre-existent hypovolemia, if present, may cause precipitous hypotension after central neuraxial blockade. Compression of great vessels within abdomen, by the pregnant uterus, abdominal tumours or abdominal packs may cause severe hypotension in presence of central neural blockade.

Respiratory System:

The phrenic nerve supplying diaphragm arises from the anterior roots of C_3, C_4, C_5 and should not be encroached upon during neuraxial blockade. Lumbar and even mid thoracic epidurals usually do not cause much effects on respiratory system. During epidural anaesthesia, breathing becomes quiet and tranquil. This is not only due to motor blockade, but also to differentiation with reduction of sensory input to respiratory centre.

The ventilation perfusion during extradural block is not greatly altered and effects on respiratory functions are relatively small with no effect on FRC or V/Q ratio. The lung volumes and capacities (tidal volume, vital capacity) are basically unchanged during epidural anaesthesia. Abdominal muscle and intercostals muscle paralysis is compensated by diaphragm moving down. The pulmonary gas exchange is preserved.

The patient may stop breathing so that respiratory support by IPPV and, if necessary, tracheal intubation may be required. Causes may be:

- Inadequate medullary blood flow due to inadequate cardiac output-a serious situation demanding immediate cardiorespiratory support.
- Massive epidural spread.
- Accidental subdural injection
- Toxic effects of local analgesic drug.
- Injecting narcotic analgesic drugs

Gastrointestinal System:

Pre ganglionic sympathetic fibres from T5 to L1 are inhibitory to gut, there is no effect on oesophagus, the innervations of which is vagus. The small gut is contracted as the sympathetic inhibitory impulses are removed, the vagus being all powerful, sphincters are relaxed and peristalsis is active although not more frequent. Pressure within the bowel lumen is increased.

Nausea and vomiting due to the hypotension may occur in up to 20% of patients, and usually come on in waves-lasting a minute or so and then passing away spontaneously. Stimuli arising in the upper abdomen might not be blocked causing discomfort. Colonic blood supply and oxygen availability are increased, perhaps an important factor in the prevention of anastomotic breakdown following gut resection.

1. Theories of causation of nausea and vomiting:
    a. Hypotension: corrected using fluid boluses and vasopressor drugs
    b. Increased peristalsis
    c. Traction on nerve endings and plexuses, especially via vagus (usually upper abdomen)
    d. Presence of bile in stomach due to relaxation of pyloric and bile-duct sphincters
    e. Narcotic analgesics (premedication)
    f. Psychological factors
    g. Hypoxia

Liver

There are no specific effects of significance. The degree of hypotension that compromises liver function is not known. Liver disease may interfere with the metabolism of local anaesthetic drugs.

Endocrine system

Surgical stress produces a variety of changes in endocrine system and metabolic function. There is an increased catabolism of proteins and oxygen consumption. Increased plasma concentrations of catecholamines, vasopressin, growth hormones, renin, angiotensin, glucose, Anti diuretic hormone (ADH) and Thyroid Stimulating Hormone (TSH) are noted and this is referred to as surgical stress response.

Neuraxial blocks in general suppress the increase in ADH. It also delays adrenal response to trauma, whereas operations under GA cause a rise in steroids.

In any case, either regional or general, there is no difference in the postoperative period once the effects of the block are discontinued. Spinal block suppresses the hyperglycaemic response to surgery and stress and so is useful in diabetic patients, but this does not extend into postoperative period. The response to insulin is augmented and anaesthetist should be aware of possibility of hypoglycaemia.

Epidural block prevents lymphopenia and granulocytosis after operation, thus inhibiting the metabolic endocrine response to surgery and preventing immune depression.

Genito Urinary System

Sympathetic supply of kidney is from T_{11} to L_1 via the lowest splanchnic nerves. As renal blood flow is maintained by autoregulation, epidural anaesthesia has very little effect on renal function. Any effects on renal function if seen is due to severe and intractable hypotension. Auto regulation of renal blood flow is impaired if mean arterial pressure falls below 50 mmHg. These changes are transient and disappear when blood pressure rises again. Sphincters of bladder are not relaxed, so soiling of table by urine is not seen and tone of ureters is not greatly altered. In fact there is urinary retention till block wears off and catheterizing the patient should be considered. Retention of urine may be moderately prolonged as L_2 and L_3 contain small autonomic fibres and their paralysis lasts longer than of the larger sensory and motor fibres. The penis is often engorged and flaccid due to paralysis of the *nervi erigentes* (S_2 and S_3). This is a useful positive sign of successful block.

Body Temperature

Vasodilatation favours heat loss. Absence of sweating favours hyperpyrexia in hot environments. Catecholamine secretion is depressed, hence less heat is produced by metabolism. Extradural space is a temperature sensitive zone, whereas intradural space is not. Cold solutions injected into extradural space may induce shivering

ANATOMY OF ILIO-INGUINAL ILIO-HYPOGASTRIC AND GENITOFEMORAL NERVE [30]

The lumbar plexus consists of the ventral divisions of the first four lumbar nerves (L1-L4), with contributions from the subcostal nerve (T12). It gives rise to several important nerves:

Ilio-hypogastric nerve (T12–L1)

Ilio-inguinal nerve (L1)

Genitofemoral nerve (L1–L2)

Femoral nerve (L2–L4)

Lateral femoral cutaneous nerve (L2–L3)

Obturator nerve (L2–L4)

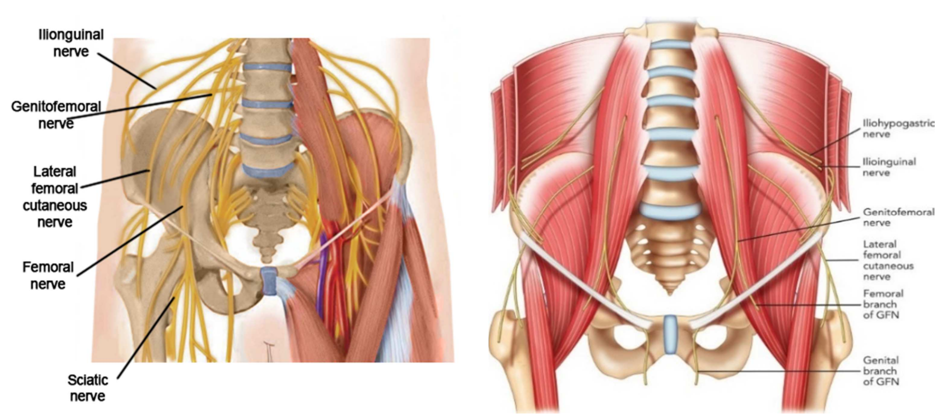
Muscular branches (T12–L4)

Additionally, the ventral division of the fourth lumbar nerve sends branches that communicate with the sacral plexus. The iliohypogastric (IH), ilioinguinal (II), and genitofemoral (GF) nerves are considered long collateral branches of the lumbar plexus

Ilioinguinal nerve:

Origin	Lumbar plexus (inferior branch of anterior ramus of spinal nerve L1)
Branches	Anterior labial nerves, anterior scrotal nerves
Supply	Motor: Internal oblique muscle, transversus abdominis muscle Sensory: Skin of proximal medial thigh, mons pubis, labium majus and root of the clitoris; anterior scrotum and root of the penis

Figure 7: **Ilioinguinal, iliohypogastric, genitofemoral nerve**



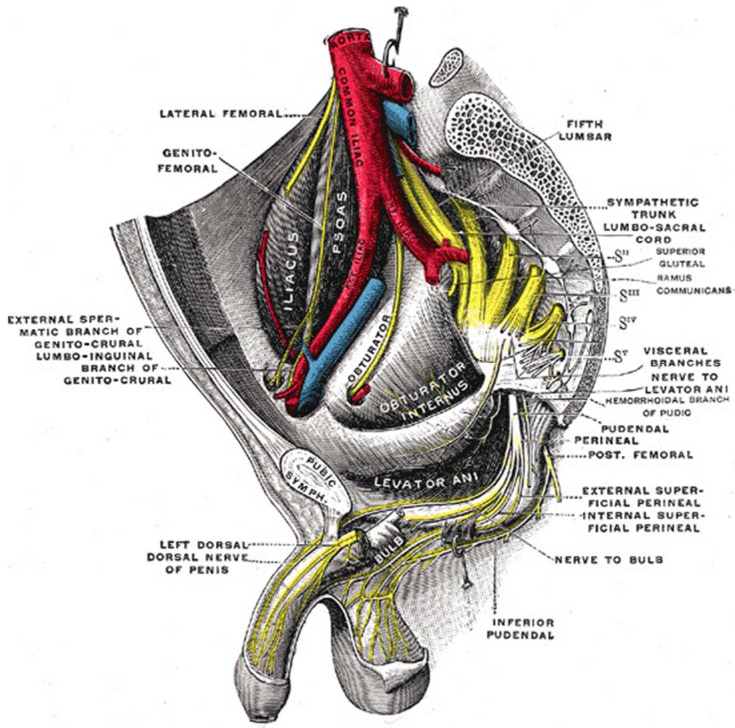
Iliohypogastric nerve:

Origin	Lumbar plexus (L1)
Branches	Anterior cutaneous branch, lateral cutaneous branch
Innervation	Motor: Transversus abdominis, internal abdominal oblique, conjoint tendon. Sensory: External abdominal oblique, transversus abdominis, internal abdominal oblique; Skin of the suprapubic region and posterolateral aspect of gluteal region.

Genitofemoral nerve:

Origin	Lumbar plexus (L1, L2)
Branches	Genital branch, femoral (lumboinguinal) branch
Sensory supply	Both sexes: Upper thigh region Males: Anterior scrotal skin Females: Mons pubis, labia majora
Motor supply	Males: Cremaster muscle

Figure 8: Genito femoral nerve



ULTRASONOGRAPHY [31]

Ultrasound, operating at 2 to 15 megahertz, is widely used in medicine for diagnosis and treatment. It works on the piezoelectric effect, where crystals convert mechanical energy into electrical energy and vice versa. The ultrasound transducer generates waves that travel through tissues and reflect back, creating images. Higher frequency transducers (5–7.5 MHz) image superficial structures, while lower frequencies (2.5–3.5 MHz) image deeper ones. Reflections occur at interfaces between tissues of different densities; greater differences produce stronger echoes and can cause acoustic shadowing, while homogeneous tissues produce echo-free images.

Transducer:

This is the handheld part of the ultrasound machine. It has the function of inter-converting the energies (electrical and mechanical) based on the piezoelectric effect. They contain lead zirconate titanate crystals commonly. They produce ultrasound waves in either linear(sequential) arrays or phased arrays.

It comprises 5 major components:

- Crystals: possessing piezoelectric property. Can be arranged in either a linear or curvilinear manner.
- Electrodes: positive and ground. For electrical connection
- Damping block: to dampen stray sound waves.
- Matching layer: one or multiple. For proper transmission of sound waves to the tissues.
- Housing.

Linear Transducer:

The piezoelectric crystals – Linearly arranged.

Produce rectangular ultrasound beam.

Used for superficial imaging.

Footprint – wide with a frequency of 2.5 – 12MHz at the center in the 2D imaging probe and frequency of 7.5 – 12 MHz at the center in the 3D imaging probe.

Applications:

- ❖ Vascular examination, venous puncture (catheterization)
- ❖ Breast imaging
- ❖ Thyroid imaging
- ❖ Tendons and joints

- During laparoscopic procedures
- Measuring body fat thickness
- Ultrasonic velocity change imaging

Figure 9: Linear USG probe

Figure 10: Curvilinear USG Probe

Curvilinear Transducer:

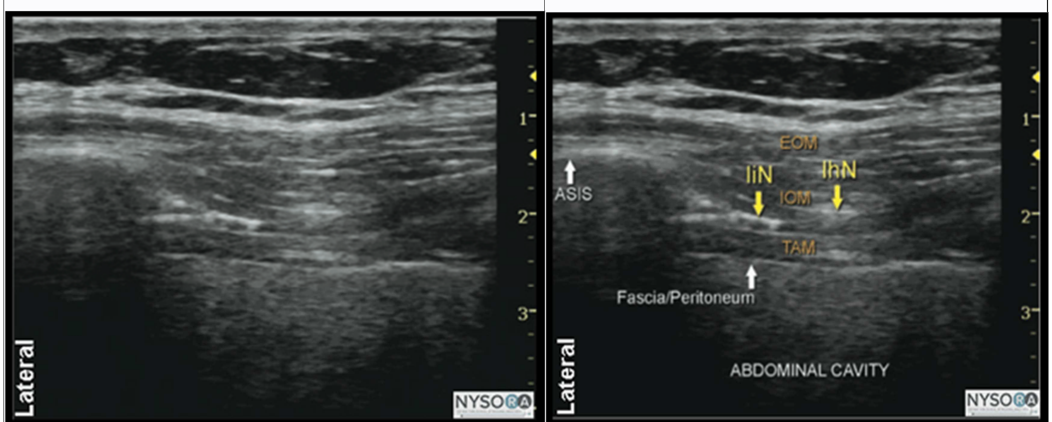
- The Piezoelectric crystals – curvilinear arrangement.
- They produce a convex ultrasound beam.
- Used to image deeper tissues.
- As the depth of imaging increases, image resolution decreases.
- A footprint is wide with central frequency being, 2.5 – 7.5MHz for 2D imaging and 3.5 – 6.5MHz for 3D imaging.
- Applications:
  - ❖ Abdominal examinations,
  - ❖ Transvaginal and transrectal examinations,
  - ❖ Diagnosis of organs.

ULTRASOUND-GUIDED ILIOHYPOGASTRIC AND ILIOINGUINAL NERVE BLOCKS [30]

General Considerations

Ilioinguinal and iliohypogastric nerves are contained in a well- defined tissue plane between the transversus abdominis and internal oblique muscles. The ability to easily image the musculature of the abdominal wall makes blocking these two nerves much more exact than the ‘feel-based’ blind technique.

Figure 11: (A) Ultrasound anatomy of the iliohypogastric and ilioinguinal nerve. (B) Labeled ultrasound anatomy of the iliohypogastric and ilioinguinal nerve, ASIS, anterior superior iliac spine; EOM, external oblique muscle; IOM, internal oblique muscle; TAM, transverse abdominal muscle; IiN, ilioinguinal nerve; IhN, iliohypogastric nerve.



A B

Ultrasound Anatomy

Imaging of the abdominal wall medial and superior to the ASIS shows three muscle layers: the external oblique (EOM), internal oblique (IOM), and transversus abdominis (TAM), separated by hyperechoic fascia. Below the TAM is the fascia transversalis, located above the peritoneum and abdominal cavity, identifiable by moving structures due to peristalsis. The hyperechoic anterior-superior iliac spine (ASIS) serves as a useful landmark, visible on the lateral side of the ultrasound image.

The iliohypogastric and ilioinguinal nerves pierce the TAM above the ilium and lie between the TAM and IOM, often seen as hypoechoic ovals, side by side or up to 1 cm apart. Color Doppler can help identify the deep circumflex iliac artery, adjacent to these nerves, serving as an additional landmark.

Distribution of block

Block of the iliohypogastric and ilioinguinal nerves results in anesthesia of the hypogastric region, the inguinal crease, the upper medial thigh, the mons pubis, part of the labia, the root of the penis, and the anterior part of the scrotum. There is considerable variation in sensory distribution between individuals.

Landmarks and Patient Positioning

Figure 12: Transducer position to image the ilioinguinal (IiN) and iliohypogastric nerves (IhN). The transducer is positioned in the immediate vicinity of the anterior superior iliac spine (ASIS).

The block of the iliohypogastric and ilioinguinal nerves is done in supine position. Palpation of the ASIS provides the initial landmark for transducer placement. This nerve block is often performed under general anesthesia, particularly in pediatric patients.

Technique

With the patient supine, disinfect the skin and place the transducer medial to the ASIS, oriented along a line from the ASIS to the umbilicus (Figure 2-2). Identify the three muscle layers: EOM, IOM, and TAM. The ilioinguinal and iliohypogastric nerves should appear as hypoechoic ovals between the IOM and TAM. Move the transducer slightly cephalad or caudad to trace the nerves. Use color Doppler to visualize the deep circumflex iliac artery if needed.

Create a skin wheal medial to the transducer and insert the needle in-plane, from medial to lateral, through the subcutaneous tissue, EOM, and IOM, advancing toward the nerves (Figures 1-1B and 2-3). A "pop" may be felt as the needle tip enters the plane between muscles. After gentle aspiration, inject 1 to 2 mL of local anesthetic to confirm needle position. If the injection appears intramuscular, adjust the needle 1 to 2 mm and repeat until correct positioning is achieved.

Perform the nerve block with either in-plane or out-of-plane needle insertion. In adults, 10 mL of local anesthetic per side is typically sufficient.

