A PROSPECTIVE RANDOMIZED CONTROLLED TRIAL TO STUDY THE ADVANTAGE OF IMPLEMENTATION OF ENHANCED RECOVERY AFTER SURGERY (ERAS) IN ACUTE PAIN MANAGEMENT DURING ELECTIVE CAESAREAN DELIVERY.

by

Dr. SANKARNARAYANAN R

Dissertation Submitted to

B.L.D.E (DEEMED TO BE UNIVERSITY)
SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE
VIJAYAPURA, KARNATAKA

In partial fulfillment of the requirements for the degree of

DOCTOR OF MEDICINE
IN
ANESTHESIOLOGY
Under the guidance of

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2025

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With sincere gratitude,

DR. SANKARNARAYANAN R

ABBREVIATIONS:

ASA - American society of anesthesiologists

CSE – Combined spinal epidural

ERAS – Enhanced recovery after surgery

VAS – Visual analogue scale

ERAC - Enhanced Recovery After Cesarean

WMD – weighted mean difference

SMD – standardized mean difference

CI – confidence interval

RR – relative risks

P – probability

MD – mean difference

CD – cesarean delivery

NPO – nil per os

CDC – centers for disease control and prevention

PDS - polydioxanone

HT – Hydroxytryptamine

NSAIDS – non steroidal anti inflammatory drugs

CSF – cerebrospinal fluid

SDB – subdural nerve block

C – cervical
L – lumbar
S – sacral

T – thoracic

ml - millilitre

mcg – microgram

cm - centimeter

LA – local anesthetics

TNS – transient neurologic symptoms

LL – lower limb

THA – total hip arthroplasty

TKA – total knee arthroplasty

ORIF – open reduction and internal fixation

TURP – transurethral resection of prostate

GTN – glyceryl trinitrate

SVR – systemic vascular resistance

HR – heart rate

BJR – bezold jarisch reflex

ECG – electrocardiogram

BMI – body mass index

IONV – intraoperative nausea and vomiting

PONV – postoperative nausea and vomiting

MAP – mean arterial pressure

PDPH – post dural puncture headache

TAP – transversus abdominis plane

USG - ultrasonogram

EOM – external oblique muscle

IOM – internal oblique muscle

TAM – transversus abdominis muscle

RAM – rectus abdominis muscle

CM – costal marigin

SPO2 – peripheral oxygen saturation

CNS – central nervous system

CYP – cytochrome P450

h - hour

EP – ERAS protocol

RP – routine protocol

iv - intravenous

P/O – per oral

NMIW – niscomed infusion warmer

ABSTRACT

BACKGROUND AND AIMS:

Indeed, giving birth to a child represents a profound joy for woman. But for those mothers whose choose to deliver by Cesarean section either by choice or maternal and fetal conditions, the happiness is short-lived due to various reasons. Post operative pain, sedation, other complications such as Shivering, nausea and vomiting prevents the mother from actively engaging with the newborn to hold, to feed which is not only a concern for the mother, but is also detrimental for the well-being of new born.

To address these short comings associated with following traditional routine protocols in cesarean delivery, we decided to study the adaptation of Enhanced Recovery After Elective Cesarean section.

The study aims to evaluate the impact of an Enhanced Recovery After Surgery (ERAS) protocol on the postoperative outcomes of patients undergoing elective cesarean delivery.

METHODOLOGY:

After the fulfillment of the inclusion criteria, patients were explained about the study and enrolled into the study after obtaining the written informed consent.

Randomized into group EP or RP.

Patients underwent thorough Pre-anaesthetic evaluation with detailed

history, airway examination, systemic examination. Patient was explained

about the protocols and sensitized about Visual analogue scale.

Routine blood investigations were done.

Patients randomized into group EP were encouraged to drink clear liquids two hours before surgery, whereas patients in group RP were kept nil by mouth for 6 hours.

In preoperative holding area, patient details were checked, and a 20G iv cannula was secured. Before shifting the patient to operating room, the forced air warmers, fluid warmers and ultrasound machines were kept ready.

Patients were monitored with ASA standards for intraoperative monitoring.

Before positioning the patient for subarachnoid block, a bolus dose of Phenylephrine 100 mcg was given. Fluid warmers and forced air warmers were turned on. Ath the end of the surgery, bilateral Tap were given using ultrasound guidance.

All the patients were followed up un till the time of discharge.

Results:

Among the 50 patients in each group, 5 patients in Group EP and 17 patients in Group RP had experienced shivering during intraoperative period. There is a significant decrease in intraoperative shivering in group EP ($p<0.005$).

In Group EP, 10 patients out of total 50 patients had hypotension intraoperatively. In Group RP, 32 patients out of total 50 patients had Hypotension intraoperatively. The patients in Group RP had higher incidence of intraoperative Hypotension compared to Group EP.

Postoperative pain was evaluated in patients 24 hours post-surgery at rest using the Visual Analog Scale (VAS). The mean VAS score in Group EP (1.76 ± 0.8221, $P<0.005$) was significantly lower than that in Group RP (2.96 ± 0.9467, $P<0.005$).

Postoperative pain was evaluated in patients 24 hours post-surgery at motion using the Visual Analog Scale (VAS). The mean VAS score in Group EP (2.46 ± 0.8134, $P<0.005$) was significantly lower than that in Group RP (3.78 ± 0.8873, $P<0.005$).

The number of patients required opioids at 24 hours in Group EP and Group RP was 2(4%) and 25 (50%) respectively. The number of patients required opioids in Group EP is significantly lower than that in Group RP with a P value less than 0.005.

The Satisfaction VAS in Group EP (6.18 ± 0.8965) is significantly higher than that of in Group Rp (4.76 ± 0.6247) with a P value lesser than 0.005.

The total length of stay (days) in hospital in Group EP (3.76 ± 0.7969) is significantly lower than that of in Group RP (4.68 ± 0.7126) with a P value of lesser than 0.005.

The postoperative length of stay (Days) in hospital in Group EP (3.04 ± 0.7273) is significantly lower than that of in Group RP (3.94 ± 0.7117) with a P value lesser than 0.005.

CONCLUSION

The adaptation of Enhanced Recovery After Cesarean section protocol for perioperative care in elective cesarean delivery, showed better outcomes with maternal pain management, reduced intraoperative complications such as Hypotension and shivering, reduced opioid consumption, early mobilization, reduced length of stay and significantly better satisfaction among the patients. Thus, ERAS protocol can be continued to be a part of standard management for individuals undergoing cesarean delivery at our institution.

KEYWORDS: Bilateral Transversus Abdominis Plane block, enhanced recovery after surgery (ERAS), Cesarean Delivery, postoperative analgesia, recovery, PONV, Intraoperative warming, fluid warming, Granisetron.

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INTRODUCTION

Cesarean section has been integral to human culture since antiquity, with narratives from both Western and non-Western societies documenting cases of the surgery yielding live mothers and healthy progeny. In Greek mythology, Apollo is described as having extracted Asclepius, the progenitor of a distinguished religious medicine cult, from his mother's womb. Numerous ancient manuscripts and traditions from Hindu, Egyptian, Greek, Roman, and other European cultures allude to cesarean sections. Moreover, ancient Chinese drawings depict the surgery being conducted on seemingly living ladies. The Mishnah and Talmud tackled inheritance issues, forbidding primogeniture for twins born through a cesarean delivery and excluding mothers who had surgery from specific purifying procedures.

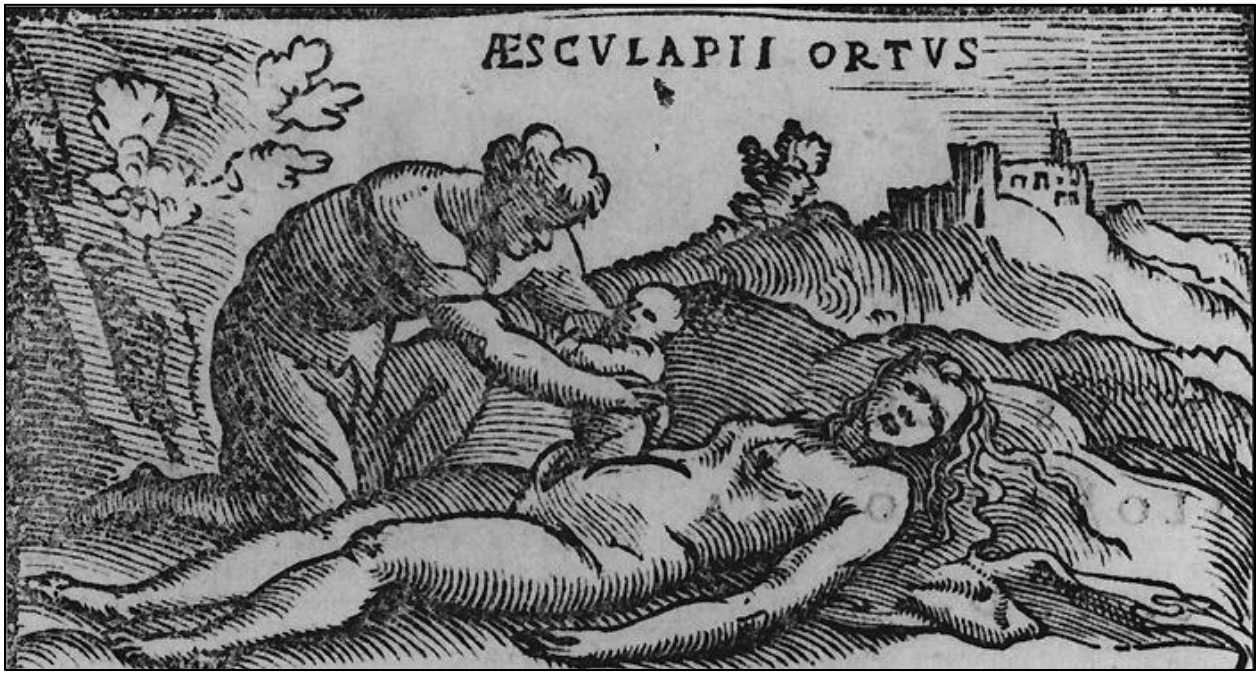


FIGURE 1: The removal of Asclepius from the abdomen of his mother, Coronis, by his father, Apollo.

The history of the cesarean section is often clouded by myths and its true origins are hard to confirm. The origin of the term “cesarean” has been widely misunderstood over time. It is commonly believed to be linked to the birth of Julius Caesar, but this idea is questionable, as his mother, Aurelia, is said to have survived long enough to hear about her son’s invasion of Britain. At that time, the procedure was typically only performed when the mother had died or was near death, with the goal of saving the baby to increase the population. Under Roman law, during Caesar's reign, the surgery was mandated for women in life-threatening childbirth situations, thus associating the term “cesarean” with this surgical method.

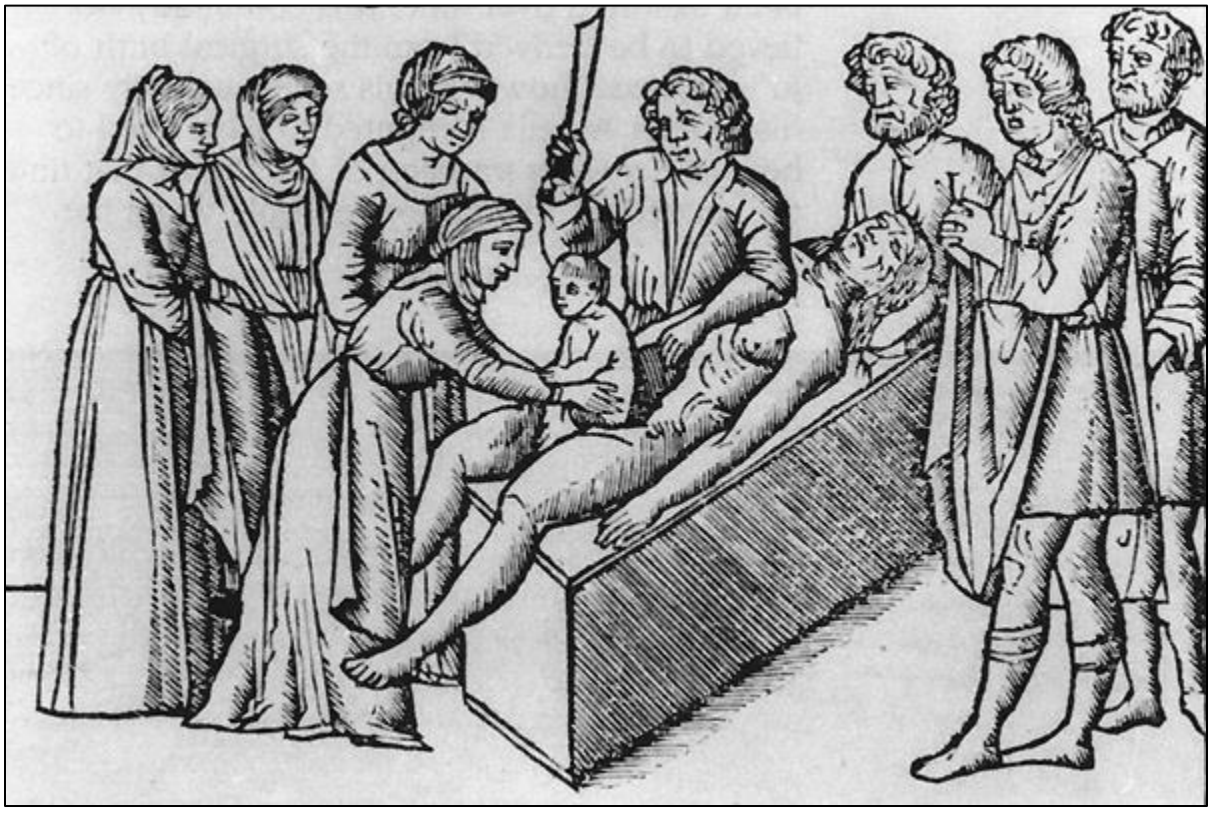


FIGURE 2: This is one of the first printed depictions of a cesarean section, allegedly showing the birth of Julius Caesar.

Alternative Latin origins of the phrase may encompass the verb “caedare,” signifying “to cut,” and “caesones,” a designation for newborns delivered via postmortem procedures. The precise origin of the name “cesarean” remains

ambiguous. Until the 16th and 17th centuries, the procedure was referred to as the "cesarean operation." However, the terminology began to shift after Jacques Guillimeau's 1598 midwifery treatise, where he introduced the term "section." As a result, "section" gradually replaced "operation" in common usage.

Initial reports indicated intermittent heroic endeavors to preserve women's lives during parturition. Despite the perception of the Middle Ages as an era of scientific and medical stagnation, many narratives regarding cesarean sections offered optimism for the eventual successful execution of the technique. The earliest documented instance of a woman and infant surviving a cesarean section originates from Switzerland in 1500. In this instance, Jacob Nufer, a swine castrator, performed surgery on his wife following her prolonged labor and the aid of thirteen midwives. When she could not give birth, her anxious husband sought and received authorization from the local authorities to conduct a cesarean section.

FIGURE 3: A cesarean section performed on a living woman.

The mother is said to have given birth to five children, including twins, with one of the babies delivered via cesarean section living to 77 years old. Historians question the reliability of this account, as it was recorded only 82 years after the event. Similar doubts arise concerning other early reports of abdominal deliveries, such as those performed by women on themselves, or births caused by attacks from horned livestock, which resulted in the peritoneal cavity being torn open.

Through his work in animal husbandry, Nufer developed a basic understanding of anatomy. A crucial step in performing any medical procedure is to understand the organs and tissues involved, a knowledge that was not easily accessible until the modern era. During the sixteenth and seventeenth centuries, as the Renaissance thrived, numerous works were published detailing human anatomy

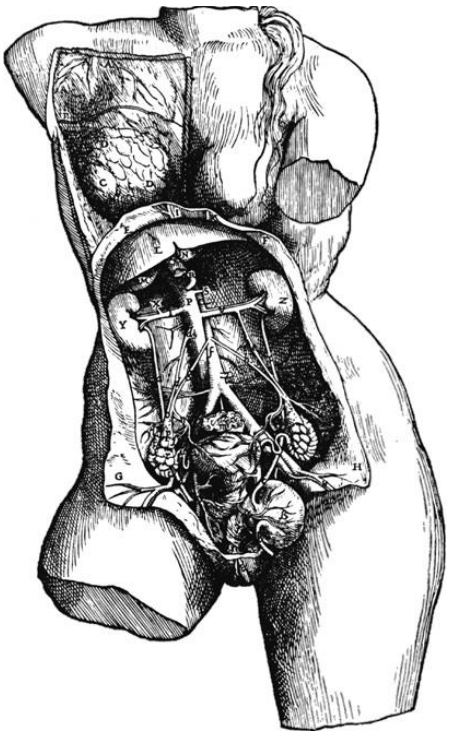


Figure 4: The female pelvic anatomy in early 16th century.

In the eighteenth and early nineteenth centuries, anatomists and surgeons greatly expanded their knowledge of both normal and pathological anatomy. By the late 1800s, increased access to human cadavers and advancements in medical education enabled students to study anatomy through hands-on dissection. This practical experience deepened their understanding and better prepared them to perform surgical procedures.

The status of women in any society reflects the progress of that civilization, and their treatment during childbirth is one of the best indicators of this.[2] Haggard wrote in 1929 that Western civilization took a major step forward on January 19, 1847, when James Young Simpson used diethyl ether to anesthetize a woman with a malformed pelvis during childbirth.

This initial use of a modern anesthetic for childbirth took place only three months after Morton's pioneering demonstration of ether's anesthetic effects at Massachusetts General Hospital in Boston.

Figure 5a: Ether demonstration.[3]

Curiously, Simpson's innovation faced harsh criticism from contemporary obstetricians, who doubted its safety, as well as from various segments of the public, who questioned its practicality.

The debate over these issues lasted more than 5 years and influenced the future of obstetric anaesthesia.[4]

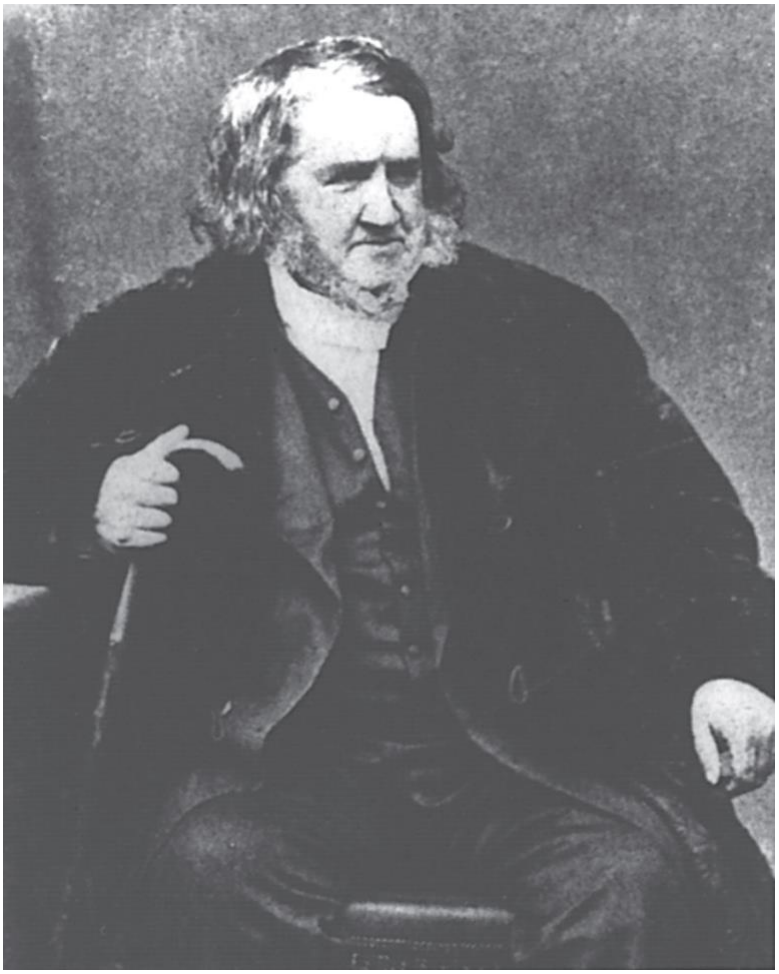


Figure 5b: James Young Simpson

James Young Simpson was an obstetrician who pioneered the use of modern anesthetics during childbirth and discovered chloroform's anesthetic properties. He is widely considered one of the most influential and renowned physicians of his era.

Shortly after Simpson exhibited the first ever anesthesia foe delivery, he wrote, “It will be necessary to ascertain anesthesia’s precise effect, both upon the action of the uterus and on the assistant abdominal muscles; its influence, if any, upon the child; whether it has a tendency to hemorrhage or other complications.”[5] In this

statement, he highlighted the issues that would be of most concern to the obstetricians who followed him, thereby influencing the future development of the specialty.

Simpson's most vocal, determined, and convincing critic was Charles D. Meigs. (Figure. 6).