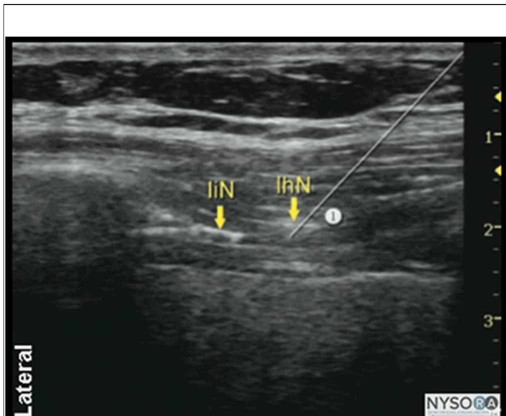
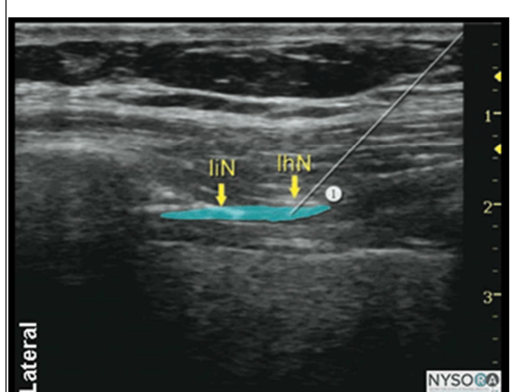
	

Figure 13: Simulated needle path (1) to reach the ilioinguinal (IiN) and iliohypogastric (IhN) nerves.	**Figure 14: Simulated needle path (1) and spread of local anesthetic (area shaded in blue) to anesthetize the ilioinguinal and iliohypogastric nerves.**

ULTRASOUND-GUIDED GENITOFEMORAL NERVE BLOCK: [30]

The procedure involves placing the patient in a supine position and identifying surface anatomy landmarks such as the anterior superior iliac spine (ASIS), inguinal ligament, and femoral artery through palpation. A high-frequency linear ultrasound transducer is then used to locate the femoral artery and identify the transition point where it becomes the external iliac artery. This transition point allows visualization of the inguinal canal, which contains the spermatic cord in men and the round ligament in women. Testicular arteries and the vas deferens may also be identified using color Doppler. The genitofemoral nerve block is performed using either an in-plane or out-of-plane technique, with the needle approaching the inguinal canal from the lateral aspect of the transducer to avoid arterial puncture. In men, 4 mL of local anesthetic is injected within and 4 mL outside the spermatic cord, while in women, 5 mL of local anesthetic is injected around the round ligament. Plain local anesthetic without epinephrine is recommended in men to avoid vasoconstriction of the testicular arteries, and steroid can be added for chronic pain management.

Figure 15: **The probe A is placed above and posterior to the ASIS and is in the short axis of the course of the II nerve. The probe B is placed in the inguinal line in the long axis of the femoral and external iliac arteries**

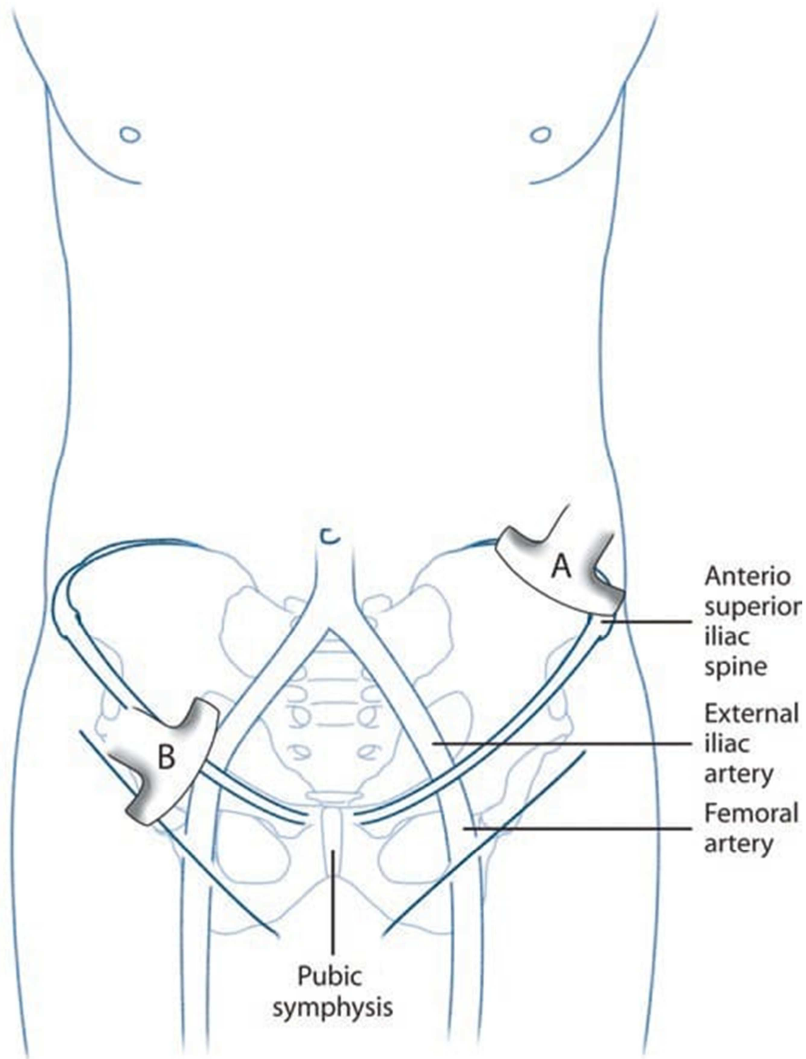
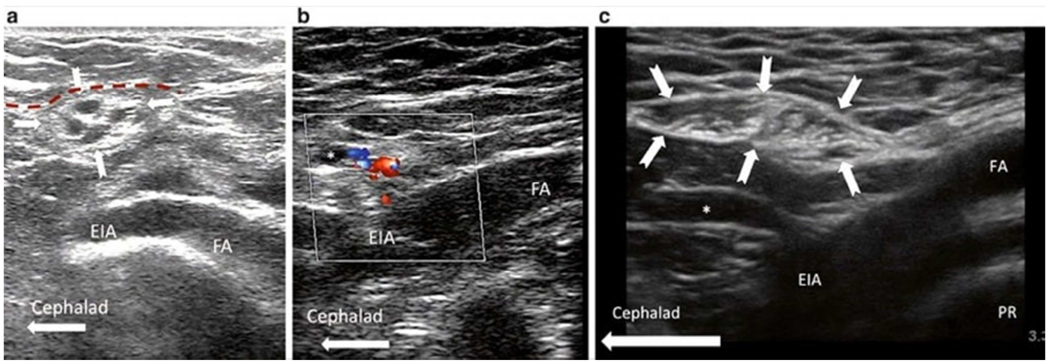


Figure 16: Ultrasound-guided GFN block. (a) Long-axis view of the femoral artery (FA) and external iliac artery (EIA) showing the crosssection of spermatic cord (solid arrows) in a male patient. The deep abdominal fascia is outlined (red dashed line). (b) Similar view as A, with colour Doppler showing the vessels inside the spermatic cord. (c) Similar view as A but in a female patient.



LOCAL ANESTHETIC:

ROPIVACAINE (32)

Introduction

Ropivacaine is a newer, longer acting local anaesthetic agent which belongs to the amino amide group. It was first synthesized by Ekenstam in 1957; however it was first introduced for clinical practice only in 1996. Chemically it belongs to the same group as bupivacaine and mepivacaine (epipecoloxylidide local anaesthetic).

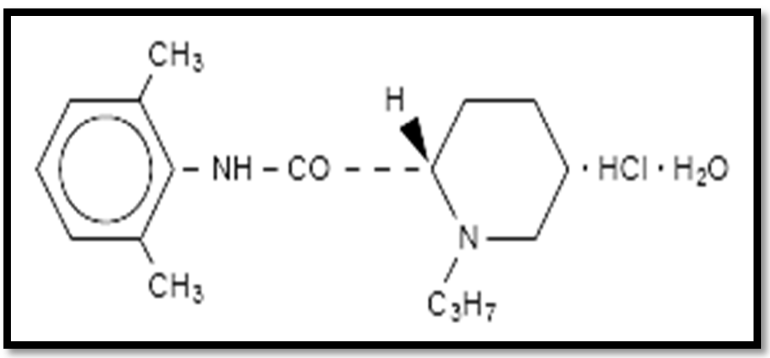
It was found that butyl derivatives of pipecoloxylidides (example bupivacaine) were more cardiotoxic than propyl derivatives, causing a significant number of cardiac arrests.

Thus, ropivacaine was developed as a pure S – enantiomeric form of pipecoloxylidides. Though ropivacaine has been available internationally for over three decades, it is a relative new entrant in the Indian market.

It is becoming increasingly popular among anaesthesiologists and has been used extensively in almost all modes of regional anaesthesia: infiltration, peripheral nerve blocks, spinal anaesthesia, epidural anaesthesia as well as caudal epidural blocks in paediatric patients.

Chemical Structure

Figure 17: Chemical structure of ropivacaine



Ropivacaine is an amino amide local anaesthetic agent, chemically described as S-(-)-1-propyl-2',6'-pipecoloxylidide hydrochloride monohydrate. The ***International Union of Pure and Applied Chemistry*** name is (S)-N-(2,6-dimethylphenyl) -1- propylpiperidine-2-carboxamide. It's molecular formula is $C_{17}H_{26}N_2O•HCl•H_2O$ and it has a molecular weight of 328.89.

Ropivacaine is a white crystalline powder. At 25°C ropivacaine hydrochloride has a solubility of 53.8 mg/mL in water and a distribution ratio between n-octanol and phosphate buffer at pH 7.4 of 14:1. The pKa of ropivacaine is 8.07 which is very similar to that of bupivacaine (8.1) .

However, ropivacaine has a much lesser lipid solubility as compared to bupivacaine and mepivacaine. This can be explained on the basis of presence of a propyl (3 Carbon) side chain in ropivacaine as compared to a butyl (4 Carbon) side chain in the other two local anaesthetics. This lower lipid solubility physical properties of ropivacaine has a significant effect on the block characteristics of ropivacaine as discussed ahead.

Mechanism Of Action and Corelation with Structure

Ropivacaine reversibly inhibits the voltage gated sodium channels present on the nerve cell membranes thus preventing the influx of sodium ions into the cells. This:

I. Blocks generation and conductance of nerve impulses.
II. Slows propagation of nerve impulses
III. Reduces the rate of rise of action potential

Almost all local anaesthetic agents block the unmyelinated C and myelinated Aδfibres, which transmit pain impulses at the same rate.

The rate of blockade of motor fibres (Aα and Aβ), however depends upon the physio chemical properties like pKa and lipid solubility of the individual drug. As ropivacaine is less lipid soluble than bupivacaine, the Aα and Aβ blockade is slower and hence motor blockade is less potent. Studies of lumbar epidural block in humans have confirmed that equal volumes and concentrations of bupivacaine and ropivacaine produce similar degree of sensory block but the motor block produced by ropivacaine is slower in onset, lesser in intensity and shorter in duration.

Clinically the order of blockade of nerve fibres is autonomic, sensory and motor, while the regression of the block occurs in reverse order.

The nerve impulse transmission is lost in the following order:

The order of the loss of nerve function is

1. Pain
2. Temperature
3. Touch
4. Proprioception
5. Skeletal muscle tone.

Pharmacokinetics

Absorption:

The systemic concentration of ropivacaine depends on the total dose and concentration of drug given, the route of administration, the patient's haemodynamic state and the vascularity of the site of administration. When administered in the epidural space, ropivacaine has a biphasic absorption. The half-lives of the two phases (mean+ SD) are 14+7 minutes and 4.2 +0.9 hours respectively.

Distribution:

After intravascular infusion, ropivacaine has a steady state of distribution of 41 ± 7 litres. It is 94% protein bound, mainly to α_1-acid glycoprotein. In case of continuous epidural infusion of ropivacaine the plasma concentration can rise due to increased protein binding and reduced clearance. Ropivacaine can easily cross the placenta.

Metabolism and excretion:

Ropivacaine is extensively metabolized by the liver, predominantly by the cytochrome P_{4501A} mediated aromatic hydroxylation to produce 3 – hydroxyl ropivacaine. After a single IV dose, approximately 37% of the total dose is excreted in the urine as both free and conjugated 3-hydroxy ropivacaine. An additional unquantified amount of 2 – hydroxyl – methyl ropivacaine has also been identified s a metabolite.

Ropivacaine metabolites are mainly excreted via kidney. After i.v. administration 86% of the dose is excreted in urine of which only 1% is in unchanged form. Following IV administration, ropivacaine has a mean ± SD total plasma clearance of 387 ± 107 mL/min, an unbound plasma clearance of 7.2 ± 1.6 L/min and a renal clearance of 1 mL/min. The mean ± SD terminal half life is 1.8 ± 0.7 h and 4.2 ±1.0 h after i.v. and epidural administration respectively.

Pharmacodynamics

Central Nervous System & Cardiovascular System :

Ropivacaine has a higher threshold for both cardiac as well as neuro toxicity as compared to bupivacaine due to its lower lipid solubility and stereo - selective properties. This holds good for both isomers of ropivacaine which have been shown to be less cardio depressant than respective bupivacaine isomers in animal studies.

CNS toxicity occurs earlier than cardiac toxicity on iv infusion in healthy volunteers.

Potency:

Lipid solubility of a local anaesthetic correlates well with its potency and toxicity. Compounds which are more lipophilic penetrate the nerve cell membrane more readily. Thus, fewer molecules are required to produce the desired conduction blockade.

Others:

Continuous epidural infusion of 0.375 % and 0.188% ropivacaine has been shown to inhibit platelet aggregation in plasma.

Adverse Effects

Excessive plasma levels are due to over dosage, unintentional intravascular injection or slow metabolic degradation. The mean doses at which CNS symptoms of toxicity begin to occur in human beings are 4.3 and 0.6 mcg/mL of total and free plasma concentrations respectively. When prolonged blocks are used the risks of reaching a toxic plasma concentration or inducing local neural injury are increased. Various possible side effects include

a) **Injection site pain**
b) **Cardiovascular system toxicity:** Vasovagal reaction, syncope, postural hypotension, non-specific ECG abnormalities which include wide QRS complexes, increased conduction time and reduced contractility.
c) **Gastrointestinal system toxicity:** Faecal incontinence, tenesmus, nausea, vomiting.
d) **Central nervous system toxicity:** Tremor, Horner's syndrome, dyskinesia, neuropathy, vertigo, convulsion and coma. Because of depressant effect of ropivacaine on medulla, excitatory stage of CNS might not occur.
e) **Liver and Biliary system toxicity:** Jaundice
f) **Metabolic disorders:** Hypomagnesemia

Advantages Over Other Local Anaesthetics

Ropivacaine produces a more differential blockade allowing better separation between sensory and motor block, and is therefore a better choice for use in labour analgesia and post operative pain relief. When compared to bupivacaine it produces less dense motor blockade of shorter duration and hence permits earlier mobilization and discharge thus reducing both morbidity as well as cost of treatment. It has a lower systemic toxicity than bupivacaine and a better, cardio stable profile. Ropivacaine has been developed to offer a safer alternative to bupivacaine while retaining the desirable blocking properties of racemic bupivacaine.

TOXICITY [33, 34]

Local anesthetic systemic toxicity (LAST) is a life-threatening adverse event associated with the increasingly prevalent utilization of local anesthetic (LA) techniques throughout various health care settings, with an incidence currently estimated to be 0.03%, or 0.27 episodes per 1,000 peripheral nerve blocks.

MATERIALS AND METHODS

Type of Study: A Randomized clinical trial.

Duration of study and study population:

Male patients aged 60 years and above, categorized under ‘American Society of Anaesthesiologist’ (ASA) grade II onwards, posted for elective inguinal surgery at ‘KLE’s Dr. Prabhakar Kore Hospital and Medical Research Centre, Nehru Nagar, Belagavi’ spanning August 2022–September 2023

(Data Collection-12 Months)

Inclusion Criteria:

- Patients in the age group 60 years and above
- ASA grade II onwards
- Posted for primary inguinal hernia repair patients with uncomplicated hernia
- Patients with comorbidities like hypertension and diabetes mellitus

Exclusion Criteria:

- Patient refusal
- Patient with local infection
- Patients with strangulated hernia, irreducible hernia, recurrent hernia
- Patients with a medical background of allergic reactions to local anesthetics.
- Patients with bleeding disorders
- Drug allergy to ropivacaine
- Patients with contraindication to epidural anaesthesia
- Patients unable to give informed consent

Sample Size Calculation [(15)]

The sample size calculation is based on a study titled "Comparison of spinal anaesthesia versus ilioinguinal–iliohypogastric nerve block applied with tumescent anaesthesia for single-sided inguinal hernia"

The following formula may be used to determine the "minimum sample size" depending on the "mean" and "standard deviation":

$$\mathbf{n} = \frac{(z_\alpha + z_\beta)^2 (s_1^2 + s_2^2)}{(\bar{X}_1 - \bar{X}_2)^2}$$

- $z\alpha$ = level of significance and
- $z\beta$ = the test's power.
- At a 5% significance level, $z\alpha$ has a value of 1.96.
- $Z\beta$ has a value of 0.84 at a power of 80%.
- The calculation takes into account the following
    - Heart rate (HR) at 5 minutes.
    - Mean value of 66.27 for the first group.
    - Mean value of 75.2 for the second group.
- The standard deviations of group 1 and group 2 are represented by the symbols s1 and s2 respectively, at 9.38 and 12.88.

- Given these values, the resulting sample size is 25
- Each group will consist of 25 cases, resulting in a total of two groups.
- For conclusive findings, the sample size will be set to 30 for each group

Sampling procedure:

A one-year randomized clinical trial.