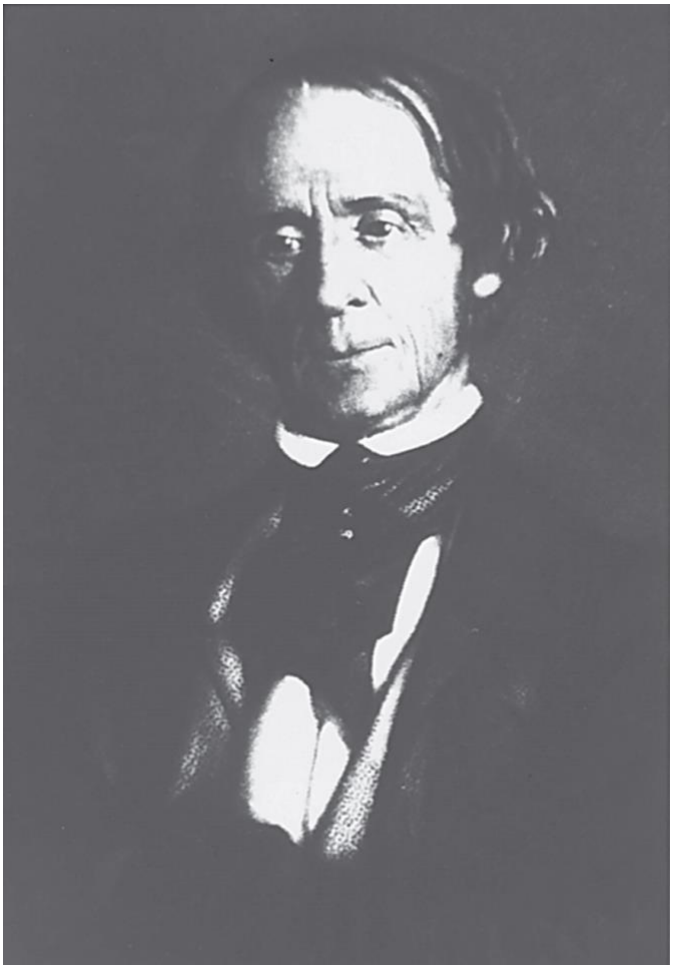


Figure 6: Charles D. Meigs

He was an American obstetrician who opposed the use of anesthesia during childbirth, raising concerns about its safety and arguing that there was no demonstrated necessity for it in routine deliveries.

Thomas Wakley, the irascible founding editor of *The Lancet,* was particularly incensed. He “could not imagine that anyone had incurred the awful responsibility of advising the administration of chloroform to her Majesty during a perfectly natural labour with a seventh child.”[6] To avoid a public confrontation, they initially denied that the Queen had received any anaesthetic. It wasn’t until four

years later, when the Queen gave birth to her ninth and final child, Princess Beatrice, that they acknowledged the use of a royal anaesthetic. However, by that time, the issue had lost its controversy.[6]

The perception of disease and pain shifted for many individuals as they began to see these experiences not as theological issues but as biological processes that could be studied and controlled through new scientific methods and technologies. This change in perspective contributed to the advancement of modern medicine and increased public acceptance of obstetric anaesthesia.[7]

In 1847, Fanny Longfellow [8], the wife of American poet Henry Wadsworth Longfellow and the first woman in the United States to receive anesthesia for childbirth wrote: I am very sorry you all thought me so rash and naughty in trying the ether. Henry's faith gave me courage, and I had heard such a thing had succeeded abroad, where the surgeons extend this great blessing more boldly and universally than our timid doctors. This is certainly the greatest blessing of this age.[8]

The next significant advancement in obstetric anesthesia occurred around 50 years later. Dämmerschlaf, meaning "twilight sleep," was a technique developed by von Steinbüchel[9] of Graz and popularized by Gauss[10] of Freiberg. Although opium has been used in medicine since the Roman Empire, its application was limited due to the challenges of obtaining consistent results with the available crude extracts. A significant advancement in therapeutics occurred in 1809 when Sertürner, a German pharmacologist, isolated codeine and morphine from a crude poppy seed extract. However, the methods for administering these drugs at the time were still quite unsophisticated.

In 1853, the year Queen Victoria delivered her eighth child, the syringe and hollow metal needle were developed. This technical advance simplified the administration of opioids and facilitated the development of twilight sleep approximately 50 years later.[11]

In July 1900, Swiss obstetrician Oscar Kreis was the first to recognize the benefits of regional analgesia in obstetrics by applying spinal cocaine to alleviate labour pain in six women with fully dilated cervix [12].

In 1902, Hopkins performed the first cesarean delivery using spinal anesthesia in the United States. As early as 1923, the earliest reports on combined spinal-

epidural anesthetics (CSE) in surgical patients emerged, initially presented as a single-shot combined technique.[13] Between 1940 and 1950, significant improvements in maternal safety were achieved with the establishment of 24-hour obstetric anesthesia services across the United States. Early experiences with caudal anesthesia in obstetrics indicated that this technique could enhance safety for both the mother and the fetus while also providing effective relief from labor pain.[14]

The first cases of continuous lumbar epidural anesthesia were initially performed using ureteric catheters, but this was soon followed by the development of various self-assembled polyvinyl tubing options. In 1962, Lee[15] introduced the first catheter with a closed tip and a lateral hole, designed to minimize trauma during insertion[16]. This catheter was further refined by adding more holes, which was later found to enhance the reliability of epidural block spreads in parturients.

Over the last two decades, the number of deaths related to neuraxial anaesthesia caused by local anaesthetic toxicity during cesarean deliveries has significantly decreased, thanks to the routine use of test doses and incremental injections [17]. In contrast, anesthesia-related deaths during general anesthesia have not decreased in the same period, making fatal outcomes 16.7 times more likely with general anesthesia. This higher mortality rate has led to regional anesthesia being the preferred method today.

AIMS AND OBJECTIVES OF THE STUDY

AIM:

The study aims to evaluate the impact of an Enhanced Recovery After Surgery (ERAS) protocol on the postoperative outcomes of patients undergoing elective cesarean delivery.

OBJECTIVES:

PRIMARY OBJECTIVE

1. Postoperative pain intensity, as measured using the Visual Analog Scale (VAS) scores.

2. Decrease in opioid requirement and its associated adverse effects.

SECONDARY OBJECTIVE

1. Perioperative discomfort.

2. Satisfaction score.

3. Length of stay.

4. Hospitalization cost.

REVIEW OF LITERATURE

AGNALDO LOPES DA SILVA FILHO et al. [18] (2018) Adopting the Enhanced Recovery After Surgery (ERAS) program represents a major change in how surgical patients are managed perioperatively. The program utilizes a multidisciplinary strategy based on scientific research and has been shown to be clinically effective, improving patient outcomes while ensuring safe, high-quality, and cost-efficient care. As a result, the ERAS program should be established as the standard approach for all women undergoing elective gynecologic surgeries.[18]

SUNANDA GUPTA et al.[19] (2022) The implementation of Enhanced Recovery After Caesarean (ERAC), which is an evidence-based, multidisciplinary approach throughout the preoperative, intraoperative, and postoperative periods, leads to a significant reduction in hospital stay duration, improved postoperative pain relief, and decreased opioid requirements for cesarean deliveries. Our data support the introduction of certain ERAC protocols for obstetric patients, resulting in positive outcomes. However, challenges do exist in fully implementing the complete ERAC protocol.[19]

EMILY E FAY et al.[20] (2019) The adoption of an enhanced recovery after surgery pathway for women undergoing planned or unplanned caesarean deliveries resulted in a notable reduction in postoperative length of stay and substantial direct cost savings per patient, without an increase in hospital readmissions. When compared to baseline, this pathway led to a significant 7.8% decrease in postoperative length of stay, or 4.86 hours overall (P<.001), for both planned (P=.001) and unplanned (P=.002) caesarean deliveries. Additionally, total postoperative direct costs dropped by 8.4%, or $642.85 per patient (P<.001), for both planned (P<.001) and unplanned (P<.001) caesarean deliveries.[20]

XIANHUA MENG et al[21]. (2021) The available evidence indicates that the adoption of ERAS (Enhanced Recovery After Surgery) for caesarean sections (CS) significantly reduced postoperative complications, lowered postoperative pain

scores and opioid use, shortened hospital stays, and potentially reduced hospital costs, without increasing readmission rates. A total of ten studies (four RCTs and six observational studies) involving 16,391 patients were included. ERAS was associated with a reduction in length of stay (LOS) (WMD -7.47 hours, 95% CI: -8.36 to -6.59 hours, $p < 0.00001$) and a lower incidence of postoperative complications (RR: 0.50, 95% CI: 0.37 to 0.68, $p < 0.00001$). Additionally, pooled analyses showed significant reductions in postoperative pain score (WMD: -1.23, 95% CI: -1.32 to -1.15, $p < 0.00001$), opioid use (SMD: -0.46, 95% CI: -0.58 to -0.34, $p < 0.00001$), and hospital costs (SMD: -0.54, 95% CI: -0.63 to -0.45, $p < 0.00001$) in the ERAS group compared to conventional care. No significant difference was found in the readmission rate (RR: 0.86, 95% CI: 0.48 to 1.54, $p = 0.62$).[21]

LUCIANA MULLMAN et al[22]. (2020) The Enhanced Recovery approach for caesarean deliveries is associated with improved outcomes, such as reduced opioid use, shorter length of stay, and decreased costs. A total of 3,679 caesarean deliveries (both scheduled and emergent) were included in the study from January 1, 2018, to August 31, 2019. Of these, 2,171 occurred before the ERAS implementation on December 17, 2018, and 1,508 after the implementation. Prior to implementation, 84% of patients received opioids as inpatients after caesarean delivery, compared to 24% postimplementation. For patients who required opioids, the total morphine milligram equivalents also significantly decreased (median 56.5 vs 15.0, mean relative change 0.32, 95% CI 0.28–0.35). In the postimplementation period, patients had a shorter length of stay (3.2 vs 2.7 days, mean relative change 0.82, 95% CI 0.80–0.83, median 3 days in both periods), lower median direct costs by $349 (mean relative change 0.93, 95% CI 0.91–0.95), and no significant change in the 30-day readmission rate (1.4% vs 1.7%, OR 0.83, 95% CI 0.49–1.41).[22]

RAJLAXMI MUNDHRA et al.[23] (2024) The adoption of the Enhanced Recovery After Surgery (ERAS) protocol in this study demonstrated significant improvements in post-operative outcomes and reduced hospital stay durations. When applied effectively, the ERAS program facilitated faster recovery and earlier discharge, which resulted in enhanced quality of life and higher patient satisfaction, even for emergency caesarean deliveries.

In particular, the use of the enhanced recovery protocol in emergency caesarean deliveries led to shorter hospital stays for patients who met discharge criteria compared to those receiving conventional care (53.87 ± 15.02 hours vs. 73.92 ± 8.96 hours). ERAS patients tolerated early mobilization well and were able to eat on the day of surgery, aiding quicker recovery of bowel and bladder function. Notably, there were no readmissions in the ERAS group. These patients also reported lower pain scores at rest, during ambulation, and while breastfeeding, compared to those receiving conventional care.

The study found that women in the enhanced recovery group experienced faster recovery than those in the conventional care group. Specifically, they resumed normal food intake earlier (16.94 ± 5.86 hours vs. 38.59 ± 12.5 hours), ambulated sooner (8.62 ± 1.96 hours vs. 23.73 ± 4.57 hours), and had earlier catheter removal (6.07 ± 1.1 hours vs. 22.8 ± 3.01 hours). These differences were statistically significant.

Other studies have also highlighted improved functional recovery in the ERAS group. A recent Indian study by Gupta S et al., focusing on women undergoing elective caesarean sections, found that those in the ERAS group ambulated earlier compared to the standard protocol group (7.73 ± 1.80 hours vs. 63.63 ± 6.76 hours, $p < 0.0001$). Additionally, the ERAS group returned to semisolid food intake faster (7.91 ± 0.75 hours vs. 33.14 ± 4.97 hours). Impressively, 92 out of 100 women mobilized within 6 to 10 hours after surgery, and early catheter removal was achieved in 98 out of 100 women within the same time frame.

When adopted properly, the program leads to faster recovery, earlier discharge, and improved quality of life and patient satisfaction, even in emergency caesarean deliveries.[23]

SULTAN et al[24]. (2021) This meta-analysis was done to examine the effects of improved recovery after cesarean birth (ERAC) on patient outcomes. Twelve studies encompassing 17,607 individuals were analyzed, with 9,693 patients not undergoing Enhanced Recovery After Cesarean (ERAC) and 7,914 patients undergoing ERAC. The findings indicated that ERAC correlated with a decrease in the subsequent factors:

- Duration of hospital stay: Mean difference (MD) of −0.51 days (95% CI: −0.94, −0.09; $p = 0.018$; $I^2 = 99\%$).

- Time to initial mobilization: Mean Difference of −11.05 hours (95% Confidence Interval: −18.64, −3.46; p = 0.004; I^2 = 98%)[24].

- Duration till urinary catheter removal: Mean difference of −13.19 hours (95% CI: −17.59, −8.79; p < 0.001; I^2 = 97%)[24].
- Opioid consumption: Mean difference of −21.85 mg morphine equivalents (95% CI: −33.19, −10.50; p < 0.001; I^2 = 91%)[24].

No notable change was observed in maternal readmission rates (odds ratio [OR] 1.23 [95% CI: 0.96, 1.57]; p = 0.10; I^2 = 0%). Furthermore, three studies indicated cost savings linked to ERAC. The GRADE ratings for the evidence of all study outcomes were classified as poor or very low quality[24]. In conclusion, ERAC correlates with abbreviated hospitalizations, expedited mobilization, prompt urinary catheter removal, and less opioid consumption. It does not substantially affect maternal hospital readmission rates post-discharge. Additional research is required to determine which ERAC interventions to apply and which results most effectively signify ERAC efficacy.[24]

ERAS SOCIETY

INTRODUCTION AND HISTORY:

The Enhanced Recovery After Surgery (ERAS) is a care paradigm established in 1997 by a consortium of general surgeons from Northern Europe, spearheaded by Henrik Kehlet [25,26]. This strategy aims to enhance surgical patient outcomes, particularly by decreasing hospital stays, complication rates, facilitating early

recovery, and alleviating economic burdens. Merely articulating and instituting a protocol is insufficient; substantial efforts and modifications are imperative to attain the objective of providing a sustainable enhancement in the overall quality of patient care. Consequently, ERAS is not a singular and inflexible protocol but rather a methodology, a "modus operandi," representing a novel approach to multidisciplinary collaboration, characterized by a willingness to adapt as knowledge advances. This signifies a transformation in medical-scientific paradigms: we must transition from the notion of "disease management" to that of "health promotion."

A study group was established to investigate the optimal care pathway for patients following open colorectal surgeries, with a particular focus on implementing measures to reduce the frequency of postoperative ileus, thereby impacting costs and the duration of hospital stays.

The essence of this strategy was to mitigate the body's response to surgical stress by enhancing perioperative nutritional status, facilitating non-opioid analgesia, and initiating early postoperative eating [27]. The group expanded over time as colleagues from many nations and surgical specializations joined, and the initial publications indicated significant enhancements in recovery time and quality following different types of surgery.[28]

Essential elements of any ERAS protocol paradigm.

(I) A period of 1 to 2 months of abstinence is necessary to enhance pulmonary

PREOPERATIVE PHASE	INTRAOPERATIVE PHASE	POSTOPERATIVE PHASE
Preadmission counseling	Prophylactic antibiotic administration	Pain management with reduced opioid use (VI)
Assessment and correction of organ impairment	Preferably regional anesthesia techniques (IV)	Balanced fluids with restricted IV therapy
Four weeks of alcohol abstinence	Balanced fluid administration	Post-operative PONV and thromboembolic prophylaxis
Reduction of smoking among abusers (I)	Minimally invasive surgery (V)	Prevention of hypoxemia and hypothermia
Nutritional assistance lasting 7 to 10 days	Reduced duration of surgical drains	Expedited removal of drains, tubes and catheters
Micronutrient Supplementation (II)	Reduced duration of nasogastric tubes	Early ambulation and oral nutritional support
Decreased fasting and use of sugary beverages	Reduced duration of urinary catheters	Do not disrupt the ongoing preoperative treatment.
Patient education regarding the postoperative care plan (III)	Maintaining normothermia	Post-discharge care follow-up

function; (II) this supplementation is designated for patients exhibiting significant

deficiencies in micronutrients, vitamins, and minerals; (III) patient education may facilitate coping mechanisms and mitigate anxiety, thereby improving postsurgical recovery; (IV) suitable regional anesthesia techniques that minimize opioid usage are essential for achieving analgesia and alleviating stress-induced organ dysfunction during the postoperative phase; (V) minimally invasive surgery is imperative for facilitating “fast track” surgery, resulting in reduced hospital stay and convalescence; (VI) it is advisable to avoid opioids and promote adjunctive multimodal non-narcotic analgesic strategies. Enhanced Recovery After Surgery (ERAS).

ENHANCED RECOVERY AFTER SURGERY CESAREAN DELIVERY [61]

The American Journal of Obstetrics & Gynecology released a three-part recommendation on Enhanced Recovery After Surgery for Cesarean Delivery (ERAS CD). This ERAS Society Guideline was designed to aid the most common surgical procedure in industrialized healthcare, the cesarean section. The purpose of this ERAS cesarean delivery guideline is to enhance the quality and safety of cesarean births, consequently improving mother and fetal/neonatal outcomes through evaluation and review.[61]

The detailed ERAS cesarean delivery components and guidelines (Parts 1-3) outline the surgical delivery process into a "focused" pathway beginning 30-60 minutes before the skin incision for both elective and emergency cesarean deliveries, continuing until hospital discharge, as well as a broader "optimized" pathway that encompasses antenatal education, maternal comorbidities, and immediate neonatal needs post-delivery.[61]

PART 1	Guidelines for Antenatal and Preoperative care in Cesarean Delivery: Enhanced Recovery After Surgery Society Recommendations.[61]
PART 2	Guidelines for intraoperative care in cesarean delivery: Enhanced Recovery After Surgery Society Recommendations.[62]
PART 3	Guidelines for postoperative care in cesarean delivery: Enhanced Recovery After Surgery (ERAS) Society Recommendations.[105]

Table 2: Parts of ERAS cesarean delivery guidelines.[61]

Antenatal and preoperative ERAS CD (Part 1)

The cesarean delivery pathway and its process aspects encompass a broader range of maternal prenatal and preoperative care, and can be integrated within the ERAS CD pathways. The preoperative pathway is a targeted protocol commencing 30-60 minutes prior to the cesarean incision and concluding at maternal (fetal) discharge from the hospital, facilitating a more uniform and generalizable Enhanced Recovery After Surgery (ERAS) Cesarean Delivery (CD) process that provides identical comprehensive care for both unplanned and planned cesarean deliveries.[61]

ANTENATAL PATHWAY

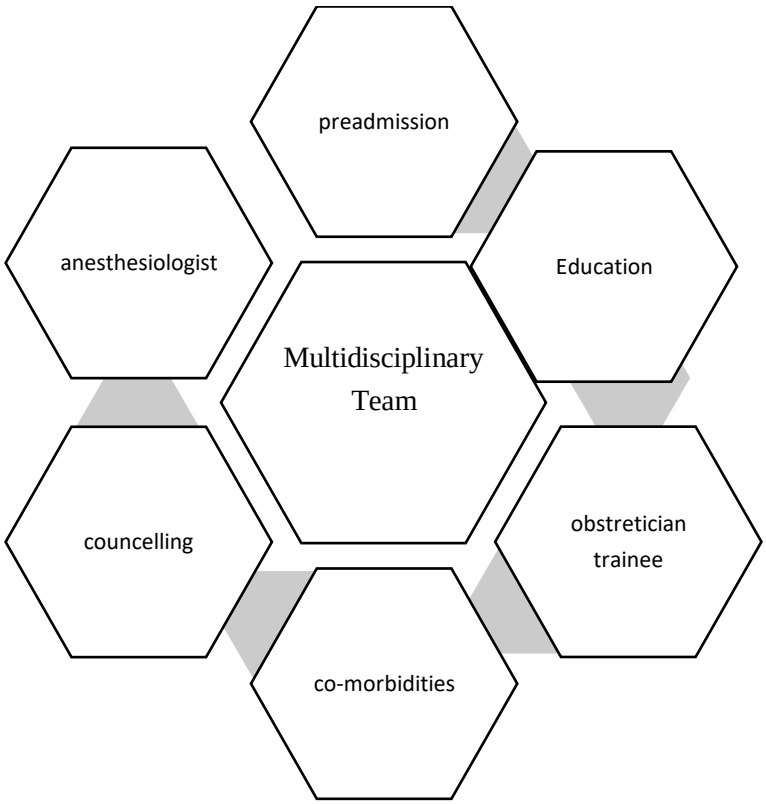


Diagram 1: Antenatal pathway

Pregnant women and their partners should be prepared for delivery, including the possibility of a vaginal or surgical delivery, as part of appropriate prenatal care. The type of procedure, the patient's acceptance or comprehension of the information, the time of the procedure, and the person who gave the information should all be included in the documentation of the preadmission information and counseling process. Furthermore, it is crucial to educate all women about the

possibility of needing a cesarean delivery as well as the hazards, advantages, and alternatives of the surgery because unplanned or emergency cesarean deliveries might happen with very little notice.[61]

Without a medical justification, a thorough preadmission assessment of the risks and advantages for the woman and her unborn child should be performed before considering a cesarean delivery. [32-35] Data regarding the heightened surgical risk of immediate complications (such as injuries to abdominal organs, postoperative infections, thrombosis, and pain) [36-39] and the established long-term consequences (including the risk of uterine rupture and placental complications in future pregnancies) [40-43] should be juxtaposed with the benefit-risk assessment of vaginal delivery during preoperative counseling.