Methodology:

Upon obtaining the Institutional Review Board (IRB) clearance, 60 participants aged 60 years and above, categorized as American Society of Anesthesia (ASA) status II or higher, diagnosed with inguinal hernia and admitted for surgery were incorporated into this research. All patients met the requirements for inclusion and consented in writing.

A comprehensive pre-anesthetic evaluation was conducted the day before the surgery, and patients were advised to adhere to the required hours of nil per mouth (NPO) status. On the surgical day, nil per oral status was verified, and an intravenous cannula was secured on the forearm.

Electrocardiogram (ECG), heart rate (HR), non-invasive blood pressure (NIBP), peripheral oxygen saturation (SpO2), and were monitored in the preparation room before anesthesia, and baseline values were obtained. Preoperative 2D echocardiography results were noted. Preloading began with a volume of suitable crystalloids at a rate of 10 mL/kg. After that, patients were randomly assigned to one of two groups by computer generated randomization: Group E, who received epidural anesthesia, and Group HB, who received a hernia block.

Group E (n=30):

In this group, patients received epidural anesthesia. The procedure involved the patient being positioned so they are sitting and employing rigorous aseptic measures. A local anesthesia was administered via a skin wheal at the L3-4 interspace, using 2 ml of 2% lidocaine. With the utilization of an 18 G Touhy needle, the epidural space was found using the air-based loss of resistance approach and a 20 G catheter positioned in the midline,

In order to confirm the location of the catheter and rule out intravascular use, a 3 mL test dose containing 2% lidocaine and 1:200,000 epinephrine was given.

In the event of a heart rate (HR) increase of 20 to 30 beats per minute or a rise of 15 to 20 mmHg in systolic blood pressure, indicated a potential injection intravascularly. Epidural activation was achieved by the graded administration of 25 ml of 0.75% ropivacaine. The drug was given in 5 ml increments at five-minute intervals, to prevent sudden hypotension. The pin-prick method was employed to evaluate the sensory block.

Assessment of motor block was carried out utilizing the 'Modified Bromage scale'.

- 0 = 'There is no paralysis, and the ability to flex hips, knees, and ankles is present'
- 1 = 'Capable of bending the knees, but unable to lift the extended legs'
- 2 = 'Capable of flex ankles, but unable to flex knees'
- 3 = 'Inability to move any part of lower limb'

Patients who have achieved a T10-L1 dermatome block under epidural anesthesia were cleared for surgery.

Group H (IINB+IHNB+GFNB Hernia Block) (n=30):

The hernia block procedure involved preparing of 25 mL of 0.75% ropivacaine for each patient

For the ilioinguinal-iliohypogastric nerve blockade, with patient in supine position, linear ultrasound (USG) probe with high frequency (5-13 MHz) was angled obliquely above the iliac crest, tracing the segment connecting the umbilicus to the anterior superior iliac spine.

Three muscle layers are visible on abdominal wall imaging, medial and superior to the ASIS. These layers, transversus abdominis muscles (TAM), the internal oblique (IOM), and the outermost external oblique (EOM), are divided by hyperechoic tissue. The TAM is penetrated above the ilium by the iliohypogastric and ilioinguinal nerves, which are located in the space between the TAM and the IOM. They usually appear as hypoechoic ovals and are frequently observed next to one other or up to one centimeter apart. A 5–8 cm, 23-gauge spinal needle was used for insertion via the in-plane technique. In between the internal oblique muscle and the transverse abdominis muscle, 20 milliliters of 0.75% ropivacaine was given after negative aspiration. A pin-prick test was used to confirm sensory block at the T12 and L1 levels.

With patient positioned supine, a high-frequency linear ultrasound probe (6-7 MHz) was utilized to examine the genitofemoral nerve. In the transverse plane, the probe was first placed beneath the inguinal ligament. In this plane, the femoral artery was visible and positioned in the middle of the screen. Subsequently, the probe was rotated to align the artery in long axis. In order to trace the femoral artery, as it enters the abdomen and becomes the external iliac artery, the ultrasound probe was advanced cranially. At this point, an oval or circular shape inguinal canal was seen superficial to the femoral artery. It houses the round ligament in women and the spermatic cord in men.

The needle placement was guided by an out-of-plane approach. The inguinal canal and the deep abdominal fascia are intended to be punctured by the needle, which was inserted on the lateral surface of the probe. Five milliliters of a 0.75% solution were placed in the inguinal canal.

Skin infiltration was commenced with 2-5 mL of 2% lignocaine at incision site.

Patients exhibiting a sensory block in the T12-L1 dermatomes were eligible for surgery. Monitoring of sensory blocks was conducted using a pin-prick test. The time taken to achieve sensory and motor blockage in each case was recorded. Patients who failed to attain an adequate sensory block for the initiation of the skin incision were excluded from the study and received general anesthesia with or without endotracheal intubation.

Throughout the surgery, continuous monitoring in the operating room included heart rates (HR), electrocardiography (ECG), peripheral oxygen saturation ($SpO2$), non-invasive blood pressure (NIBP), and mean arterial pressure (MAP). Intraoperatively, these parameters were documented at five-minute intervals for the initial 15 minutes, followed by every ten minutes for the first hour and, every fifteen minutes from second hour onwards. Patients who develop hypotension (20% below the baseline) received intravenous fluid replacement and/or 6 mg of mephentemine, whereas 0.5 mg IV atropine was administered in the event of bradycardia.

Perioperative comfort of the patient is assessed by 'Critical Care Pain Observation Tool (CPOT)' along with hemodynamics.

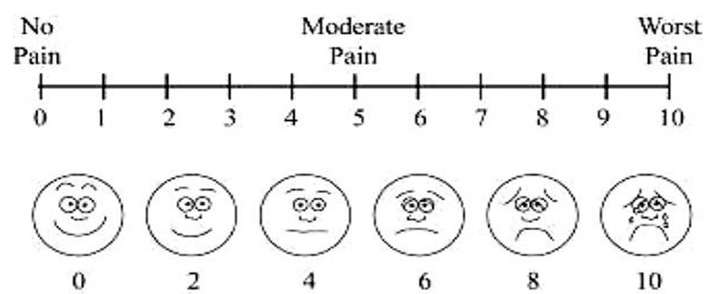
Sub scale	Description	Score
Vocalization	**Speaking in a normal voice or remaining silent** **Sighing, moaning** **Crying, sobbing**	**0** **1** **2**
Facial expression	**Relaxed or neutral** **Tense** **Grimacing**	**0** **1** **2**
Body movement	**Absence of movements (relaxed)** **Protection** **Restless**	**0** **1** **2**
Muscle tone	**Relaxed** **Tense or rigid** **Very tense or rigid**	**0** **1** **2**

For patients scoring ≤ 2 on the CPOT scale, minimal to no pain is likely. Re-evaluation in the future may be warranted.

For patients with a CPOT score exceeding 2, an unacceptable level of pain is evident. Sedation was administered.

Duration of surgery were recorded. Rescue analgesia i.e., Paracetamol 15 mg/kg was prescribed when visual analogue scale (VAS) >/= 4 was recorded and time for first rescue analgesia was noted.

Figure 18: Visual analogue scale



STATISTICAL ANALYSIS:

Data analysis involves utilizing ‘statistical software R version 4.4.0’. and ‘Microsoft Excel’. Categorical variables are presented in frequency tables, while continuous variables are expressed as ‘Mean ± SD’ or ‘Median (Min, Max)’. The association between categorical variables and groups is examined using the Chi-square test. Normality of variables is assessed via the ‘Shapiro-Wilk test’ and ‘QQ plots’. Parametric tests will be applied if the data has a normal distribution. Otherwise, non-parametric tests will be employed. The two-sample t-test is utilized for comparing variable means across groups, while the ‘Mann-Whitney U’ test is employed to compare variable distributions among groups. The Friedman test, on the other hand, is utilized to compare variable distributions over time. **Statistical significance is indicated by ‘p-value =/< 0.05’.**

RESULT:

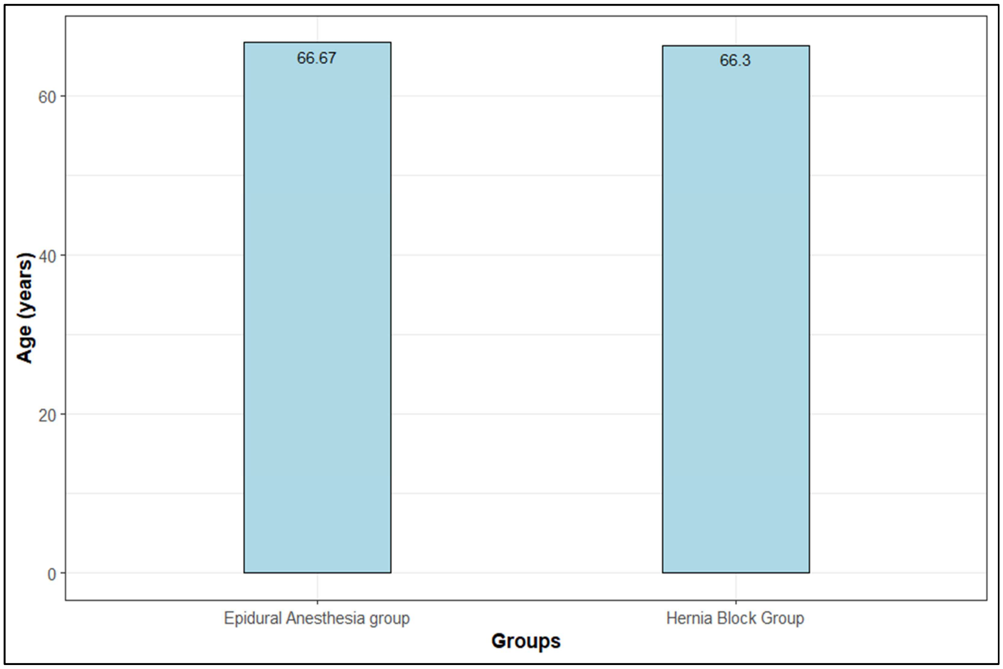
Measurements from 60 people total, split into two groups of thirty each, make up the dataset.

Table 1: Comparing demographic details among different cohorts.

Variables	Sub Category	Epidural Anesthesia group	Hernia Block Group	Total	p-value
Age (years)	Mean ± SD	66.67 ± 6.39	66.3 ± 5.51	66.48 ± 5.92	0.9585[MW]
	Median (Min, Max)	65.5 (60, 84)	65 (60, 84)	65 (60, 84)	
Gender	Male	30 (100%)	30 (100%)	60 (100%)	1[C]

Abbreviation: 'MW – Mann Whitney U test', 'C – Chi square test'.

Participants in the Epidural Anesthesia group had a mean age of 66.67 ± 6.39 years. With a range of 60 to 84 years old, the average age was 65.5 years. In the Hernia Block group, the mean age was 66.3 ± 5.51years, and the range of ages was 60 to 84 years, with 65 being the average age. However, the 'Mann-Whitney U test' indicated the age gap between the two groups was statistically insignificant (p-value = 0.9585. Additionally, gender distribution was identical across both groups, with all participants being male (30 in each group). No substantial variation in gender distribution between the groups (p-value = 1) was observed from 'Chi-square test'.



Graph 1: Mean age plotted across different groups.

Table 2: Comparing clinical details among groups.

Variables	Sub Category	Epidural Anesthesia group	Hernia Block Group	Total	p-value
Weight (Kg)	Mean ± SD Median (Min, Max)	72.27 ± 8.33 72.5 (58, 87)	68 ± 7.13 69 (56, 86)	70.13 ± 7.98 70 (56, 87)	**0.0374^{t}* (significant)**
ASA	2	26 (86.67%)	28 (93.33%)	54 (90%)	0.6817^{MC} (Not significant)
	3	4 (13.33%)	2 (6.67%)	6 (10%)	
Diagnosis	Left inguinal Hernia	19 (63.33%)	13 (43.33%)	32 (53.33%)	0.1205^{C} (Not significant)
	Right inguinal hernia	11 (36.67%)	17 (56.67%)	28 (46.67%)	
Surgery	Hernioplasty	30 (100%)	30 (100%)	60 (100%)	1^{C} (Not significant)
Sensory block onset at T10 (min)	Mean ± SD Median (Min, Max)	12.3 ± 3.75 10 (3, 20)	15.23 ± 2.62 15 (10, 20)	13.77 ± 3.53 15 (3, 20)	**0.0028^{MW}* (significant)**
Duration of Surgery (min)	Mean ± SD Median (Min, Max)	76.9 ± 18.05 75 (40, 120)	77.67 ± 16.9 75 (50, 120)	77.28 ± 17.34 75 (40, 120)	0.9694^{MW} (Not significant)
Time of administration of rescue analgesia (hr)	Mean ± SD Median (Min, Max)	5.27 ± 0.84 5 (4, 7)	7.25 ± 1.74 7 (4, 12)	6.26 ± 1.68 6 (4, 12)	**< 0.001^{MW}* (significant)**

*Abbreviation: 't – Two sample t test, MW – Mann Whitney U test, C – Chi square test, MC – Chi square test with Monte Carlo simulation, * indicates statistical significance'.*

The mean weight of participants in the Epidural Anesthesia cohort was 72.27 ± 8.33 kg, and the median weight was 72.5 kg, ranging from 58 to 87 kg. In the Hernia Block group, the mean weight was 68 ± 7.13 kg, and the median weight was 69 kg, ranging from 56 to 86 kg. From 'two sample t test', a statistically substantial variation in weight among the cohorts was observed (p-value = 0.0374).

Regarding the ASA classification, 86.67% of participants in the Epidural Anesthesia group were classified as ASA 2, compared to 93.33% in the Hernia Block group. The remaining participants were classified as ASA 3, with 13.33% in the Epidural Anaesthesia cohort and 6.67% in the Hernia Block cohort. However, from 'Chi square test', observation revealed there was no statistical significance in the spread of ASA classification across the groups. (p-value = 0.6817).

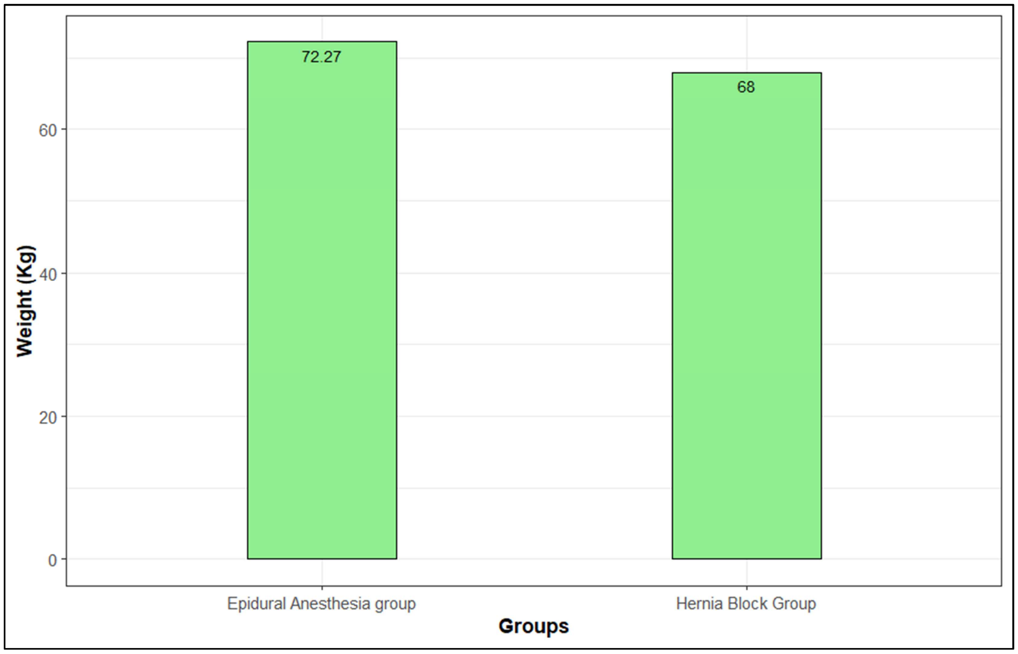
For the diagnosis, 63.33% of participants in the Epidural Anesthesia group had a left inguinal hernia, compared to 43.33% in the Hernia Block group. Right inguinal hernia was diagnosed in 36.67% of the Epidural Anesthesia collective and 56.67% of the Hernia Block collective. From 'Chi square test', insignificant variation was observed among the groups (p-value = 0.1205). All participants in both groups underwent hernioplasty showing no difference in the type of surgery performed (p-value = 1).