SUMMARY AND RECOMMENDATIONS:

Despite the absence of robust evidence, sound clinical practice includes informing the patient about procedures prior to, during, and following cesarean delivery.[61] The antenatal optimization of maternal comorbidities and their influence on cesarean delivery falls outside the purview of this specific ERAS process/pathway recommendation.[61]

PREOPERATIVE PATHWAY:

The concentrated preoperative duration of 30 to 60 minutes is significantly constrained for women undergoing an unplanned cesarean delivery, while a scheduled cesarean delivery permits a more extensive antenatal/preoperative information transfer.
A checklist for the targeted ERAS CD will provide the patient and surgical team with a concise summary of the essential information required by the patient, as well as the comprehensive preoperative, intraoperative, and postoperative components of the ERAS CD Table 4-5.[61]

ERAS checklist for patient/maternal "informed knowledge."

The patient/maternal comprehends the subsequent factors clearly:	
1.	The rationale for the cesarean section
2.	The site and type of the abdominal laparotomy incision
3.	The approach employed for closing the abdominal skin incision by the attending surgeon is supported by randomized controlled trial evidence favoring subcuticular skin closure for enhanced patient satisfaction and esthetic results.[44]
4.	The preventive strategies that are used to minimize postoperative maternal infective morbidity (wound/uterus/pelvis/bladder); estimated prevalence of 3–15%.[45.46]
5.	5. The patient's estimated personalized postoperative risk evaluation for thromboembolism and the necessity for supplementary medical prophylaxis beyond typical mechanical methods (elastic stockings or sequential compression devices); The estimated prevalence is 0.5–2.2 per 1000 pregnancies, with venous thromboembolism occurring at a rate of 1–2 per 1000. Antepartum deep vein thrombosis accounts for 80% of cases, whereas pulmonary embolism [47] represents 20–25%. After delivery,[30] the incidence of pulmonary embolism varies from 40–60%.
6.	The gastrointestinal and oral intake protocols for preoperative and postoperative phases
7.	The expected postoperative activities and venues for the mother and infant.

Table 3: ERAS CD checklist.[61]

	Preoperative	Intraoperative	Postoperative

ERAS CD Elements	Pharmacological management, Fasting, Oral Carbohydrate Supplementation, Antibiotic prophylaxis, Skin preparation, vaginal sanitation to minimize infectious risk, Strategies for the prevention of intraoperative hypothermia.[61]	Pre- and intraoperative anesthetic management, Abdominal/vaginal antimicrobial cleansing, Cesarean delivery surgical techniques (opening-delivery-closure), Perioperative fluid management, Neonatal immediate care/delayed cord clamping.[61]	ERAS sham feeding/chewing gum, Nausea and vomiting management, Pain management, Perioperative nutritional care/early feeding, Glucose control, Thromboembolism prevention, Expedited mobilization, Urinary drainage management.[61]
Maternal and neonate discharge			

Table 4: ERAS CD ELEMENTS.[61]

PREOPERATIVE ANESTHETIC MEDICATIONS:

Although uncommon, aspiration pneumonitis is still a cause of maternal mortality during anesthesia for cesarean delivery even in well-resourced settings.[48] Hence methods have been adopted to reduce the risk of aspiration pneumonitis.[49] A combination of antacid sodium citrate and H2 receptor blocker is more effective than no intervention. Evidence Level: Low/Recommendation Grade: Strong

Preoperative sedation during cesarean delivery is detrimental for both maternal and neonatal wellbeing. Maternal sedation may delay the skin-to-skin contact between mother and newborn, hence should be used judiciously.[50] The administration of benzodiazepines in pregnancy has been associated with "Floppy baby syndrome," [50,51] disturbed neonatal thermogenesis and lower Apgar scores.[51]

Considering the potential side effects for both maternal as well neonatal, preoperative sedation should be avoided.[61]

Oral or mechanical bowel preparation should not be used before cesarean delivery, as it is a mere discomfort to the patient without any benefits. [52,53]

PREOPERATIVE FASTING: (focused element)

Preoperative fasting was initially introduced as a strategy to avert vomiting following the administration of ether anesthetics. Following the identification of post-operative aspiration pneumonia syndrome, it became increasingly customary to extend fasting periods from 6 hours to the normal "NPO after midnight." [54]

Women should be advised to drink clear fluids (pulp-free juice, coffee or tea without milk) 2 hours before to surgery. A lite meal can be consumed 6 hours before to surgery.

A Cochrane Review determined that shorter preoperative fasting intervals did not result in an increase in stomach content volume, a reduction in pH, or an escalation in problems.[55] The European Society of Anesthesiology Guideline advises that both adults and children be permitted to consume clear fluids until 2 hours before elective surgery, including cesarean delivery. Solid meal consumption should be restricted for 6 hours before elective surgery in both adults and children.[56] No "fasting" experiments have been conducted on cesarean delivery patients; nevertheless, two investigations reported comparable outcomes in individuals soon postpartum. [57'58]

PREOPERATIVE CARBOHYDRATE DRINK: (focused element)

Numerous trials have investigated the use of oral carbohydrate supplementation administered up to 2 hours prior to surgery. A Cochrane Review indicated that the majority of trials exhibited a significant risk of bias, with therapy correlating to a minimal reduction in length of stay (0.3 days) and a shortened duration to the passage of flatus (0.39 days). In summary, postoperative complications were

unchanged, and no instances of aspiration pneumonia were documented.[59] The practice of carbohydrate loading before to surgery is contentious and not endorsed for pregnant women with diabetes mellitus.

Oral carbohydrate drink, 2 hours prior to cesarean delivery, may be offered to nondiabetic pregnant women.[60]

The preoperative administration of carbohydrate loading in nonpregnant patients with diabetes mellitus was assessed in a prospective, noninferiority cohort study; carbohydrate loading was determined to be non-inferior to fasting, with neither group demonstrating superiority in preoperative blood glucose levels, hyperglycemia, or duration of hospitalization.[60]

INTRAOPERATIVE MANAGEMENT GUIDELINES FOR CESAREAN DELIVERY- ENHANCED RECOVERY AFTER SURGERY [62] PART 2

ANTIBIOTIC PROPHYLAXIS AND SKIN PREPARATION: (focused element)

A cesarean section incision is generally considered clean contaminated/class II if there is no rupture of membrane OR contaminated/class III if there is a rupture of membrane/chorioamnionitis prior to incision.

CDC surgical wound classification.[63]

Class I incisions will primarily be susceptible to abdominal skin flora, while class II and class III incisions are at risk from both skin flora and vaginal flora exposure. The key concerns of prophylactic antibiotics, wound preparation, and vaginal preparation are these microbiological dangers.

GRADE	DEFINITION
CLASS I/CLEAN	A non-infected operative wound characterized by the absence of inflammation, with no involvement of the respiratory, alimentary, genital, or uninfected urinary system. Moreover, clean wounds are predominantly sutured and, if required, subjected to closed drainage. Operative incisional wounds resulting from non-penetrating (blunt) trauma should be classified in this category if they fulfill the specified criteria.[63]
CLASS II/CLEAN-CONTAMINATED	A surgical wound involving the respiratory, alimentary, vaginal, or urinary tracts, created under controlled conditions and devoid of atypical contamination.[63] Operations pertaining to the biliary tract, appendix, vagina, and oropharynx are included in this category, contingent upon the absence of infection or significant breaches in sterile procedure.[63]
CLASS III/DIRTY	Accidental, exposed, fresh wounds. Furthermore, procedures involving significant breaches in sterile technique (e.g., open heart massage), substantial gastrointestinal spillage, or incisions exhibiting acute or absent purulent inflammation are encompassed under this category.[63]
CLASS IV/DIRTY-INFECTED	Old traumatic wounds with retained devitalized tissue and those that involve existing clinical infection or perforated viscera.[63] This definition suggests that the organisms causing postoperative infection were present in the operative field before the operation.[63]

Table 5: CDC surgical wound grade.[63]

In cesarean deliveries conducted prior to membrane rupture, the established standard of care involves administering a narrow-spectrum first-generation cephalosporin targeting skin flora for infection prophylaxis, although comparable advantages have been observed with alternative antibiotic protocols.[64]

Prophylactic antibiotics should be administered routinely within 60 minutes before the cesarean delivery skin incision.[64] In all women, a first-generation cephalosporin is recommended; in women in labor or with ruptured membranes, the addition of azithromycin confers additional reduction in postoperative infections (evidence level: high/recommendation grade: strong).[63,64]

WOUND AND VAGINAL PREPARATION:

Chlorhexidine-alcohol is favored over aqueous povidone-iodine solution for abdominal skin antisepsis prior to cesarean delivery [63] (evidence level: low/recommendation grade: strong). The application of povidone-iodine solution for vaginal preparation should be contemplated to diminish the risk of infections following cesarean delivery [63] (evidence level: moderate/recommendation grade: weak).

Intraoperative anesthetic management (focused elements):

Regional anesthesia enhances recovery outcomes by optimizing pain control, organ performance, mobility, postoperative nausea and vomiting, length of hospital stay, and incidence of adverse events. Regional obstetric anesthetic techniques are regarded as safer than general anesthesia, and their increased application is thought to be a contributing factor to the reduction in mother mortality rates linked to anesthesia. The results of spinal and epidural anesthesia are similar; however, spinal anesthesia exhibits a more rapid onset for effective blockade and a lower occurrence of intraoperative pain relative to epidural anesthesia. Combined spinal epidural anesthesia may facilitate a more rapid motor recovery than spinal anesthesia, while the inclusion of an epidural catheter allows for the extension or duration of an inadequate spinal block. Intrathecal morphine administration improves postoperative analgesia; nevertheless, the risk of side effects, including nausea, vomiting, and pruritus, increases with higher dosages, and the optimal dose is yet to be established.

Regional anesthesia is the preferred method of anesthesia for caesarean delivery as part of an enhanced recovery protocol.

Intraoperative Hypothermia (focused element):

Neuraxial anesthesia is the preferred method for parturients undergoing cesarean sections. Perioperative hypothermia affects 50-80% of individuals undergoing spinal anesthesia for cesarean delivery. Multiple randomized controlled trials have shown that perioperative hypothermia is associated with complications in nonpregnant persons. Complications include included surgical site infection, heart ischemia, altered drug metabolism, coagulopathy, prolonged hospitalization, shivering, compromised skin integrity, and insufficient patient satisfaction. Hypothermia as can adversely affect babies by influencing temperature, umbilical pH, and Apgar score.

SURGICAL INCISION (focused element):

The standard technique for cesarean delivery employs the Pfannenstiel skin incision, which is meticulously performed through the subcutaneous tissue, fascia, and into the parietal peritoneum. The Kerr hysterotomy is performed incisively in a transverse orientation into the uterus. A bladder flap was conventionally created to separate the bladder inferiorly from the hysterotomy; however, a recent meta-analysis does not support this procedure as routine. The uterine incision is often closed in one or two layers with a continuous unlocked suture. A two-layer closure is generally utilized because nonrandomized trial evidence suggests a higher incidence of uterine rupture in women with pregnancies following a previous cesarean delivery when hysterotomies are closed in a single layer. Historically, the visceral and parietal peritoneum were sutured; however, rigorous assessments reveal minimal evidence that outcomes, such as intraabdominal adhesions, vary or that surgical durations are shortened when the peritoneum is left open. The rectus muscles were generally sutured along the midline; however, there is no evidence to support this closure, and worries exist over the potential rupture of intramuscular sutures.

The abdominal fascia is typically closed with a continuous suture, utilizing either Polydioxanone (PDS) or Vicryl. The subcutaneous tissue, when measuring less than 2 cm in thickness, is often not reapproximated. In women with subcutaneous tissue thickness of 2 cm or greater, reapproximation with catgut or Vicryl sutures has demonstrated a reduction in wound complications.

SUMMARY OF RECOMMENDATIONS [62]:

1.	Blunt expansion of a transverse uterine hysterotomy at time of cesarean delivery is recommended to reduce surgical blood loss (evidence level: moderate/recommendation grade: weak).
2.	Closure of the hysterotomy in 2 layers may be associated with a lower rate of uterine rupture (evidence level: low/recommendation grade: weak).
3.	The peritoneum does not need to be closed because closure is not associated with improved outcomes and increases operative times (evidence level: low / recommendation grade: weak).
4.	In women with ≥2 cm of subcutaneous tissue, reapproximation of that tissue layer should be performed (evidence level: moderate/recommendation grade: weak).
5.	The skin closure should be closed with subcuticular suture in most cases, because of evidence of reduced wound separation in those whose staples were removed 4 days after surgery (evidence level: moderate/recommendation grade: weak).

Table 6: Summary of Recommendations.[62]

PERIOPERATIVE FLUID MANAGEMENT:

Ensuring perioperative euvolemia is essential for optimal outcomes after cesarean delivery. The intravascular volume affects blood pressure, cardiac output, and oxygen supply. Ensuring adequate uterine perfusion increases fetal oxygenation, minimizes acidosis, and allows nutrient supply and waste removal from the uterine myometrium. Perioperative fluid overload increases the risk of elevated cardiovascular workload and pulmonary edema in pregnant women. Excessive maternal intrapartum fluid may result in weight loss in babies within the first three days following delivery. The incidence of hypotension after spinal anesthesia is considerable and can lead to severe repercussions for both the mother and fetus. Studies suggest that a combination of vasopressors and adequate hydration therapy may successfully reduce the incidence and severity of hypotension following spinal anesthesia for cesarean delivery.

While the administration of intravenous fluids for circulatory preload is advised, a recent consensus statement and its accompanying editorial indicate that intravenous fluids alone possess limited effectiveness.

Consequently, numerous clinicians are now utilizing prophylactic phenylephrine infusions, which not only avert hypertension but also diminish the risk of fetal acidosis.

A meta-analysis and systematic review shown that goal-directed fluid therapy in patients undergoing major surgery decreased postoperative sequelae, including wound infection, gastrointestinal issues, and hypotension.[65] A subsequent meta-analysis and systematic review demonstrated that goal-directed fluid therapy markedly decreased the occurrence of surgical site infections and the duration of hospital stay following abdominal surgery.[66]

Neonate Care pathway (focused element):

In all settings performing cesarean deliveries, service readiness includes the availability of resources (equipment, personnel, and experience) and the preparedness for prompt neonatal resuscitation if required. Deferring the Clamping the umbilical cord for at least 1 minute after term birth diminishes anemia in infancy and improves neurodevelopmental outcomes.[62]

In a cesarean delivery, the newborn may be placed on the mother's abdomen or legs, or held by the surgeon or assistant adjacent to the placenta until the umbilical cord is snapped. Hypothermia is associated with increased morbidity and mortality in newborns across all gestational ages. Standards for operating room temperature (21-25°C) may maintain normothermia in both moms and newborns. Body temperature must be evaluated and regulated between 36.5°C and 37.5°C post-birth throughout admission and stabilization. Approximately 85% of term children initiate spontaneous respiration within 10 to 30 seconds after birth; an additional 10% react to drying and stimulation, while the other 5% necessitate some form of assisted ventilation. Routine airway suctioning or gastric aspiration should be avoided; secretions should be eliminated only if they restrict the airway. A similar approach is recommended if meconium is identified in the amniotic fluid. Regular suctioning of the airway or stomach aspiration should be eschewed; secretions should be removed only if they are obstructing the airway. A comparable method is advised if meconium is detected in the amniotic fluid.

Summary and recommendations.[62]	
1.	Delayed cord clamping for at least 1 minute at a term delivery is recommended (evidence level: moderate/ recommendation grade: strong).
2.	Delayed cord clamping for at least 30 seconds at a preterm delivery is recommended (evidence level: low moderate/recommendation grade: strong).
3.	Body temperature should be measured and maintained at between 36.5C and 37.5C after birth, through admission and stabilization (evidence level: low-moderate/recommendation grade: strong).
4.	Routine suctioning of the airway or gastric aspiration should be avoided and used only for symptoms of an obstructive airway (by secretions or meconium; evidence level: low/recommendation grade: strong).
5.	Routine neonatal supplementation with room air is recommended because the use of inspired air with oxygen is not recommended and may be associated with harm (evidence level: low-moderate/ recommendation grade: strong).
6.	In all settings that perform cesarean delivery, a capacity for immediate neonatal resuscitation is mandatory (evidence level: high/recommendation grade: strong).

TABLE 7: **SUMMARY AND RECOMMENDATIONS PART-2[62]**

ENHANCED RECOVERY AFTER SURGERY (ERAS) SOCIETY RECOMMENDATIONS FOR POSTOPERATIVE CARE IN CESAREAN DELIVERY-PART 3.[67]

ERAS sham feeding (chewing gum) after cesarean delivery:

Postoperative chewing gum after abdominal surgery has been assessed in numerous clinical trials and, according to a Cochrane review, seems to expedite the recovery of gastrointestinal function.[68] A distinct review of gum chewing post-cesarean delivery identified 15 clinical trials.[69] The protocols for gum chewing exhibited considerable variability across studies: start ranged from immediately post-operation to 12 hours thereafter, session durations spanned 15 to 60 minutes, and the frequency of sessions per day varied from 3 to over 6.

Prevention of Postoperative Nausea and Vomiting:

Nausea and vomiting are prevalent symptoms encountered during cesarean delivery, occurring either during the surgery if the patient is conscious or subsequently in the recovery room.[70] The total incidence of nausea and vomiting during regional anesthesia for cesarean birth ranges from 21% to 79%.[70] Maternal symptoms may extend the surgical length and elevate the risk of hemorrhage and surgical injury. Nausea and vomiting can elevate the risk of aspiration, a known contributor to maternal mortality. Nausea and vomiting diminished patient satisfaction and postponed hospital release.

Nausea and vomiting during cesarean delivery might arise from various factors. Maternal hypotension resulting from regional anesthetic is a prevalent cause. Various strategies are presently employed to mitigate or avert hypotension, which is expected to reduce the occurrence of nausea and vomiting. A Cochrane review encompassing 75 studies and 4,624 women who underwent spinal anesthesia for cesarean delivery demonstrated that colloid or crystalloid preloading, intravenous administration of ephedrine or phenylephrine, and lower limb compression (via bandages, stockings, or inflatable boots) mitigated the occurrence of hypotension associated with spinal anesthesia.[71]

Prophylactic antiemetic medicines administered during cesarean delivery under regional anesthetic effectively prevent nausea and vomiting. A multimodal strategy

for the prevention of nausea and vomiting is rapidly establishing itself as a standard of care. A Cochrane review encompassing 41 studies and 5046 patients indicated that 5-HT3 antagonists (e.g., ondansetron, **granisetron**[72]), dopamine antagonists (e.g., metoclopramide, droperidol), and sedatives (e.g., midazolam, propofol) were efficacious in mitigating intraoperative nausea and vomiting.[71] Corticosteroids, including dexamethasone, were observed to attenuate solely intraoperative nausea and vomiting. Anticholinergic medications (e.g., scopolamine) were beneficial in mitigating postoperative nausea and vomiting. Alternative therapies (opioids, additional oxygen, intravenous fluids, acupressure/acupuncture) failed to mitigate intraoperative nausea or postoperative nausea and vomiting.

Summary and recommendations:

It is advisable to utilize multimodal postoperative analgesia, incorporating frequent NSAIDs and paracetamol, to facilitate improved recovery following cesarean birth. Moderate evidence level; high recommendation grade.[67]

POSTOPERATIVE ANALGESIA:

Inadequate postoperative pain management can adversely affect recovery following any surgical procedure. Pain might extend healing time and postpone discharge, adversely affecting rehabilitation. High pain scores during cesarean delivery may hinder early mobilization and the mother's ability to achieve independence and care for her newborn.
Multimodal analgesia is essential in postoperative pain management within an enhanced recovery protocol, leading to reduced side effects and expedited recovery.
Analgesia during cesarean delivery may be improved with various intraoperative treatments. Long-acting intrathecal opioids, such as morphine, offer analgesia for several hours post-cesarean administration, albeit with various adverse effects including nausea, vomiting, and itching.

Postoperative nutritional care:

Numerous randomized controlled trials regarding early feeding have been conducted globally over the past 15 years,[75] reflecting diverse cultural norms. Early feeding is variably described as occurring between 30 minutes and 8 hours post-cesarean birth.[76] The most extensive trial investigating early feeding randomized 1,154 patients to either conventional feeding within 18 hours or early feeding within 2 hours. The study revealed a decrease in thirst and hunger,

enhanced maternal satisfaction, increased ambulation, and reduced length of stay, with no effect on readmissions, gastrointestinal symptoms, or infections.[77] The results of this trial align with those of other studies that have shown comparable or improved satisfaction, expedited resumption of solid food intake, accelerated bowel activity recovery, and decreased hospital stay duration, without any indication of increased complication rates associated with wound healing or infection. A comprehensive review and meta-analysis of 17 research corroborated these findings.[78] A study documented greater nausea associated with the early resumption of eating; however, this was self-limiting.

Early mobilization after cesarean delivery:

Early mobilization theoretically enhances several short-term postoperative outcomes, including expedited bowel function recovery, diminished thrombosis risk, and shortened hospital stay.
No research is available to assess whether early mobilization enhances outcomes following cesarean delivery.[79]
Early mobilization is frequently included in a surgical protocol known as "fast track" or "enhanced recovery after surgery" (ERAS). These packages encompass comprehensive preoperative counseling, enhanced preoperative nutrition, superior pain management, expedited postoperative dietary resumption, and prompt mobilization. This care bundle has not been assessed in patients following cesarean delivery.