The average time for sensory block onset at T10 was 12.3 ± 3.75 minutes in the Epidural Anesthesia group, with a median of 10 minutes (range 3 to 20 minutes)**. In the Hernia Block group, the mean onset time was 15.23 ± 2.62 minutes**, with a median of 15 minutes (range 10 to 20 minutes). From 'Mann Whitney U test', **statistical significance in the distribution of sensory block onset among the groups was highlighted with p-value = 0.0028.**

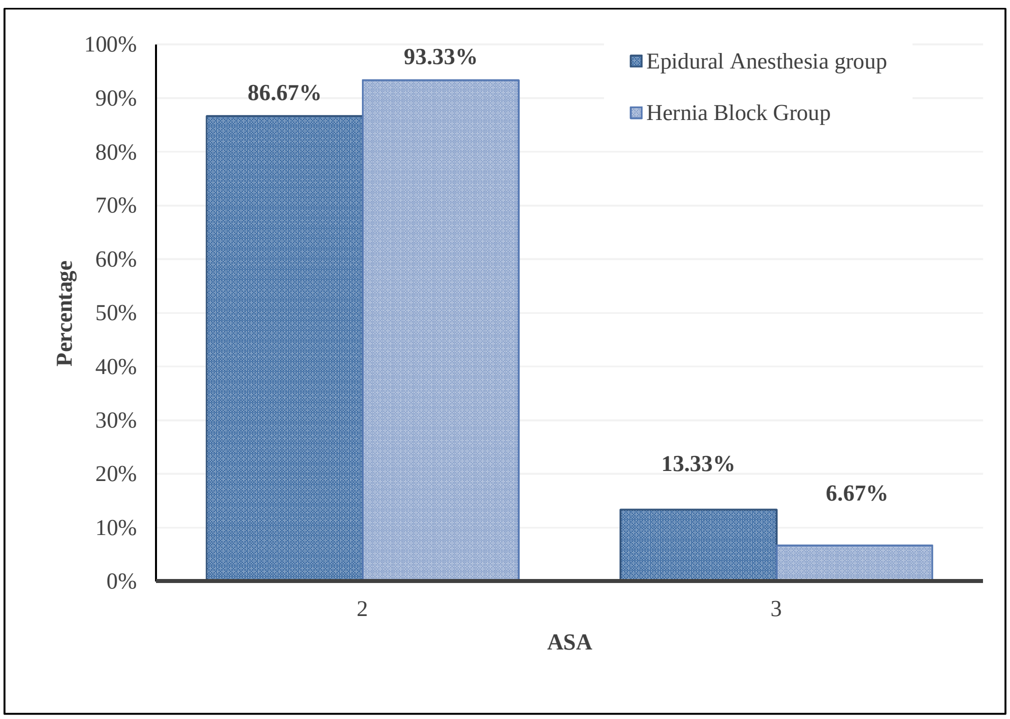
The average duration of surgery was 76.9 ± 18.05 minutes in the Epidural Anesthesia group, with a median of 75 minutes (range 40 to 120 minutes). In the Hernia Block group, the mean duration was 77.67 ± 16.9 minutes, with a median of 75 minutes (range 50 to 120 minutes). The 'Mann-Whitney U test' results indicated insignificant disparity in the spread of surgery duration among the groups (p-value = 0.9694).

The average time to administration of rescue analgesia with 15 mg/ kg of Paracetamol was **5.27 ± 0.84 hours in the Epidural Anesthesia group**, Having a median of 5 hours within a range of 4 to 7 hours. **In the Hernia Block group, the mean time was 7.25 ± 1.74 hours**, having a median duration of 7 hours, with the range spanning from 4 to 12 hours. From 'Mann Whitney U test', **there was a statistical significance in the timing of rescue analgesia administration among the groups with p-value < 0.001.**

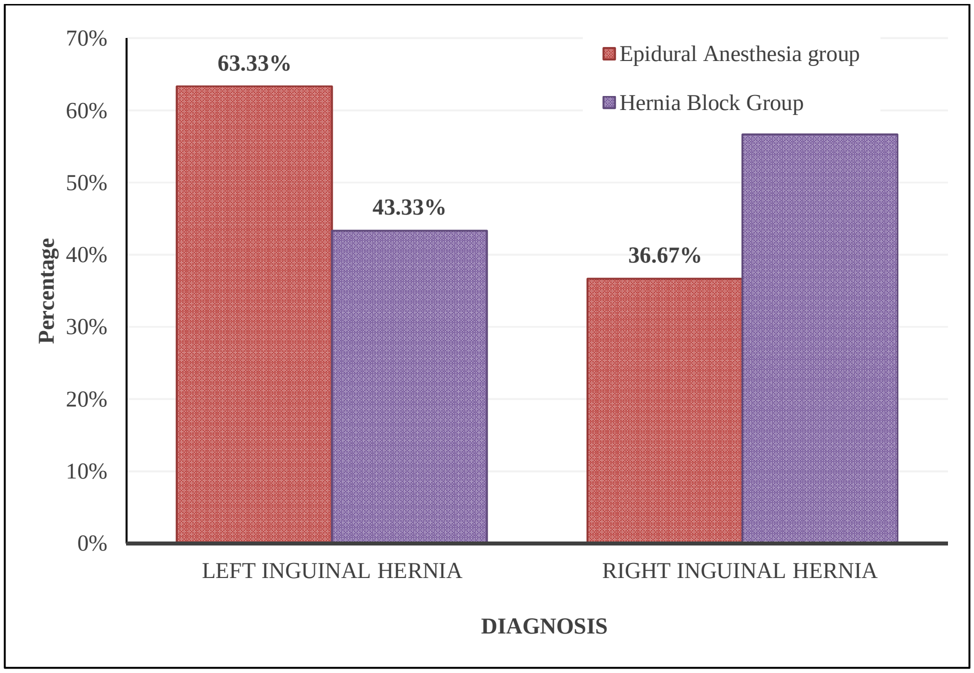
Note: The mean onset time for grade 3 motor blockade in the Epidural Anesthesia group was 16.07 minutes, having a standard deviation of 3.89 minutes. The median onset time being 15 minutes, with a range from 5 to 22 minutes.



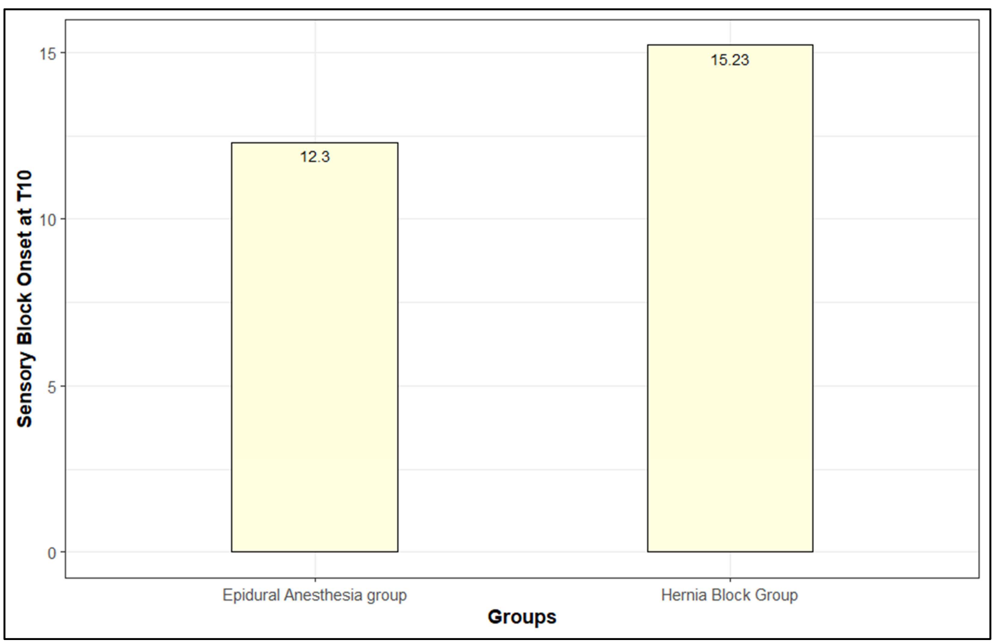
Graph 2: Mean plot of weight over groups.



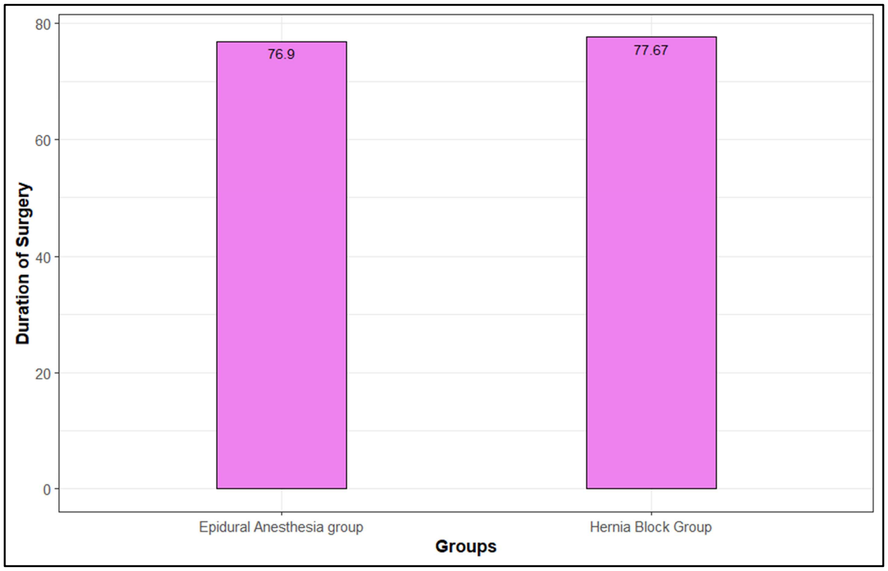
Graph 3: Distribution of ASA over groups.



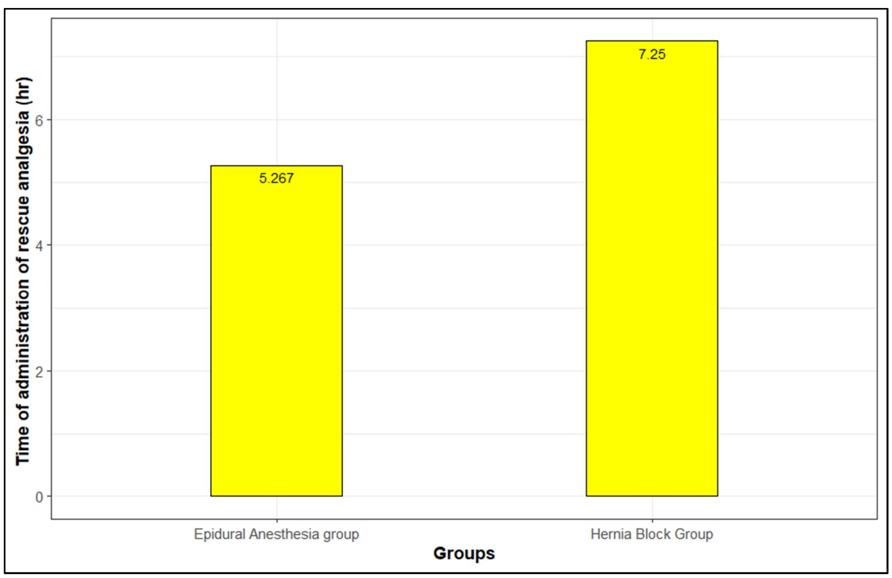
Graph 4: Distribution of left and right inguinal hernia



Graph 5: Plotting the mean onset of sensory block at T10 between various groupings.



Graph 6: Plotting the average duration of surgery in various groups.



Graph 7: Mean plot of time of administration of rescue analgesia over groups.

<u>Note:</u> At the 105-minute mark, data was available for 4 participants in Epidural Anesthesia collective and 2 participants in the Hernia Block collective. Similarly, at 120-minute mark, data was available for 2 subjects in both the Epidural Anesthesia and Hernia Block groups. Consequently, the vitals at these two time points were not compared due to the limited sample sizes.

Table 3: Comparing heart rate across different time points and groups.

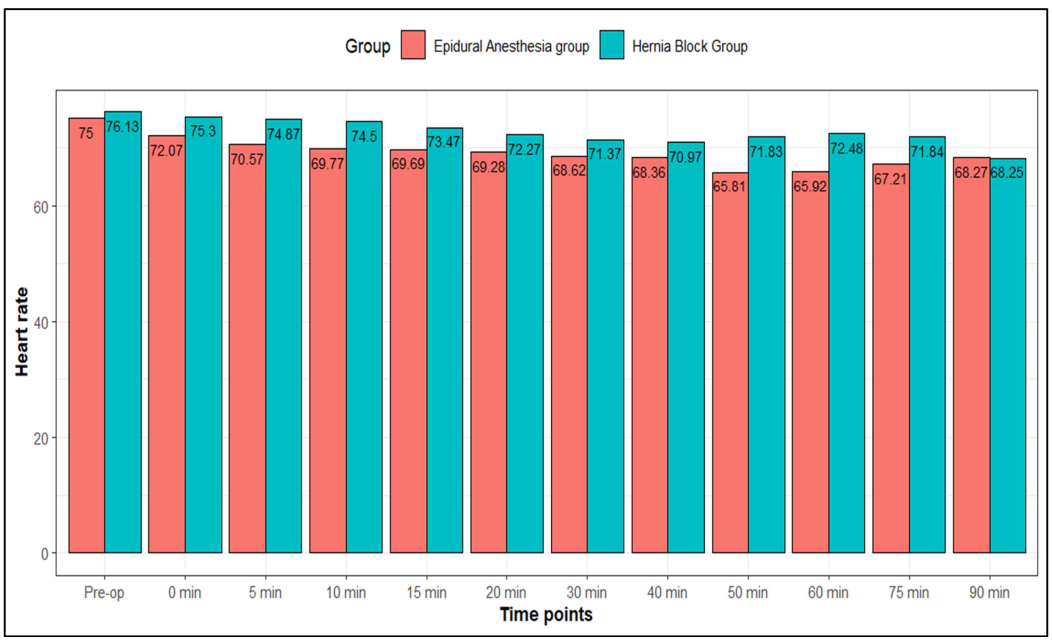
HR	Epidural Anesthesia group	Hernia Block Group	Total	p-value
Preoperative	75 ± 10.74 73.5 (60, 96)	76.13 ± 9.95 75 (60, 93)	75.57 ± 10.28 73.5 (60, 96)	0.6731^{t}
0 min	72.07 ± 14.47 70 (51, 121)	75.3 ± 12.51 77.5 (53, 97)	73.68 ± 13.51 71.5 (51, 121)	0.1978^{MW}
5 min	70.57 ± 11.94 69 (52, 103)	74.87 ± 11.68 76.5 (55, 95)	72.72 ± 11.91 71 (52, 103)	0.1640^{t}
10 min	69.77 ± 12.52 69 (50, 115)	74.5 ± 11.53 74 (56, 95)	72.13 ± 12.17 70 (50, 115)	0.1020^{MW}
15 min	69.69 ± 14.04 68 (53, 112)	73.47 ± 12.74 74 (56, 99)	71.61 ± 13.41 71 (53, 112)	0.1077^{MW}
20 min	69.28 ± 16.15 68 (50, 127)	72.27 ± 11.67 75.5 (52, 92)	70.8 ± 14.01 69 (50, 127)	0.101^{MW}
30 min	68.62 ± 14.12 66 (50, 112)	71.37 ± 11.5 74 (52, 92)	70.02 ± 12.81 69 (50, 112)	0.2213^{MW}
40 min	68.36 ± 13.38 66 (50, 100)	70.97 ± 10.4 72 (53, 92)	69.71 ± 11.89 70.5 (50, 100)	0.2128^{MW}
50 min	65.81 ± 12.74 62 (46, 97)	71.83 ± 10.51 72 (57, 95)	68.98 ± 11.91 68 (46, 97)	**0.0226^{MW}* (significant)**
60 min	65.92 ± 12.04 61 (47, 95)	72.48 ± 10.7 73 (57, 93)	69.44 ± 11.7 67.5 (47, 95)	**0.0234^{MW}* (significant)**
75 min	67.21 ± 13.04 67 (44, 92)	71.84 ± 10.52 72 (57, 92)	69.53 ± 11.92 68 (44, 92)	0.2359^{t}
90 min	68.27 ± 12.84 67 (50, 91)	68.25 ± 11.74 64.5 (57, 92)	68.26 ± 11.99 67 (50, 92)	0.9965^{t}
p-value	0.3619^{F}	0.4602^{F}	-	-

*Abbreviation: 't – Two sample t test', 'MW – Mann Whitney U test', 'F – Friedman's test', * indicates statistical significance.*

Pre operatively, the mean heart rate was 75 ± 10.74 bpm in the Epidural Anaesthesia grouping and 76.13 ± 9.95 bpm in the Hernia Block grouping, with no significant difference noted.

From 0 to 90 minutes post-surgery, no statistically substantial variation in heart rate among the two groups except at the 50-minute and 60-minute marks were noted. During these intervals, the heart rate in Hernia Block collective was notably elevated compared to the Epidural Anesthesia collective showing statistical significance with p-values of 0.0226 and 0.0234 respectively.

According to the results of ‘Friedman's test’, there were no significant fluctuations in heart rate observed over time within each group.



Graph 8: Average HR plot over time and by group.

Table 4: Comparison of SBP over time and groups.