Urinary drainage after cesarean delivery:

The insertion of a urinary catheter during cesarean delivery is a commonly endorsed procedure. Bladder drainage is widely regarded as a method to quantify urine flow, mitigate urinary system damage, and diminish postoperative urinary retention.[80] Urinary tract infection is one of the most prevalent consequences following cesarean birth. Indwelling urinary catheters can elevate the occurrence of urinary tract infections, urethral discomfort, and impaired voiding. These difficulties lead to postponed ambulation, extended hospital stays, and heightened expenses.
In 2003, Ghoreishi conducted prospective research involving 270 individuals who underwent cesarean delivery. The findings demonstrated that the insertion of a

urinary catheter during cesarean birth did not enhance surgical visibility of the lower uterine region nor mitigate urinary tract harm. Patients devoid of indwelling urinary catheters exhibited a reduced mean ambulation duration and shorter hospital stay. In a nonrandomized clinical investigation involving 344 patients, Senanayake [81] shown that the incidence of postoperative urine retention following cesarean delivery was low in patients without an indwelling urinary catheter.

Summary and recommendation:

In women who do not need ongoing strict assessment of urine output, the urinary catheter should be removed immediately after cesarean delivery, if placed during surgery. (Evidence level: low; recommendation grade: strong.)

Discharge counseling:

Research on appropriate discharge counseling for women post-cesarean delivery is sparse. Active surveillance of complications following cesarean delivery indicates that surgical site infections arise in approximately 10% of patients, with over 80% occurring post-discharge.[82] This underscores the necessity for women to receive thorough information regarding the typical discharge process, signs and symptoms of infection, activity limitations, and guidance on when to seek medical assistance. The Perceived Readiness for Discharge After Birth Scale is a validated instrument that assists doctors in identifying individuals at heightened risk of post-discharge[83] complications.

FUNCTIONAL ANATOMY OF SPINAL SUBARACHNOID BLOCK

A comprehensive understanding of the spinal column, spinal cord, and spinal nerves is essential for examining the functional anatomy of subarachnoid block. This chapter succinctly examines the anatomy, surface anatomy, and sonoanatomy of the spinal cord. The spinal column comprises 33 vertebrae: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 4 coccygeal segments. The vertebral column typically comprises three bends. The cervical and lumbar curves exhibit anterior convexity, while the thoracic curve displays posterior convexity. The curvature of the vertebral column, in conjunction with gravity, the baricity of local anesthetics, and the patient's position, affects the distribution of local anesthetics within the subarachnoid space. Figure 7 illustrates the spinal column, vertebrae, intervertebral discs, and foramina.

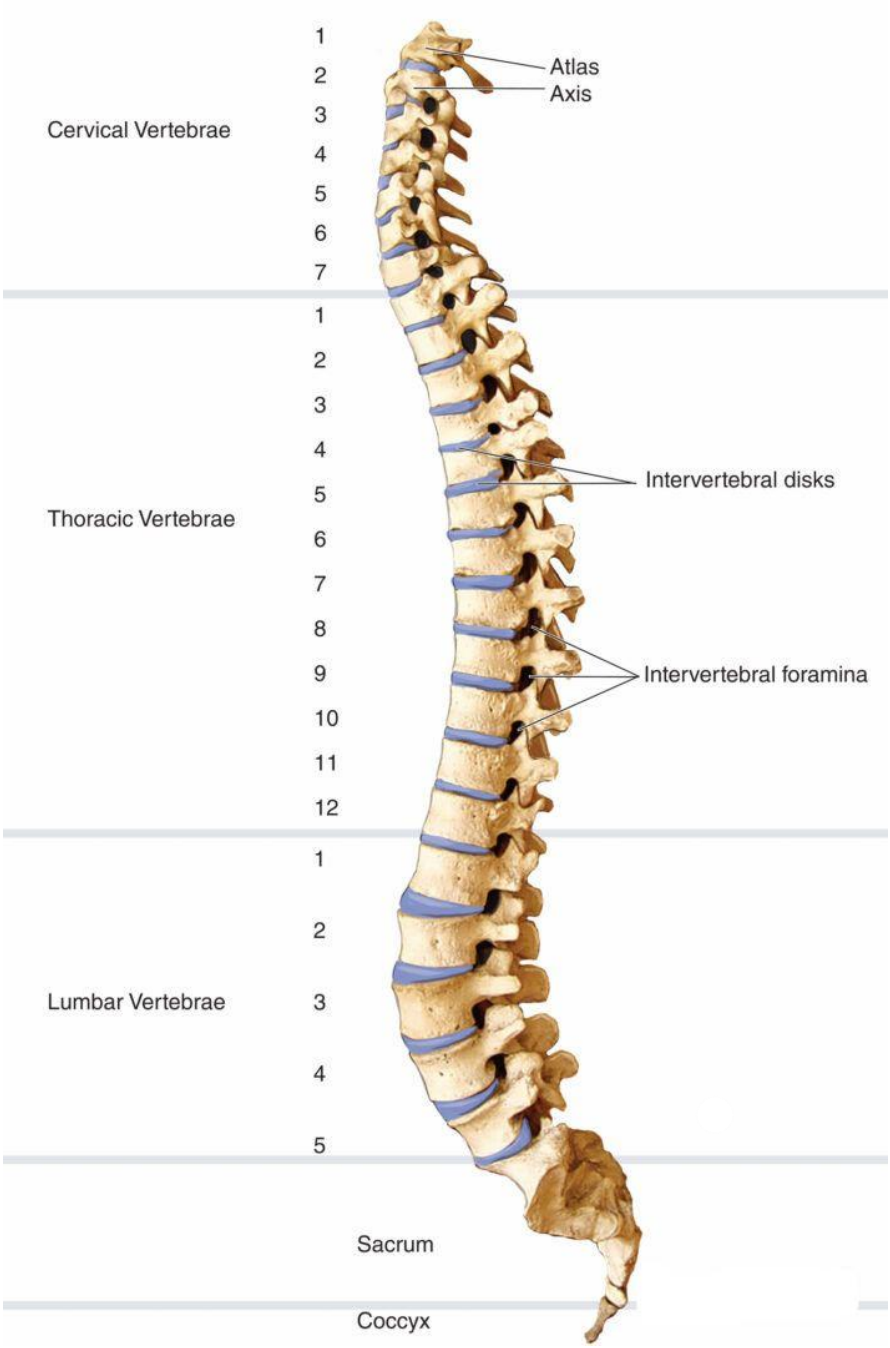


FIGURE 7: Spinal column, vertebrae, and intervertebral disks and foramina.

Five ligaments stabilize the spinal column (Figure 2). The supraspinous ligaments link the apices of the spinous processes from the seventh cervical vertebra (C7) to the sacrum. The supraspinous ligament is referred to as the ligamentum nuchae in the region superior to C7. The interspinous ligaments link the spinous processes.

The ligamentum flavum, often known as the yellow ligament, unites the laminae superior and inferior to one another. The posterior and anterior longitudinal ligaments connect the vertebral bodies.

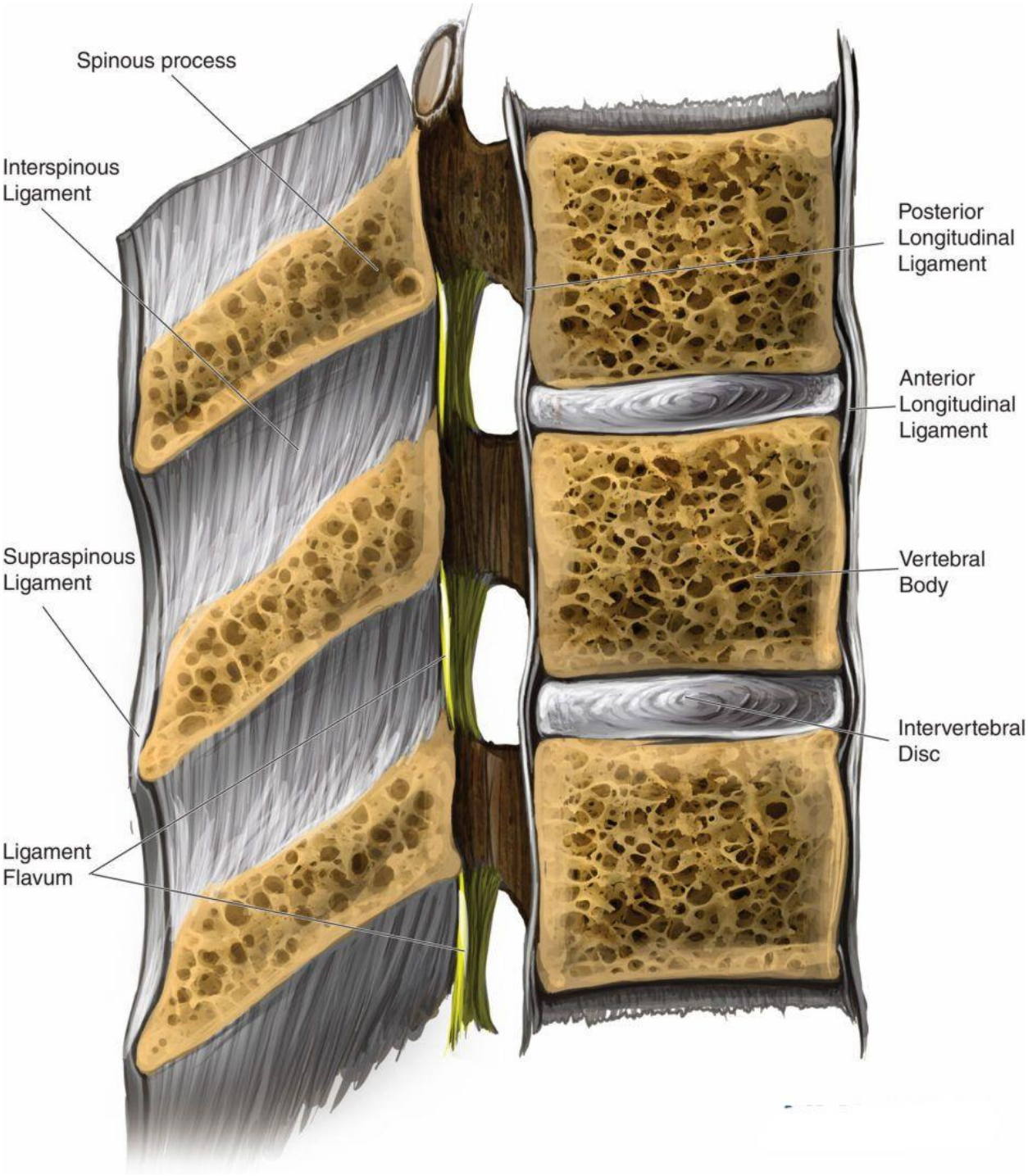


FIGURE 8: Cross section of the spinal canal and adjacent ligaments.[84]

The spinal cord is safeguarded by three membranes: the dura mater, arachnoid mater, and pia mater. The dura mater, sometimes known as the tough mother, constitutes the outermost layer. The dural sac reaches the second sacral vertebra (S2). The arachnoid mater constitutes the intermediate layer, while the subdural space is situated between the dural mater and the arachnoid mater. The arachnoid mater, also known as the cobweb mother, terminates at S2, similar to the dural sac. The pia mater, also known as the soft mother, adheres to the spinal cord's surface and terminates in the filum terminale, which anchors the spinal cord to the sacrum. The interval between the arachnoid and pia mater is referred to as the subarachnoid space, where spinal nerves and cerebrospinal fluid (CSF) are present. Figure 9 illustrates the spinal cord, dorsal root ganglia, ventral rootlets, spinal nerves, sympathetic trunk, rami communicantes, and the pia, arachnoid, and dura mater.