SBP	Epidural Anesthesia group	Hernia Block Group	Total	p-value
Preoperative	130.23 ± 17.9 130 (96, 170)	128.7 ± 14.75 126 (100, 160)	129.47 ± 16.28 128 (96, 170)	0.8160^{MW}
0 min	127.63 ± 20.45 123.5 (101, 170)	134.03 ± 11.14 134.5 (110, 156)	130.83 ± 16.65 130 (101, 170)	**0.0489^{MW}* (significant)**
5 min	123.93 ± 17.48 119 (104, 173)	129.67 ± 11.68 130 (109, 153)	126.8 ± 15.02 124.5 (104, 173)	**0.0290^{MW}* (significant)**
10 min	118.97 ± 17.07 111 (97, 163)	127.27 ± 11.48 127 (100, 149)	123.12 ± 15.02 125 (97, 163)	**0.0075^{MW}* (significant)**
15 min	118.31 ± 17.66 114 (86, 162)	126.77 ± 12.05 125.5 (100, 153)	122.61 ± 15.54 123 (86, 162)	**0.0354^{t}* (significant)**
20 min	119.79 ± 18.54 121 (86, 160)	127.97 ± 11.96 129 (100, 149)	123.95 ± 15.95 125 (86, 160)	**0.0482^{t}* (significant)**
30 min	121.41 ± 17.88 119 (85, 164)	126.77 ± 12.47 127 (100, 149)	124.14 ± 15.47 123 (85, 164)	0.1863^{t}
40 min	120.57 ± 15.69 119 (98, 164)	126.63 ± 10.81 129 (106, 142)	123.71 ± 13.62 122 (98, 164)	0.0904^{t}
50 min	121.07 ± 14.18 119 (100, 163)	125.43 ± 11.04 123.5 (108, 149)	123.37 ± 12.7 121 (100, 163)	0.1639^{MW}
60 min	124.16 ± 14.59 120 (105, 159)	126.07 ± 11.76 128 (100, 145)	125.19 ± 13.05 125 (100, 159)	0.5967^{t}
75 min	124.26 ± 15.79 122 (104, 159)	129.58 ± 10.69 134 (111, 142)	126.92 ± 13.57 128.5 (104, 159)	0.2365^{MW}
90 min	127.55 ± 15.38 125 (105, 163)	130.42 ± 9.75 130 (116, 148)	129.04 ± 12.54 129 (105, 163)	0.5951^{t}
p-value	0.4713^{F}	0.1405^{F}	-	-

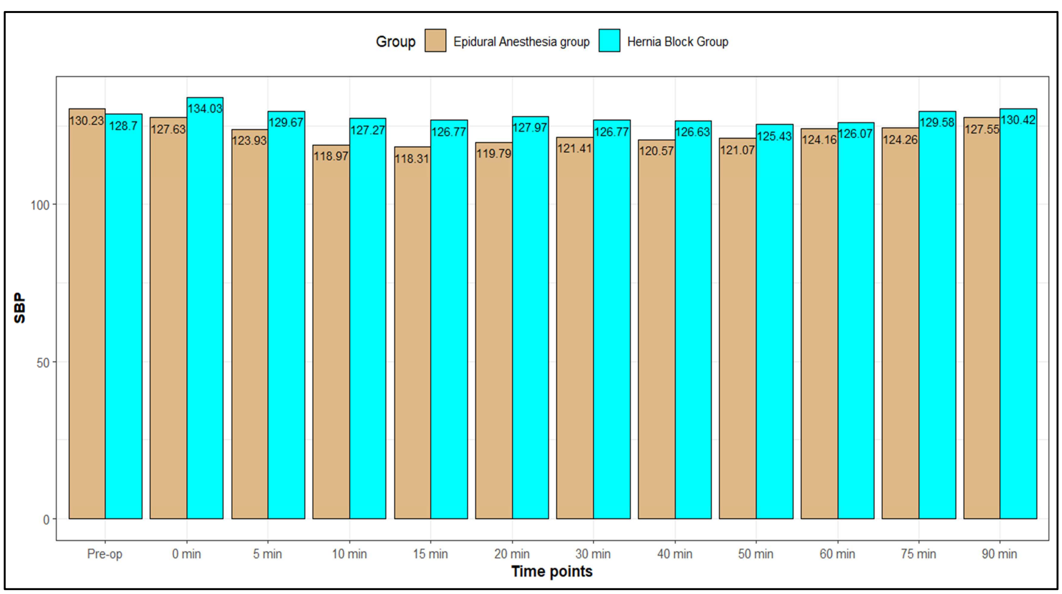
*Abbreviation: 't – Two sample t test', 'MW – Mann Whitney U test', 'F – Friedman's test', * indicates statistical significance.*

Preoperatively, the mean SBP was 130.23 ± 17.9 mmHg in the Epidural Anesthesia group and 128.7 ± 14.75 mmHg in the Hernia Block group, with no substantial variation observed (p-value = 0.8160).

The mean SBP was substantially elevated in the Hernia Block grouping in comparison to the Epidural Anaesthesia grouping. **This difference was seen at 5, 10, and 15 minutes, showing statistical significance with p-values of 0.0290, 0.0075, and 0.0354 respectively**. Similarly, **at the 20-minute mark**, the mean systolic blood pressure (SBP) in the Group HB consistently exceeded that of the Group E which was **statistically significant (p-value = 0.0482).**

Nonetheless, there weren't any discernable differences in SBP among the cohorts at 30, 40, 50, 60, 75, and 90 minutes.

Furthermore, 'Friedman's test' showed insignificant variations of SBP over time within group.



Graph 9: Average SBP graph by group and time.

Table 5: DBP comparison across groups and time periods.

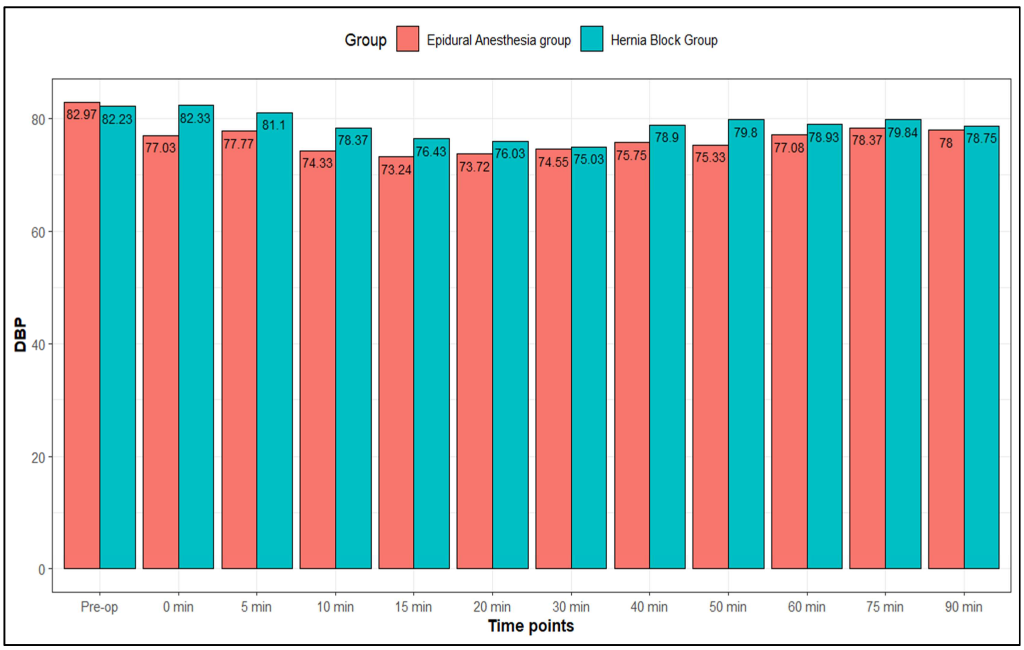
DBP	Epidural Anesthesia group	Hernia Block Group	Total	p-value
Preoperative	82.97 ± 8.65 80 (70, 110)	82.23 ± 10.1 80 (60, 100)	82.6 ± 9.33 80 (60, 110)	0.8894^{MW}
0 min	77.03 ± 11.62 76.5 (55, 97)	82.33 ± 10.25 81.5 (60, 99)	79.68 ± 11.19 80 (55, 99)	0.0660^{t}
5 min	77.77 ± 12.82 76.5 (61, 115)	81.1 ± 8.62 80 (60, 99)	79.43 ± 10.96 79 (60, 115)	0.0665^{MW}
10 min	74.33 ± 8.74 72 (61, 95)	78.37 ± 10.21 75.5 (60, 97)	76.35 ± 9.64 73.5 (60, 97)	0.0695^{MW}
15 min	73.24 ± 9.99 72 (52, 97)	76.43 ± 9.53 74.5 (60, 97)	74.86 ± 9.8 73 (52, 97)	0.2141^{t}
20 min	73.72 ± 12.71 71 (52, 104)	76.03 ± 12.12 73 (50, 106)	74.9 ± 12.36 73 (50, 106)	0.4778^{t}
30 min	74.55 ± 10.2 73 (54, 99)	75.03 ± 10.34 74.5 (57, 93)	74.8 ± 10.19 73 (54, 99)	0.8578^{t}
40 min	75.75 ± 9.96 78 (59, 100)	78.9 ± 11.41 80 (50, 103)	77.38 ± 10.76 80 (50, 103)	0.2689^{t}
50 min	75.33 ± 9.76 74 (52, 97)	79.8 ± 10.65 81 (57, 100)	77.68 ± 10.39 78 (52, 100)	0.1058^{t}
60 min	77.08 ± 9.37 76 (66, 104)	78.93 ± 9.51 78 (60, 96)	78.07 ± 9.4 76 (60, 104)	0.3213^{MW}
75 min	78.37 ± 8.41 79 (65, 97)	79.84 ± 8.05 80 (60, 96)	79.11 ± 8.16 80 (60, 97)	0.5846^{t}
90 min	78 ± 6.87 79 (68, 88)	78.75 ± 10.52 77.5 (65, 95)	78.39 ± 8.77 78 (65, 95)	0.8432^{t}
p-value	0.0747^{F}	0.6422^{F}	-	-

*Abbreviation: 't – Two sample t test', 'MW – Mann Whitney U test', 'F – Friedman's test', * indicates statistical significance.*

Preoperatively, the mean DBP was 82.97 ± 8.65 mmHg in the Epidural Anesthesia group and 82.23 ± 10.1 mmHg in the Hernia Block group, with no substantial variation observed (p-value = 0.8894).

Similarly, throughout the subsequent time points (5 to 90 minutes), the two groups' DBPs did not differ in a statistically meaningful way.

Furthermore, 'Friedman's test' indicated insignificant variations in each group's DBP over time.



Graph 10: Plotting the mean diastolic blood pressure (DBP) across time and groups.

Table 6: Comparing mean arterial pressure (MAP) across time points and groupings.

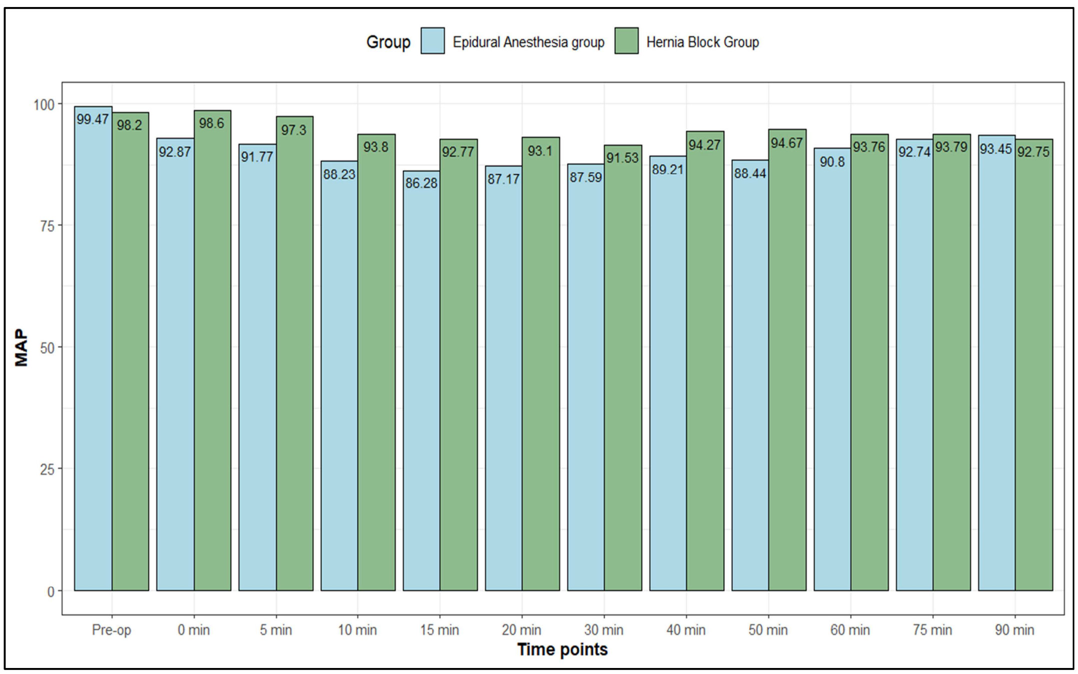
MAP	Epidural Anesthesia group	Hernia Block Group	Total	p-value
Preoperative	99.47 ± 10.33 97 (79, 130)	98.2 ± 10.49 97.5 (80, 120)	98.83 ± 10.34 97 (79, 130)	0.8638 MW
0 min	92.87 ± 13.17 91 (74, 119)	98.6 ± 8.78 99.5 (77, 117)	95.73 ± 11.47 97 (74, 119)	**0.0383 MW* (significant)**
5 min	91.77 ± 13.27 89.5 (76, 124)	97.3 ± 9.14 97 (77, 117)	94.53 ± 11.63 95 (76, 124)	**0.0177 MW* (significant)**
10 min	88.23 ± 12.92 84 (76, 132)	93.8 ± 9.36 92 (78, 114)	91.02 ± 11.53 87 (76, 132)	**0.0048 MW* (significant)**
15 min	86.28 ± 11.33 83 (63, 109)	92.77 ± 9.62 91.5 (78, 116)	89.58 ± 10.91 87 (63, 116)	**0.0209 t* (significant)**
20 min	87.17 ± 13.43 84 (63, 112)	93.1 ± 10.55 92 (77, 120)	90.19 ± 12.32 90 (63, 120)	0.0640 t
30 min	87.59 ± 11.68 87 (67, 115)	91.53 ± 8.82 91 (77, 108)	89.59 ± 10.43 91 (67, 115)	0.1477 t
40 min	89.21 ± 11 89.5 (72, 115)	94.27 ± 9.84 93 (73, 116)	91.83 ± 10.63 92 (72, 116)	0.0702 t
50 min	88.44 ± 10.11 87 (72, 112)	94.67 ± 9.48 93 (78, 113)	91.72 ± 10.19 92 (72, 113)	**0.0199 t* (significant)**
60 min	90.8 ± 9.81 90 (78, 112)	93.76 ± 9.2 93 (75, 108)	92.39 ± 9.52 91 (75, 112)	0.2586 t
75 min	92.74 ± 9.52 92 (78, 110)	93.79 ± 9.98 95 (68, 109)	93.26 ± 9.63 93.5 (68, 110)	0.7412 t
90 min	93.45 ± 8.85 94 (82, 112)	92.75 ± 11.58 93 (68, 108)	93.09 ± 10.14 93 (68, 112)	0.8723 t
p-value	0.0899 F	0.4221 F	-	-

*Abbreviation: 't – Two sample t test', 'MW – Mann Whitney U test', 'F – Friedman's test', * indicates statistical significance.*

Preoperatively, the average MAP was 99.47 ± 10.33 mmHg in the Epidural Anaesthesia grouping and 98.2 ± 10.49 mmHg in the Hernia Block grouping, with no substantial variation observed (p-value = 0.8638).

The mean MAP in the Epidural Anaesthesia collective was considerably less than in the Hernia Block grouping. **This difference was noted at 5-, 10-, and 15-minutes, with the Epidural Anesthesia group consistently showing lower MAP compared to the Hernia Block group. This was of statistical significance with p-values of 0.0177, 0.0048, and 0.0209 respectively**. Although the mean MAP tends to reduce in the Epidural Anaesthesia grouping at the subsequent time points (20 to 90 minutes), these variations were statistically insignificant except **at 50 min where statistical significance was noted with p-value = 0.0199.**

Moreover, 'Friedman's test' indicated no substantial changes of MAP across time within each collective.



Graph 11: Average map of the MAP by group and time.

Table 7: Examining CPOT scores across time and across different groups.

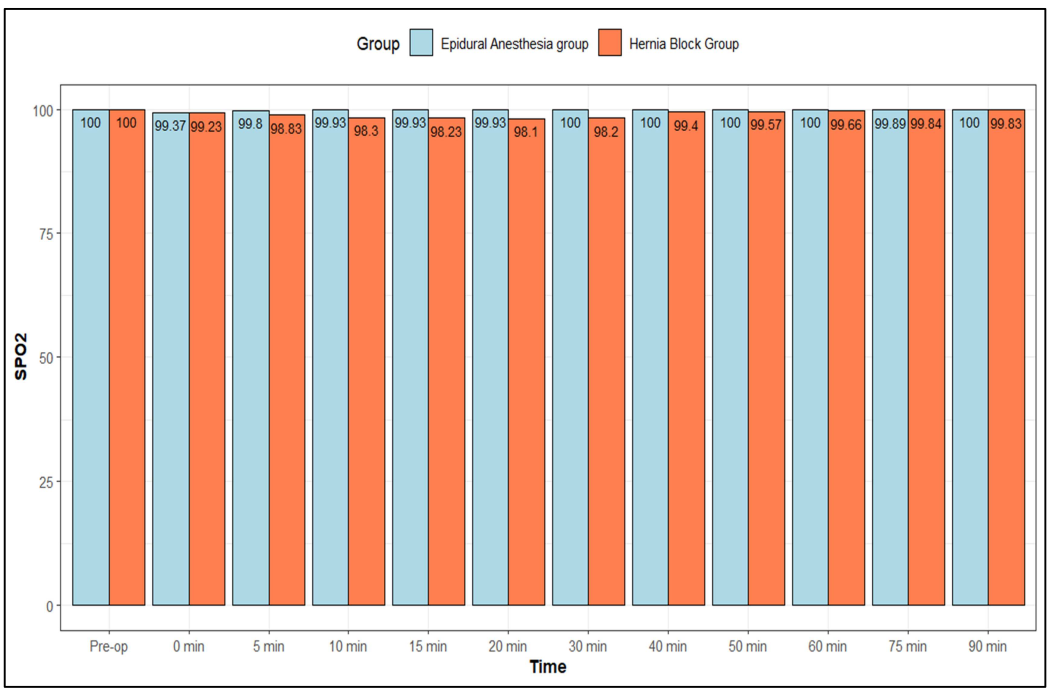
CPOT score	Epidural Anesthesia group	Hernia Block Group	Total	p-value
0 min	0.23 ± 0.57 0 (0, 2)	0.37 ± 0.72 0 (0, 2)	0.3 ± 0.65 0 (0, 2)	0.4841^{MW}
5 min	0.17 ± 0.38 0 (0, 1)	0.37 ± 0.72 0 (0, 2)	0.27 ± 0.58 0 (0, 2)	0.3960^{MW}
10 min	0.03 ± 0.18 0 (0, 1)	0.13 ± 0.35 0 (0, 1)	0.08 ± 0.28 0 (0, 1)	0.1647^{MW}
15 min	0.1 ± 0.41 0 (0, 2)	0.17 ± 0.38 0 (0, 1)	0.14 ± 0.39 0 (0, 2)	0.2794^{MW}
20 min	0 ± 0 0 (0, 0)	0.27 ± 0.64 0 (0, 2)	0.14 ± 0.47 0 (0, 2)	**0.0228^{MW}* (significant)**
30 min	0 ± 0 0 (0, 0)	0.3 ± 0.7 0 (0, 2)	0.15 ± 0.52 0 (0, 2)	**0.0228^{MW}* (significant)**
40 min	0 ± 0 0 (0, 0)	0.2 ± 0.41 0 (0, 1)	0.1 ± 0.31 0.2 0 (0, 1)	**0.0132^{MW}* (significant)**
50 min	0 ± 0 0 (0, 0)	0.03 ± 0.18 0 (0, 1)	0.02 ± 0.13 0 (0, 1)	0.3428^{MW}
60 min	0 ± 0 0 (0, 0)	0 ± 0 0 (0, 0)	0 ± 0 0 (0, 0)	1^{MW}
75 min	0 ± 0 0 (0, 0)	0 ± 0 0 (0, 0)	0 ± 0 0 (0, 0)	1^{MW}
90 min	0 ± 0 0 (0, 0)	0.08 ± 0.29 0 (0, 1)	0.04 ± 0.21 0 (0, 1)	0.3384^{MW}
p-value	0.1704^{F}	0.2143^{F}	-	-

*Abbreviation: 'MW – Mann Whitney U test', 'F – Friedman's test', * indicates statistical significance.*

Despite a little rise in CPOT scores at 0 minutes in the Hernia Block Group compared to the Epidural Anaesthesia collective, this disparity was statistically insignificant (p-value = 0.4841). Subsequent evaluations at 5, 10, and 15 minutes revealed no obvious disparities between the groups in the minutes.

However, **at the 20, 30, and 40-minute marks, there were variations in CPOT scores within the Hernia Block Group, with statistically significant p-values of 0.0228, 0.0228, and 0.0132, respectively.** Notably, the differences did not sustain in later assessments.

Additionally, the Friedman's test did not identify any significant changes in CPOT scores over time within either group.



Graph 12: Average CPOT score plotted by group and time.

DISCUSSION

With variable degrees of success, general, spinal, epidural, and local anaesthetic procedures have been employed for inguinal hernia repair. Epidural anaesthesia offers prolonged and adjustable analgesia by allowing additional doses of anesthetic, providing better control over the block's intensity and duration. It has a more gradual onset of sympathetic blockade, reducing the potential to cause severe hypotension. It is linked with a decrease in the occurrence of headache post-dural puncture and allows for segmental anesthesia, which can preserve more muscle function compared to spinal anesthesia. [5]

Hernia block (ilio-inguinal-ilio-hypogastric nerve) for inguinal hernia repair has several advantages: it reduces operating room time and lowers the incidence of urinary retention compared to other anesthesia techniques. [13] Patient satisfaction is comparable to other methods, and it also leads to lower postoperative pain and decreased requirement for analgesics. As per the latest recommendations by 'European society of regional anesthesia and pain therapy', a field block (ilio-hypogastric/ilio-inguinal block) in conjunction with or without wound infiltration is advised. This is a grade A recommendation. [7] Despite this strong endorsement, many anesthesiologists remain hesitant to adopt this technique. This reluctance may be due to factors such as familiarity with other anesthetic methods, perceived technical difficulties, and concerns about the adequacy and duration of local anesthesia. [1] In this study we evaluated the onset, hemodynamic stability, intra operative comfort, duration of first rescue analgesia of epidural anesthesia as compared to inguinal hernia block (ilioinguinal-iliohypogastric nerve and genitofemoral nerve block).

The study was conducted on a total of 60 individuals, split into two groups of thirty each. The average age of the participants in the Epidural Anaesthesia grouping was 66.67 ± 6.39 years, while in the Hernia Block group, the mean age was 66.3 ± 5.51years and held no statistical significance. All participants in the study were male, resulting in identical gender distribution across groups.

In the Epidural Anesthesia group, with 25 mL of 0.75% Ropivacaine, the average time for the sensory block and motor block was 12.3 ± 3.75 minutes and 16.07 ± 3.89 minutes, respectively. Charles E. Pither et al.'s research on Epidural Anaesthesia employing Ropivacaine (7.5 mg/mL), with/without ephedrine, observed a sensory onset at T10 dermatome roughly around 10 minutes post-administration, with the motor block onset at the 20-minute mark. [36] Sridevi b et al [37] and Kiran Kumar S et al [38] conducted studies with results comparable to the current study.

In contrast, in the Hernia Block group, the mean onset time was 15.23 ± 2.62 minutes, showing a statistically significant difference (p = 0.0028) as opposed to the epidural group. A study done by Yinglan Su et al on efficacy of different concentrations of ropivacaine (0.25%, 0.5%, 0.75%) in inguinal hernia repairs surgeries revealed the onset of 0.75% ropivacaine to be 14.75±1.45. [39] Similarly, in a study conducted by Khedkar on iliohypogastric and ilioinguinal nerve blocks guided by ultrasound, in contrast to the landmark method, the beginning of sensory action in the blockade group guided by ultrasound was 14.03 ± 2.82 minutes. [40] These results seem comparable to the outcomes in our investigation.

The Epidural Anesthesia group demonstrated a quicker onset of sensory block compared to the Hernia Block group. Despite this statistical difference, both techniques achieve rapid sensory block onset, crucial for effective pain management during surgery. Factors such as the use of Ultrasonography, technique of administration, dosage of local anesthetic, patient anatomy, and individual response to the block may contribute to this variation. Nonetheless, both approaches seem effective in providing sufficient sensory block for inguinal hernia repair.

In the Hernia Block group, the average time to administer rescue analgesia was noticeably longer *(7.25 ± 1.74 hours) compared to the Epidural Anesthesia group (5.27 ± 0.84 hours, p < 0.001). In Kaur*'s study on *comparing ropivacaine vs ropivacaine with dexmedetomidine given epidurally, the duration for first recue analgesia in the ropivacaine grouping was* 312.64 ± 16.217 min (5.2 hr), which is in line with the finding of the current study. [41] In a study by Kumar, Neera et al., the total time of sensory blockade was found to be 362.60 ± 5.96 (6 hr) minutes when comparing Epidural Ropivacaine to Ropivacaine–Clonidine. [42] In Charles E. Pither et al.'s study on Epidural Anaesthesia using Ropivacaine, the total time of sensory block at dermatomes pertinent to surgery (levels T10 to S1) was from 3.6 to 5.7 hours. [36]

In Priyadarshini K's research on transverse abdominis plane block commanded by ultrasound, iliohypogastric/ilioinguinal nerve blockade, and quadratus lumborum blockade for hernia repair, the iliohypogastric/ilioinguinal nerve blockade group demonstrated a median time to initial pain relief of 480 minutes (8 hr), consistent with findings in the current study. [43] In Khedkar SM's study on ilioinguinal and iliohypogastric nerve block, Ultrasound-guided vs conventional technique, the duration to rescue analgesia was prolonged in ultrasound guided grouping, with a duration of 7.22 ± 0.97 hours, which aligns with the results observed in our study. [40] In Guilherme S et al.'s study, they assessed post-surgery pain and discharge from hospital following inguinal and iliohypogastric nerve blockade using ropivacaine (0.75%) for inguinal hernia repair. They found that the duration till the requirement of rescue dose of nalbuphine, ketorolac, and dipyrone was 8.5 ± 5.9 hours, 7.7 ± 5.0 hours, and 5.0 ± 2.6 hours, respectively. These results closely mirror the findings obtained in our study. [44]

Patients who receive the Hernia Block experience extended pain relief, reducing the necessity for additional analgesic interventions. This longer-lasting analgesia decreases the requirement for rescue analgesics, lowering the risk of medication-related complications. Improved comfort and satisfaction postoperatively may expedite recovery and discharge. Enhanced pain relief facilitates engagement in daily activities and rehabilitation, promoting swifter recovery. Ultimately, this effective pain management strategy leads to cost savings for both patients and healthcare providers. [45]

There were no statistically substantial variations in heart rate among the groups, except at the 50-minute and 60-minute marks.

The Hernia Block group showed notably higher mean systolic blood pressure (SBP) compared to the Epidural Anaesthesia group (p = 0.0489), persisting up to 20 minutes. However, from 30 to 90 minutes, insignificant SBP variations were noted among groups, and SBP remained stable within each. Diastolic blood pressure (DBP) didn't significantly differ between groups at any point.

Mean arterial pressure (MAP) was substantially lesser in the Epidural Anesthesia group at 5, 10, and 15 minutes (p-values: 0.0177, 0.0048, and 0.0209, respectively), with a notable difference at 50 minutes (p = 0.0199).

Mustafa Kaçmaz et al. conducted a study where they examined the contrast between spinal anesthesia and ilioinguinal–iliohypogastric nerve block combined with tumescent anesthesia where mean blood pressure values at minutes zero, fifteen, and thirty during the procedure were substantial in patients receiving spinal anesthesia compared to those receiving nerve block ($p < 0.005$), which is comparable to our study [15]

In a study by Yilmazlar A, comparing iliohypogastric/ilioinguinal nerve blockade to spinal anaesthesia, the spinal anesthesia group showed a statistically substantial reduction in both mean arterial pressure and pulse rate ($P = 0.001$) as seen in the current study. [46]

In Khedkar's study comparing ultrasound-guided versus conventional techniques for ilioinguinal and iliohypogastric nerve block, there was little fluctuation observed in the mean systolic blood pressure throughout the procedure in line with our findings. (p = Not significant) [40]

Lumbar epidural anesthesia, targeting sympathetic blockade below T10, modestly decreases arterial blood pressure by affecting fewer vasoconstrictor fibers, leaving the splanchnic nerves and adrenal medulla unaffected. Preganglionic sympathetic denervation causes dilation of lower limb vessels, reducing total peripheral resistance. [38]

In G. Simon's investigation it was observed that administering 15 mL of 1.0% ropivacaine epidurally notably reduced mean arterial pressure (MAP), particularly in the oldest patients. In 19 patients (geriatric age group), nine experienced a MAP decrease of over 30% within the initial hour post-epidural. This hypotension is likely attributed to the extensive cephalad spread of analgesia, with all affected patients having analgesia above the T5 dermatome. Furthermore, age-related alterations in hemodynamic stability may have played a contributing role. In elderly patients, diminished cardiac reserves, structural arteriolar changes, and alterations in the autonomic nervous system may exacerbate this condition. [23]

In essence, the study findings indicate that while both the hernia block group and the epidural group experienced relatively minor alterations in hemodynamic parameters, the hernia block technique demonstrated a more consistent and stable profile in terms of these changes (p = 0.0489). This suggests that when considering the administration of nerve blocks in elderly patients, particularly those with potential cardiovascular concerns, the hernia block approach may offer advantages in maintaining hemodynamic stability throughout the procedure. This stability is crucial in ensuring the safety and well-being of elderly patients undergoing such interventions, potentially making the hernia block technique a preferred choice in this population. No other studies have reported the parameters observed in this study, so references could not be obtained.

At 20, 30, 40 minutes, CPOT scores were significantly higher in the Hernia Blockade collective in contrast to the Epidural Anaesthesia collective with p-values of 0.0228, 0.0228, and 0.0132, respectively. These variations did not persist in later assessments. Notably, there were no scores indicating the need for sedation or conversion to general anesthesia in either group. In line with current research findings, by Goel et al reported heightened intraoperative pain reported by patients in local anesthesia group. [47]

In a study by Earle AS on patients getting operated for inguinal hernia with local anaesthesia, 23 patients (50%) experienced slight pain, while the other 23 patients (50%) felt no pain. [48] Pain during the operation was more likely in cases of large hernias or when dissection was challenging due to adhesions of the sac. [49] Comparable studies conducted by Sultana A et al. [50] and Ruben N Van Veen et al. [51] demonstrated that 34% and 35% of patients, respectively, experienced moderate intraoperative discomfort during hernia sac dissection when a standard inguinal field block was used. C J Sparks el al [52] and Aysun Yilmazlar et al [37] noted failure rates of 3.33%, 3.17% for local inguinal field blocks. The failure rate can be minimalized with more experience and skill in this technique. [46]

Sasaoka N's study assessed the effectiveness of genitofemoral nerve blockade as an adjunct to iliohypogastric and ilioinguinal nerve blockade for hernia repair, it showed that this combined approach significantly decreased both the frequency and degree of systemic arterial pressure (SAP) and heart rate (HR) elevation during sac manipulation during the procedure. [21] In contrast, Pradeep Goyal's study comparing hernia repair under local anaesthesia versus spinal anaesthesia found significant differences in intraoperative pain perception. Patients undergoing local anesthesia reported significantly less pain compared to those receiving spinal anesthesia ($p < 0.05$). [53]

Balentine CJ et al. showcased the substantial advantages of employing local anesthesia in inguinal hernia surgery, particularly for patients aged 75 and above. This group experienced diminished postoperative complications, specifically a lowered occurrence of urinary tract infections, possibly attributable to decreased postoperative urinary retention. Additionally, utilizing local anesthesia did not extend the overall operative time for these patients. Notably, individuals aged 65 to 74 underwent expedited hernia repairs when local anesthesia was administered. [54]

CONCLUSION

Several studies have compared inguinal field block with spinal anesthesia, as well as spinal anesthesia with epidural anesthesia. Comparing the hemodynamic stability of ultrasound-guided inguinal field block and epidural anesthesia in geriatric patients using ropivacaine concluded that, inguinal field block appears to be the more stable option, particularly when considering the burden of comorbidities prevalent in this population.

Limitations:

The statistical power and robustness are limited by the short sample size. Increased sample size would enhance validity. The study's limited generalizability and introduction of selection bias result from its single-center methodology. Other institutions may have different populations and practices. Future research should overcome these inadequacies to give a more comprehensive understanding of anesthetic techniques.

SUMMARY

The study titled "COMPARING THE EFFECT OF EPIDURAL ANAESTHESIA AND ULTRASOUND GUIDED HERNIA BLOCK ON HAEMODYNAMIC CHANGES IN GERIATRIC PATIENTS UNDERGOING INGUINAL HERNIA REPAIR USING ROPIVACAINE– A ONE YEAR RANDOMISED CONTROL TRIAL**".** was conducted.

The study involved sixty patients aged 60 years and above, all classified as ASA II or higher, who were undergoing open inguinal hernia repair. These patients were randomly divided into two groups: Group E, which received epidural anaesthesia, and Group H, which received a hernia block (ilioinguinal-iliohypogastric nerve block and genitofemoral nerve block). Perioperative haemodynamics, comfort scale (CPOT scores), and the time to first rescue analgesia were recorded to evaluate the effectiveness of each anaesthetic technique.

Results indicated that the Hernia Block group initially had higher systolic blood pressure ($p = 0.0489$), which persisted for 20 minutes. In contrast, the Epidural Anaesthesia group consistently exhibited lower mean arterial pressure at various time points (with p-values of 0.0383, 0.0177, 0.0048, 0.0209, and 0.0199 at 0, 5, 10, 15, and 50 minutes, respectively). Additionally, the Hernia Block group had significantly higher CPOT scores at 20, 30, and 40 minutes (p-values of 0.0228, 0.0228, and 0.0132, respectively), indicating lower peri-operative comfort compared to the epidural group.

In conclusion, the inguinal field block appeared to be the more stable choice overall.

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ANNEXURE I -INFORMED CONSENT FORM

"COMPARING THE EFFECT OF EPIDURAL ANAESTHESIA AND ULTRASOUND GUIDED HERNIA BLOCK ON HAEMODYNAMIC CHANGES IN GERIATRIC PATIENTS UNDERGOING INGUINAL HERNIA REPAIR USING ROPIVACAINE– A ONE YEAR RANDOMISED CONTROL TRIAL"

Objective: To study the haemodynamic changes and intra operative comfort in hernia block and epidural anaesthesia in geriatric patients undergoing inguinal hernia repair

Explanation of procedure: If you agree to enrol in my study, I will ask you present, past and family history. Then you will be clinically examined in detail. You will be allotted into one of the two groups randomly using computer generated software. Group 1 will receive Epidural anaesthesia with 15-25 ml of 0.75% ropivacaine. Group 2 will receive HERNIA block with 20- 25 ml mixture of 0.75% ropivacaine and 2% lignocaine.

Withdrawal from participation in the study: Participation in this study is voluntary. You will be free to decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so. However, please convey the decision to the principal investigator.

Possible benefits from participating in the study: You will/will not have nor get any benefits by participating in this study. The data gathered will help the population at large.

Possible risks from participating in the study: There are no risks involved in participating in this study.

Privacy and confidentiality: The information collected from you will be coded, to prevent any person from identifying you. Your identity will never be revealed. The data collected from you will be kept confidential and only processed or aggregated data will be used for publication.

Financial incentives: You will not receive any payment for participating in this study.

Authorization for publication of aggregated data: Results obtained after processing of the aggregated data will be published for scientific purposes and or presented to scientific groups. However, your identity will never be revealed.

CONSENT STATEMENT

I am making a voluntary decision to participate in the study "**COMPARING THE EFFECT OF EPIDURAL ANAESTHESIA AND ULTRASOUND GUIDED HERNIA BLOCK ON HAEMODYNAMIC CHANGES IN GERIATRIC PATIENTS UNDERGOING INGUINAL HERNIA REPAIR USING ROPIVACAINE– A ONE YEAR RANDOMISED CONTROL TRIAL**.". My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and that they have been answered to my satisfaction.

Name of the participant:

Signature or left thumb impression of the participant:

Name of the witness:

Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator:

ANNEXURE - II - PROFORMA

Project title: "**COMPARING THE EFFECT OF EPIDURAL ANAESTHESIA AND ULTRASOUND GUIDED HERNIA BLOCK ON HAEMODYNAMIC CHANGES IN GERIATRIC PATIENTS UNDERGOING INGUINAL HERNIA REPAIR USING ROPIVACAINE– A ONE YEAR RANDOMISED CONTROL TRIAL**"

GROUP ALLOTED: 1 2

Date of Examination : IP No. :

Name :

Age : Gender :

PRE-ANAESTHETIC EVALUATION

Chief complains:

HOPI:

Past History

- H/O comorbidities and drug intake:
- H/O previous surgery/(s) where difficult airways was encountered:
- Previous anaesthetic experience:

Family History

General physical examination

Weight (kgs)		Pallor	
Height (cms)		Icterus	
Temperature (^{o}F)		Cyanosis	
Pulse		Clubbing	
Blood Pressure			
Respiratory Rate			

Systemic examination:

Respiratory System		CNS	
CVS		GIT	

Airway Assessment:

Teeth: Jaw movements: MPG:

Spine:

Investigations:

Hb: TLC: Platelet count:

Serum Creatinine: FBS: PT/INR:

Chest x-ray: ECG:

PREOPERATIVE PHYSICAL STATUS ASA Grade I II III IV V

Diagnosis:

Proposed surgery: Inguinal Hernia Repair

PARAMETERS	HR	SBP	DBP	MAP	SPO2	PREOPERATIVE COMFORT (CPOT SCORE)
BASELINE						
5 MIN						
10 MIN						
15 MIN						
20 MIN						
30 MIN						
40 MIN						
50 MIN						
60 MIN						
75 MIN						
90 MIN						
105 MIN						
120 MIN						

	EPIDURAL ANAESTHESIA	HERNIA BLOCK
TIME OF INDCUTION		
TIME TAKEN TO ACHIEVE SENSORY BLOCKADE MOTOR BLOCKADE		
RECOVERY FROM SENSORY BLOCK		
DURATION OF SURGERY		
TIME OF ADMINISTRATION OF FIRST RESCUE ANALGESIA (as measure by VAS>/=4)		

INVESTIGATOR	
WITNESS	
ANAESTHESIOLOGIST	

ANNEXURE - III - PHOTOGRAPHS

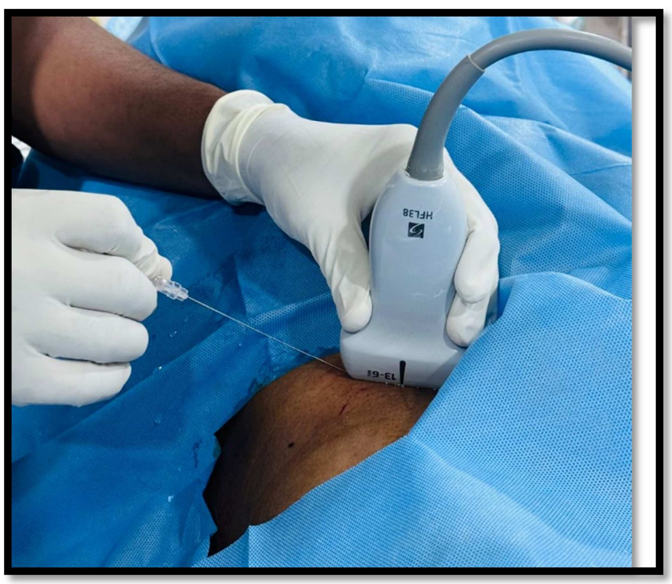
PHOTOGRAPH 1: USG machine with probe

PHOTOGRAPH 2: Linear ultrasound probe

PHOTOGRAPH 3: 0.75% Ropivacaine

PHOTOGRAPH 4: Tray for Hernia Block

PHOTOGRAPH 5: Ilioinguinal iliohypogastric nerve

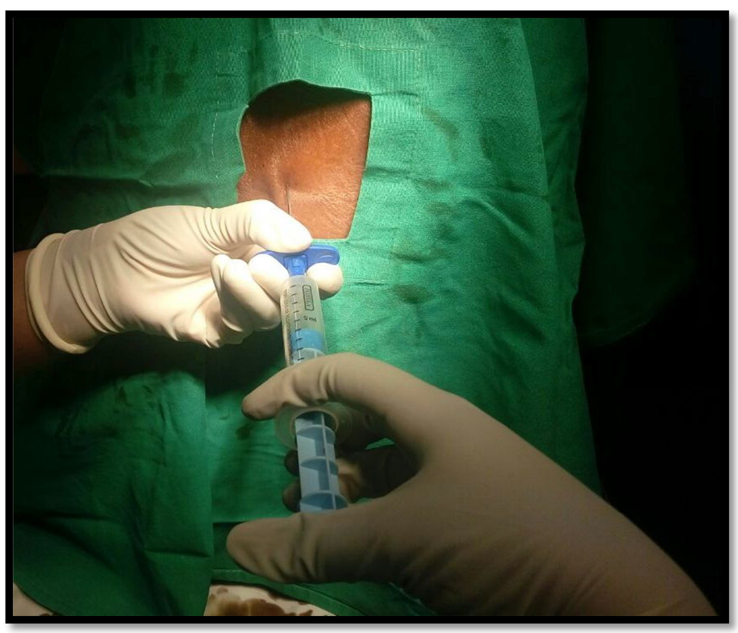


PHOTOGRAPH 6: Probe position for Ilioinguinal iliohypogastric nerve

PHOTOGRAPH 7: Genitofemoral nerve

PHOTOGRAPH 8: Probe position for Genitofemoral Nerve

PHOTOGRAPH 9: Epidural Tray



PHOTOGRAPH 10: Procedure of epidural

ANNEXURE - IV – KEY TO MASTER CHAT

KGs	-	Kilogram
MIN	-	Minutes
DBP	-	Diastolic Blood Pressure
MAP	-	Mean Arterial Pressure
SBP	-	Systolic Blood Pressure
CPOT	-	Critical Care Pain Observation Tool
HR	-	Heart Rate
VAS	-	Visual Analogue Score

ANNEXURE - V –MASTER CHAT

Sl no.	Sex	Age	Weight	ASA	Diagnosis	Surgery	sensory block	duration of surgery	Preoperative Vitals					Vitals At 0 min.						Vitals at 5 min.						Vitals At 10 Min.						Vitals at 15 Min.						Vitals at 20 Min.						Vitals at 30 Min.						Vitals at 40 Min		
		(Years)	(kgs.)				onset at T10(min)	min	HR (BPM)	SBP	DBP	MAP	SPO2	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP
1	M	76	70	2	left inguinal hernia	hernioplasty	10	60	80	120	90	103	100	80	130	90	103	96	0	76	120	80	100	98	0	74	120	60	80	99	0	72	115	70	85	99	0	76	116	60	79	97	0	73	119	60	80	99	0	71	126	80
2	M	66	68	2	right inguinal hernia	hernioplasty	14	75	93	153	99	117	100	93	153	99	117	98	0	90	153	99	117	98	0	91	149	97	114	100	0	93	153	97	116	100	0	92	143	96	112	100	0	88	137	93	108	98	0	84	133	90
3	M	60	72	2	left inguinal hernia	hernioplasty	13	75	86	140	90	107	100	82	130	80	97	100	0	82	122	76	97	100	0	82	122	77	92	100	0	80	128	76	94	100	0	78	127	77	94	100	0	77	127	77	94	100	0	79	130	80
4	M	62	64	2	right inguinal hernia	hernioplasty	15	75	72	110	80	90	100	78	130	90	103	98	0	77	132	92	103	98	0	74	128	88	101	98	0	72	128	72	91	100	0	71	128	71	90	100	0	70	127	72	90	100	0	72	121	75
5	M	69	70	2	left inguinal hernia	hernioplasty	13	60	82	116	72	87	100	90	116	72	87	96	0	86	117	70	86	95	0	80	120	69	86	96	0	76	119	68	85	97	0	78	130	73	92	99	0	80	126	74	91	98	0	82	120	80
6	M	65	58	2	left inguinal hernia	hernioplasty	20	90	70	140	90	107	100	80	156	77	100	100	0	82	146	77	100	100	0	80	145	73	92	199	0	78	145	73	97	100	0	78	136	70	92	100	0	76	136	70	92	100	0	76	136	70
7	M	62	82	2	right inguinal hernia	hernioplasty	12	120	86	150	90	110	100	68	144	76	93	100	0	65	140	77	91	100	0	66	130	74	87	100	0	56	126	72	85	100	0	56	123	70	83	100	0	56	149	85	91	100	0	56	134	73
8	M	60	70	2	right inguinal hernia	hernioplasty	15	75	72	100	72	81	100	90	137	85	102	98	1	93	130	88	102	98	2	89	126	84	98	98	0	92	120	82	95	97	0	91	132	82	99	99	0	89	123	81	95	100	2	85	128	90
9	M	70	60	2	right inguinal hernia	hernioplasty	18	90	64	120	70	87	100	62	110	60	77	100	0	60	112	60	77	100	0	58	114	60	78	100	0	60	116	65	82	100	0	62	120	65	83	100	0	63	100	65	77	100	0	63	110	65
10	M	64	70	2	left inguinal hernia	hernioplasty	13	60	72	160	100	120	100	80	144	63	90	100	0	82	150	70	97	100	0	84	149	70	96	100	0	81	149	70	96	100	0	78	147	70	96	100	0	79	147	67	94	100	0	77	142	68
11	M	62	60	2	right inguinal hernia	hernioplasty	15	60	82	130	90	103	100	80	130	90	103	99	0	79	120	80	93	98	0	78	126	70	89	97	0	76	115	60	78	99	0	75	110	70	80	96	0	80	119	60	80	96	0	70	120	50
12	M	65	80	2	left inguinal hernia	hernioplasty	20	60	60	140	90	107	100	90	140	90	107	100	0	86	130	80	97	98	0	95	119	70	86	99	0	90	120	60	80	99	0	87	130	50	77	96	0	80	119	60	80	95	0	75	117	70
13	M	66	70	2	right inguinal hernia	hernioplasty	16	75	62	120	80	93	100	80	140	80	107	98	0	80	142	82	107	98	0	75	138	80	99	100	0	76	135	70	92	100	0	77	135	70	92	100	0	73	132	75	91	100	0	72	140	90
14	M	84	66	2	right inguinal hernia	hernioplasty	15	90	72	150	80	103	100	77	141	80	100	100	0	72	142	82	107	100	0	73	135	70	92	100	0	77	140	80	107	100	0	76	135	70	92	100	0	75	133	70	92	100	0	72	138	80
15	M	69	65	2	left inguinal hernia	hernioplasty	14	120	86	150	90	110	100	68	144	76	93	100	0	65	140	77	91	100	0	66	130	74	87	100	0	56	126	72	85	100	0	56	123	70	85	100	0	56	149	85	91	100	0	56	134	73
16	M	67	63	2	right inguinal hernia	hernioplasty	14	90	80	126	80	95	100	97	148	92	108	100	0	95	139	88	104	100	1	93	141	89	106	100	0	93	141	89	106	100	0	92	141	89	106	100	0	92	141	92	108	100	0	92	142	88
17	M	63	75	2	right inguinal hernia	hernioplasty	15	50	88	126	84	98	100	73	134	97	110	100	0	73	115	74	87	100	0	73	100	75	83	100	0	71	100	75	83	100	0	67	100	66	77	100	0	60	104	78	87	100	0	61	116	91
18	M	63	70	2	right inguinal hernia	hernioplasty	15	75	90	130	80	97	100	61	140	77	91	100	0	65	130	74	87	100	0	66	126	72	85	100	0	56	123	70	83	100	0	56	149	85	91	100	0	56	134	73	84	100	0	57	141	103
19	M	68	70	2	left inguinal hernia	hernioplasty	20	90	78	120	80	93	100	58	131	88	102	100	0	58	129	90	104	100	0	61	131	92	105	100	0	61	134	92	106	100	0	62	135	93	106	100	0	65	137	92	107	100	0	64	133	98
20	M	65	75	2	right inguinal hernia	hernioplasty	15	75	80	110	70	93	100	92	131	96	108	99	2	83	135	97	116	99	2	85	132	86	101	100	1	85	132	86	101	100	1	86	132	84	100	100	1	86	131	86	101	100	0	85	131	85
21	M	72	59	2	right inguinal hernia	hernioplasty	14	90	65	120	80	93	100	60	145	74	98	98	2	87	130	79	96	98	2	87	134	94	107	100	1	81	138	89	105	100	1	77	148	106	120	100	0	77	131	75	94	100	0	78	136	84
22	M	73	86	3	right inguinal hernia	hernioplasty	18	75	60	120	80	93	100	72	119	79	92	199	0	65	119	71	87	100	1	68	112	70	84	65	0	67	112	66	81	62	0	66	113	73	86	60	0	67	112	66	81	62	0	61	16	73
23	M	60	70	2	right inguinal hernia	hernioplasty	18	75	72	140	90	107	100	68	122	88	999	100	2	64	121	85	97	100	2	64	128	90	103	100	1	66	129	89	102	100	1	63	120	85	97	100	1	63	123	85	98	100	2	63	121	84
24	M	69	65	2	left inguinal hernia	hernioplasty	12	60	88	140	90	107	100	84	120	60	80	99	1	82	121	93	102	89	0	82	118	70	86	99	0	83	111	82	91	100	0	80	115	71	85	100	0	80	114	76	88	100	0	79	106	64
25	M	67	72	3	right inguinal hernia	hernioplasty	17	90	72	130	90	103	100	53	143	88	106	100	2	55	146	89	108	100	0	57	138	88	105	100	0	57	138	86	103	100	1	52	133	57	105	99	2	52	133	57	103	99	2	60	134	87
26	M	64	56	2	right inguinal hernia	hernioplasty	12	75	92	130	60	83	100	93	124	83	96	99	0	91	126	83	96	99	0	88	125	96	104	99	1	99	125	82	96	98	1	84	135	92	106	99	2	80	118	71	85	99	2	77	117	82
27	M	60	68	2	left inguinal hernia	hernioplasty	20	90	70	120	90	103	100	66	135	81	99	99	1	70	130	85	100	99	1	67	130	84	99	99	0	72	125	74	91	98	0	69	125	76	92	99	2	77	121	63	82	100	1	80	136	59
28	M	74	60	2	left inguinal hernia	hernioplasty	15	90	68	110	70	83	100	60	119	80	89	100	0	62	109	80	86	100	0	59	105	71	82	100	0	60	119	80	89	100	0	62	109	80	86	100	0	59	105	71	82	100	0	71	115	75
29	M	60	66	2	left inguinal hernia	hernioplasty	15	60	80	120	60	80	100	60	130	82	98	100	0	61	128	82	97	100	0	64	125	82	96	100	0	61	124	67	86	100	0	65	123	73	90	100	0	56	126	87	100	100	0	58	118	80
30	M	64	60	2	left inguinal hernia	hernioplasty	14	60	62	120	80	93	100	64	135	97	103	100	0	60	116	73	87	100	0	56	122	76	91	100	0	57	117	79	92	98	0	56	126	87	100	99	0	56	130	85	100	100	0	53	118	80

			Vitals at 50 Min.						Vitals at 60 Min.						Vitals at 75 Min.						Vitals at 90 Min.						Vitals at 105 Min.						Vitals at 120 Min.						Rescue analgesia
MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	time of administration of rescue analgesia (hr) VAS>/=4
95	99	0	72	117	60	79	99	0	69	115	70	85	99	0																									8
104	100	0	90	133	93	106	100	0	87	131	92	105	100	0	83	134	90	105	100	0																			7
97	100	0	79	130	80	97	100	0	80	132	78	97	100	0	82	135	80	98	100	0																			5
90	100	0	74	121	75	90	100	0	74	122	75	91	100	0	68	120	80	92	100	0	68	121	78	93	100	0													6
93	96	0	85	115	82	93	96	0	90	110	76	87	98	0																									8
92	100	0	76	132	76	95	100	0	72	140	67	91	100	0	75	140	67	91	100	0	76	148	67	94	199	0													8
84	100	0	57	124	81	92	100	0	57	140	76	90	100	0	57	131	81	68	100	0	58	129	68	82	100	0	58	134	73	84	100	0	57	123	70	83	100	0	8
103	100	1	86	136	100	113	100	0	82	128	76	93	100	0																									4
80	100	0	63	114	63	80	100	0	64	110	60	77	100	0	62	114	60	77	100	0	60	116	65	82	100	0													6
93	100	0	78	149	70	96	100	0	78	145	68	94	100	0																									9
73	97	0	72	115	60	78	98	0	70	110	70	80	99	0																									7
86	96	0	76	115	80	92	98	0	75	120	90	100	97	0																									7
107	100	0	72	142	85	104	100	0	77	141	82	102	100	0	72	141	80	100	100	0																			6
99	100	0	72	142	82	107	100	0	78	141	85	104	100	0	80	138	80	99	100	0	80	136	70	92	100	0													7
84	100	0	57	124	81	92	100	0	57	124	81	92	100	0	57	140	76	90	100	0	57	131	81	68	100	0	58	129	68	82	100	0	57	123	70	83	100	0	8
106	100	0	95	141	89	106	100	0	93	141	92	108	100	0	92	142	88	106	100	0	92	141	92	108	100	0													10
101	100	0	66	116	91	101	100	0																															5
116	100	0	58	140	76	90	100	0	57	131	81	91	100	0																									12
109	100	1	63	134	95	107	100	0	64	140	93	108	100	0	68	138	96	109	100	0	69	135	95	108	100	1													10
100	99	0	77	112	76	88	99	0	77	113	76	88	99	0	73	111	76	86	99	0																			5
101	98	1	86	135	97	110	100	1	91	131	96	108	98	0	88	138	84	102	998	0	82	137	82	100	98	0													7
87	100	0	63	117	74	88	100	0	65	116	62	80	100	0	67	119	73	88	100	0																			7
96	100	1	62	115	86	96	100	0	61	126	84	98	100	0	60	119	83	95	100	0																			8
78	100	0	78	108	73	84	100	0	78	100	65	75	100	0																									9
103	99	0	60	134	87	103	99	0	61	133	86	102	100	0	61	135	86	99	100	0	57	129	94	103	100	0													7
92	99	1	82	126	83	96	98	0	84	125	82	96	100	0	82	126	83	96	100	0																			6
85	100	1	67	123	57	79	100	0	65	128	76	93	100	0	64	130	75	93	100	0	59	126	76	93	100	0													9
88	100	0	69	117	80	92	100	0	73	114	78	87	100	0	74	111	79	88	100	0	61	116	77	90	100	0													5.5
93	100	0	63	120	81	93	100	0	60	129	89	102	100	0																									6
93	99	0	57	116	81	93	100	0	63	120	83	95	100	0																									7

Sl no.	Sex	Age	Weight	ASA	Diagnosis	Surgery	sensory block	motor block	duration of surgery	Preoperative Vitals					Vitals At 0 min.						Vitals at 5 min.						Vitals At 10 Min.						Vitals at 15 Min.						Vitals at 20 Min.						Vitals at 30 Min		
		(years)	(kgs.)				onset at T10(min)	onset (min)grade 3 motor blockade	min	HR (BPM)	SBP	DBP	MAP	SPO2	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP
1	M	63	73	2	left Inguinal Hernia	Hernioplasty	10	10	60	96	158	84	103	100	121	156	92	109	100	0	89	111	71	84	100	0	88	106	68	80	100	0	86	106	73	84	100	0	82	109	67	81	100	0	87	122	84
2	M	73	72	2	left Inguinal Hernia	Hernioplasty	10	15	90	65	120	80	93	100	68	144	77	93	100	0	65	140	74	91	100	0	66	130	72	87	100	0	66	130	72	87	100	0	56	126	70	85	100	0	56	149	73
3	M	65	80	2	ight inhuinal hernia	Hernioplasty	10	15	75	90	130	80	97	100	60	132	76	86	100	0	73	116	65	78	100	0	71	123	61	76	100	0	68	126	72	83	100	0	56	123	70	83	100	0	57	134	73
4	M	72	86	2	ight inhuinal hernia	Hernioplasty	15	15	105	90	130	90	103	100	70	112	88	99	100	0	61	121	85	97	100	0	67	128	90	103	100	0	66	129	89	97	100	0	68	123	85	98	100	0	66	121	84
5	M	70	85	2	left Inguinal Hernia	Hernioplasty	15	20	90	60	120	80	93	100	78	105	61	74	100	0	76	106	67	79	100	0	79	106	70	81	100	0	75	109	97	103	100	0	75	113	61	76	100	0	79	109	63
6	M	60	65	2	left Inguinal Hernia	Hernioplasty	15	20	75	60	120	80	103	100	61	112	69	81	100	0	62	114	74	87	100	0	62	110	73	86	100	0	62	116	73	86	100	0	61	116	74	86	100	0	63	119	74
7	M	61	74	2	left Inguinal Hernia	Hernioplasty	10	20	120	70	130	80	97	100	87	166	90	115	96	0	91	151	108	122	99	0	115	153	95	114	99	0	112	148	97	107	98	0	127	146	98	107	100	0	112	136	99
8	M	84	64	3	left Inguinal Hernia	Hernioplasty	8	20	50	66	120	80	93	100	77	113	72	85	98	1	55	120	71	87	100	1	58	107	79	88	100	0	58	99	62	74	100	0	50	91	58	67	100	0	56	85	58
9	M	66	70	2	ight inhuinal hernia	Hernioplasty	15	20	75	66	110	70	93	100	51	106	65	79	98	0	52	111	64	80	100	1	51	104	62	76	100	0	55	106	66	79	100	0	62	118	74	89	100	0	50	119	70
10	M	60	73	2	ight inhuinal hernia	Hernioplasty	10	20	80	84	130	90	103	100	88	170	95	118	100	0	103	150	115	124	100	0	85	111	84	92	100	0	108	162	87	109	100	0	108	160	89	108	100	0	103	151	88
11	M	60	65	2	ight inhuinal hernia	Hernioplasty	20	20	90	76	140	90	107	100	96	144	84	104	97	0	77	131	84	96	100	0	75	130	82	98	100	0	71	133	80	98	100	0	68	126	78	94	100	0	66	119	77
12	M	62	82	2	left Inguinal Hernia	Hernioplasty	10	15	97	64	120	80	93	100	64	153	87	109	100	0	65	153	86	108	100	0	73	162	87	112	100	0	68	140	78	102	100	0	70	158	80	106	100	0	81	164	91
13	M	71	70	2	left Inguinal Hernia	Hernioplasty	15	15	105	75	160	90	113	100	86	158	91	111	98	1	90	151	79	100	99	0	65	97	74	80	100	0	73	131	78	92	100	0	76	98	69	79	100	0	65	100	69
14	M	70	75	2	ight inhuinal hernia	Hernioplasty	10	10	60	72	130	80	97	100	63	119	74	87	100	2	62	116	78	88	100	1	50	109	66	79	100	0	54	107	67	69	100	0	55	110	64	75	100	0	69	117	73
15	M	75	80	2	left Inguinal Hernia	Hernioplasty	15	15	90	72	170	100	123	100	68	163	97	119	98	1	62	173	95	121	98	1	71	163	86	132	100	0	69	150	76	101	100	2	62	144	75	100	100	0	61	144	78
16	M	60	60	2	left Inguinal Hernia	Hernioplasty	10	15	75	90	130	80	97	100	61	114	91	93	98	0	65	140	77	91	100	0	66	130	74	87	100	0	56	126	70	83	100	0	56	123	85	91	100	0	56	149	73
17	M	64	70	2	left Inguinal Hernia	Hernioplasty	10	20	60	76	96	70	79	100	52	1100	55	89	100	0	54	107	65	78	100	0	53	106	71	82	100	0	53	103	65	78	100	0	54	110	67	80	100	0	54	107	68
18	M	69	58	3	left Inguinal Hernia	Hernioplasty	10	15	40	60	110	80	90	100	71	128	82	97	100	0	71	128	82	97	100	0	70	111	70	84	100	0	75	101	63	76	100	0	74	86	52	63	100	0	74	92	54
19	M	60	64	2	ight inhuinal hernia	Hernioplasty	15	20	45	60	116	80	92	100	75	101	63	76	100	0	71	128	82	97	100	0	70	111	70	84	100	0	74	86	52	63	100	0	74	92	54	67	100	0	67	115	81
20	M	60	70	2	ight inhuinal hernia	Hernioplasty	10	15	75	90	130	80	97	100	60	132	70	86	100	0	71	123	61	76	100	0	68	126	72	85	100	0	56	123	70	83	100	0	57	134	70	84	100	0	57	124	81
21	M	70	75	3	left Inguinal Hernia	Hernioplasty	18	22	75	76	170	110	130	100	73	105	68	80	98	2	81	106	67	80	98	1	75	103	66	78	99	1	75	99	64	76	100	1	67	107	64	76	100	0	64	104	64
22	M	66	65	2	left Inguinal Hernia	Hernioplasty	10	15	75	66	126	80	95	100	92	110	68	82	100	0	83	109	69	82	100	0	83	117	85	82	100	0	81	104	67	79	100	0	71	98	61	73	98	0	64	120	72
23	M	63	70	2	left Inguinal Hernia	Hernioplasty	20	20	60	88	126	84	98	100	66	116	91	101	100	0	61	104	78	87	100	0	60	100	66	77	100	0	67	100	75	83	100	0	71	134	97	110	100	0	73	116	91
24	M	64	75	2	left Inguinal Hernia	Hernioplasty	15	15	75	80	140	90	107	100	59	108	66	79	100	0	56	109	68	81	100	0	58	111	67	80	100	0	59	106	70	81	100	0	58	106	66	80	100	0	58	106	66
25	M	71	60	2	ight inhuinal hernia	Hernioplasty	15	15	90	88	120	70	87	100	70	130	77	95	100	0	69	119	81	94	100	0	70	130	82	98	100	0	69	127	79	95	100	0	69	129	79	96	100	0	69	120	77
26	M	67	85	2	left Inguinal Hernia	Hernioplasty	15	15	75	72	110	70	93	100	76	117	70	83	100	0	74	111	68	81	100	0	76	114	69	82	100	0	77	114	71	84	100	0	82	125	104	112	100	0	80	113	65
27	M	77	80	2	left Inguinal Hernia	Hernioplasty	10	10	90	80	160	90	113	100	70	130	77	95	100	0	69	119	81	94	100	0	70	130	82	98	100	0	69	114	76	89	100	0	77	121	81	94	100	0	75	123	79
28	M	60	60	2	ight inhuinal hernia	Hernioplasty	10	15	75	72	120	80	93	100	60	132	70	86	100	0	73	116	65	78	100	0	68	126	72	85	100	0	56	123	70	83	100	0	57	134	75	84	100	0	58	129	68
29	M	60	87	2	left Inguinal Hernia	Hernioplasty	10	15	75	66	135	81	99	100	67	130	84	99	100	0	69	126	76	92	100	0	65	109	68	82	100	0	67	108	73	81	100	0	68	131	105	111	100	0	64	125	98
30	M	77	75	3	ight inhuinal hernia	Hernioplasty	3	5	60	80	130	90	103	100	72	113	61	76	100	0	67	109	97	103	100	0	65	106	67	79	100	0	63	113	65	78	100	0	66	114	71	84	100	0	700	114	69

Vitals at 30 Min.			Vitals at 40 Min.						Vitals at 50 Min.						Vitals at 60 Min.						Vitals at 75 Min.						Vitals at 90 Min.						Vitals at 105 Min.						Vitals at 120 Min.						Rescue analgesia
MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	HR (BPM)	SBP	DBP	MAP	SpO2	CPOT SCORE	time of administration of rescue analgesia (hr) VAS>/=4
97	100	0	86	117	68	83	100	0	84	119	80	89	100	0	78	122	83	96	100	0																									4
91	100	0	57	134	81	84	100	0	57	128	76	92	100	0	58	140	81	90	100	0	58	131	81	91	98	0	57	129	68	82	100	0													6
84	100	0	57	124	81	92	100	0	58	129	68	82	100	0	58	129	68	82	100	0	57	140	70	90	100	0																			6
96	100	0	70	115	86	96	100	0	65	126	84	95	100	0	63	119	83	95	100	0	70	122	84	97	100	0	72	123	84	97	100	0	69	126	84	98	100								6.5
77	100	0	91	136	100	113	100	0	83	126	88	106	100	0	81	128176	93	100	100	0	85	136	85	101	100	0	88	131	86	99	100	0													4
87	100	0	62	109	66	79	100	0	56	116	78	88	100	0	54	109	66	79	100	0	55	107	67	79	100	0																			4.5
105	100	0	100	130	86	101	100	0	96	127	85	99	100	0	92	125	85	98	100	0	91	125	84	98	100	0	91	125	82	95	100	0	86	121	82	95	100	0	84	121	81	94	100	0	5
67	100	0	55	98	59	72	100	0	51	115	52	77	100	0																															6
86	100	0	50	118	79	92	100	0	46	112	67	85	100	0	47	118	74	89	100	0	44	118	79	92	100	0																			5
108	100	0	99	148	90	108	100	0	97	148	92	108	100	0	95	141	89	108	100	0	92	142	88	106	100	0																			6
91	100	0	65	121	80	94	100	0	62	120	79	93	100	0	60	120	76	91	100	0	60	127	84	98	100	0	62	120	79	93	100	0													5
115	100	0	75	164	90	115	100	0	68	163	88	112	100	0	68	159	86	110	100	0	68	159	86	110	100	0	68	163	88	112	100	0	73	167	95	119	100	0	85	127	75	92	100	0	4
78	100	0	59	101	67	78	100	0	57	105	69	80	100	0	55	106	67	78	100	0	54	105	68	79	100	0	50	105	71	82	100	0	56	113	72	84	100	0							5
85	100	0	73	120	81	92	100	0	69	124	83	95	100	0	66	117	73	85	100	0																									6
98	100	0	56	143	77	99	100	0	57	144	78	100	100	0	56	147	80	102	100	0	56	143	78	102	100	0	55	144	77	98	100	0													5.5
84	100	0	57	134	81	92	100	0	58	130	74	87	100	0	57	140	77	91	100	0	57	140	77	91	100	0																			4.5
70	100	0	55	105	68	79	100	0	54	107	66	72	100	0	59	108	67	79	100	0																									5
67	100	0	67	115	81	92	100	0																																					6
92	100	0	68	121	81	94	100	0																																					4
92	100	0	58	129	68	82	100	0	58	125	72	84	100	0	57	140	76	90	100	0																									5
77	100	0	64	101	63	76	100	0	63	103	66	78	100	0	61	105	66	79	100	0	67	104	65	78	100	0																			6
88	100	0	74	113	68	83	100	0	70	108	72	84	100	0	67	120	70	87	100	0	67	109	71	84	100	0	66	113	68	83	100	0													4
101	100	0	67	104	78	87	100	0	60	100	66	74	100	0																															4.5
80	100	0	58	107	67	79	100	0	59	112	67	81	100	0	60	110	71	84	100	0	69	112	72	84	100	0																			5
91	100	0	71	124	81	95	100	0	68	117	97	90	100	0	73	114	76	89	100	0	77	121	81	94	100	0	75	123	79	94	100	0													6
75	100	0	78	103	61	79	100	0	76	106	70	81	100	0	79	106	70	81	100	0	75	109	97	103	100	0																			5
94	100	0	80	123	78	93	100	0	77	117	75	89	100	0	75	116	70	85	100	0	75	111	72	85	100	0	67	127	76	93	100	0													5.5
82	100	0	58	129	68	82	100	0	58	125	72	84	100	0	57	140	76	90	100	0																									6
104	100	0	62	133	96	104	100	0	59	109	86	91	100	0	60	111	81	87	100	0	62	105	78	84	100	0																			7
82	100	0	72	111	68	81	100	0	70	117	70	83	100	0	72	125	104	112	100	0																									6