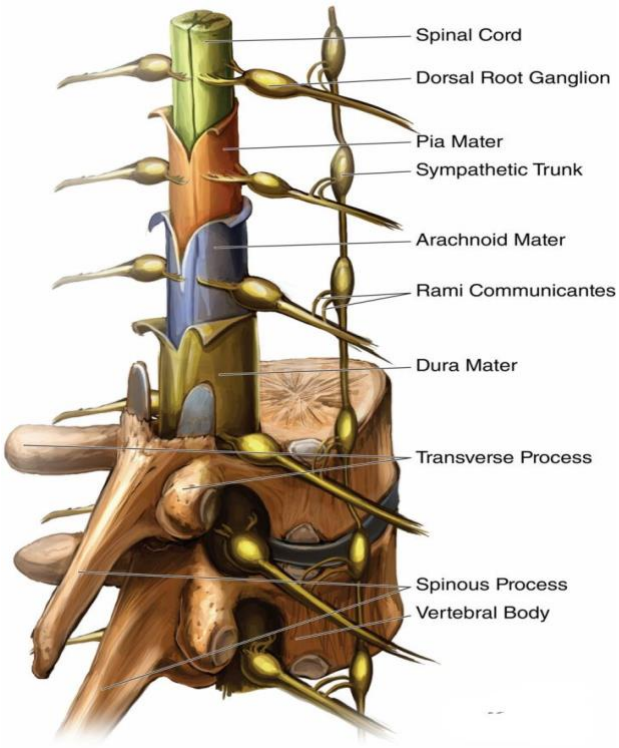


FIGURE 9: Spinal cord accompanied by meningeal layers, dorsal root ganglia, and the sympathetic nerve trunk.

During the administration of a spinal anesthetic via the midline approach, the anatomical layers traversed from posterior to anterior include the skin, subcutaneous fat, supraspinous ligament, interspinous ligament, ligamentum

flavum, dura mater, subdural space, arachnoid mater, and ultimately the subarachnoid space. In the application of the paramedian procedure, the spinal needle must penetrate the skin, subcutaneous adipose tissue, paraspinous musculature, ligamentum flavum, dura mater, subdural space, and arachnoid mater before entering the subarachnoid space.

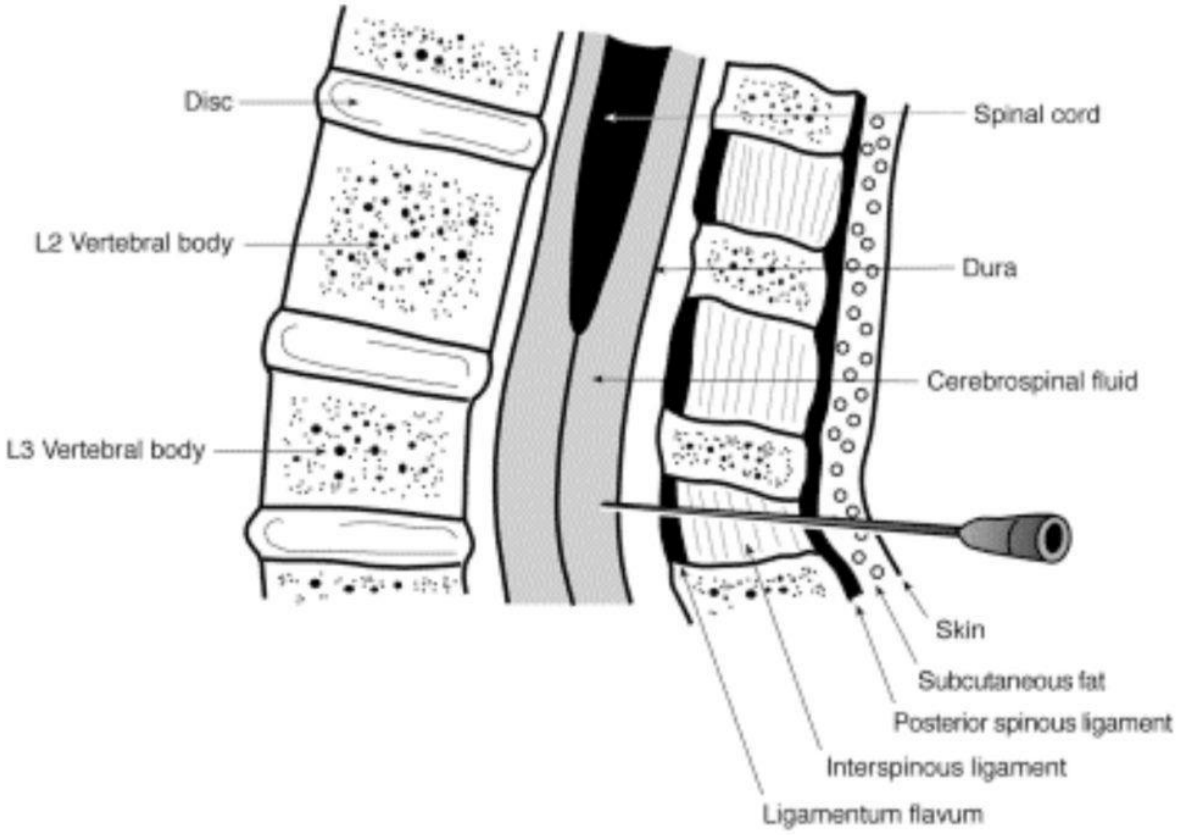


FIGURE 10: Layers to be transversed in midline approach.

During the administration of a spinal anesthetic via the midline method, the anatomical layers traversed (from posterior to anterior) are

1. Skin
2. Subcutaneous fat
3. Supraspinous ligament

4. Interspinous ligament
5. Ligamentum flavum
6. Dura mater
7. Subdural space
8. Arachnoid mater
9. Subarachnoid space

Paramedian approach:

1. Skin
2. Subcutaneous fat
3. Paraspinal musculature
4. Ligamentum flavum
5. Dura mater
6. Subdural space
7. Arachnoid mater
8. Subarachnoid space

The anatomy of the subdural space necessitates careful consideration. The subdural space is a meningeal layer situated between the dura mater and the arachnoid mater, spanning from the cranial cavity to the second sacral vertebra. Ultrastructural analysis has revealed that this is an acquired region that materializes only upon the rupture of neurothelial cells within it. The subdural space extends laterally encircling the dorsal nerve root and ganglia. The subdural area next to the ventral nerve roots has less potential capacity. This may elucidate the preservation of anterior motor and sympathetic fibers following subdural nerve block (SDB).

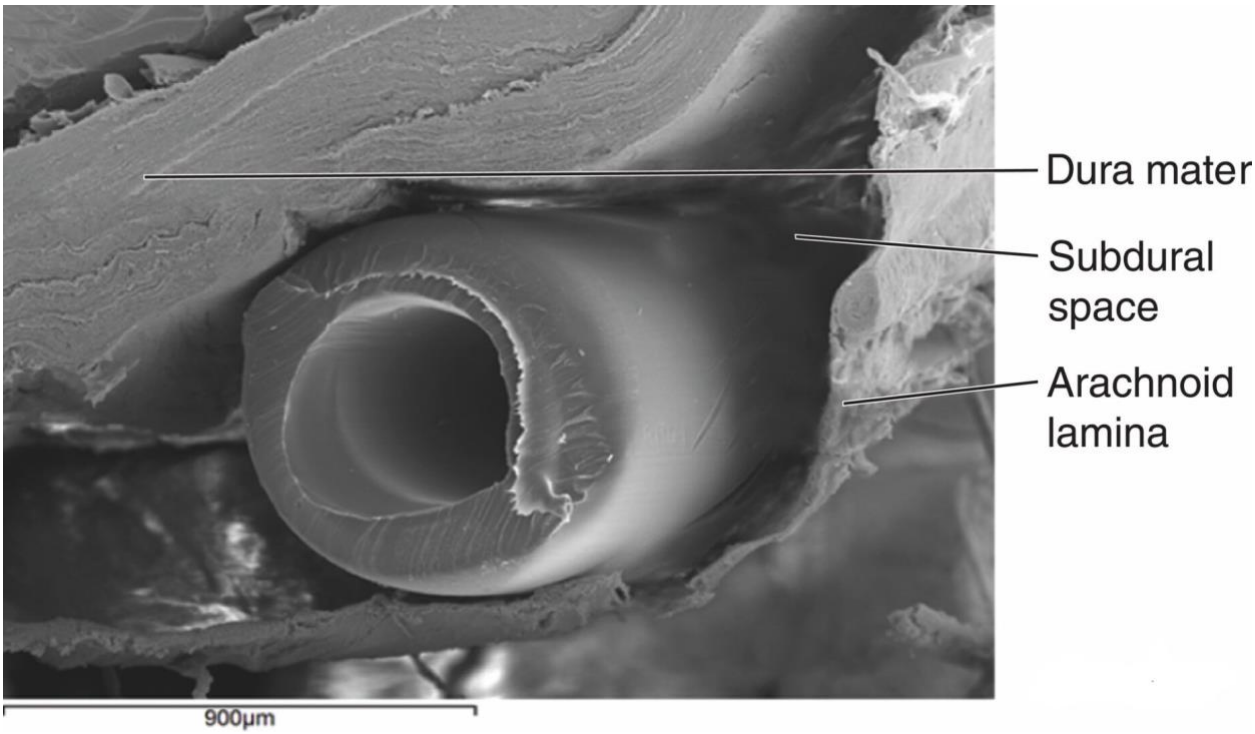


FIGURE 11: Subdural space.

The length of the spinal cord fluctuates with age. During the first trimester, the spinal cord reaches the terminus of the spinal column; however, as the fetus matures, the vertebral column elongates more significantly than the spinal cord. At birth, the spinal cord terminates around the L3 vertebra. In adults, the terminal portion of the spinal cord, referred to as the conus medullaris, is located at approximately the L1 vertebra. MRI and cadaveric investigations indicate that the conus medullaris is located below L1 in 19%–58% of cases and below L2 in 0%–5% of cases. The conus medullaris can be located anywhere from T12 to L3.

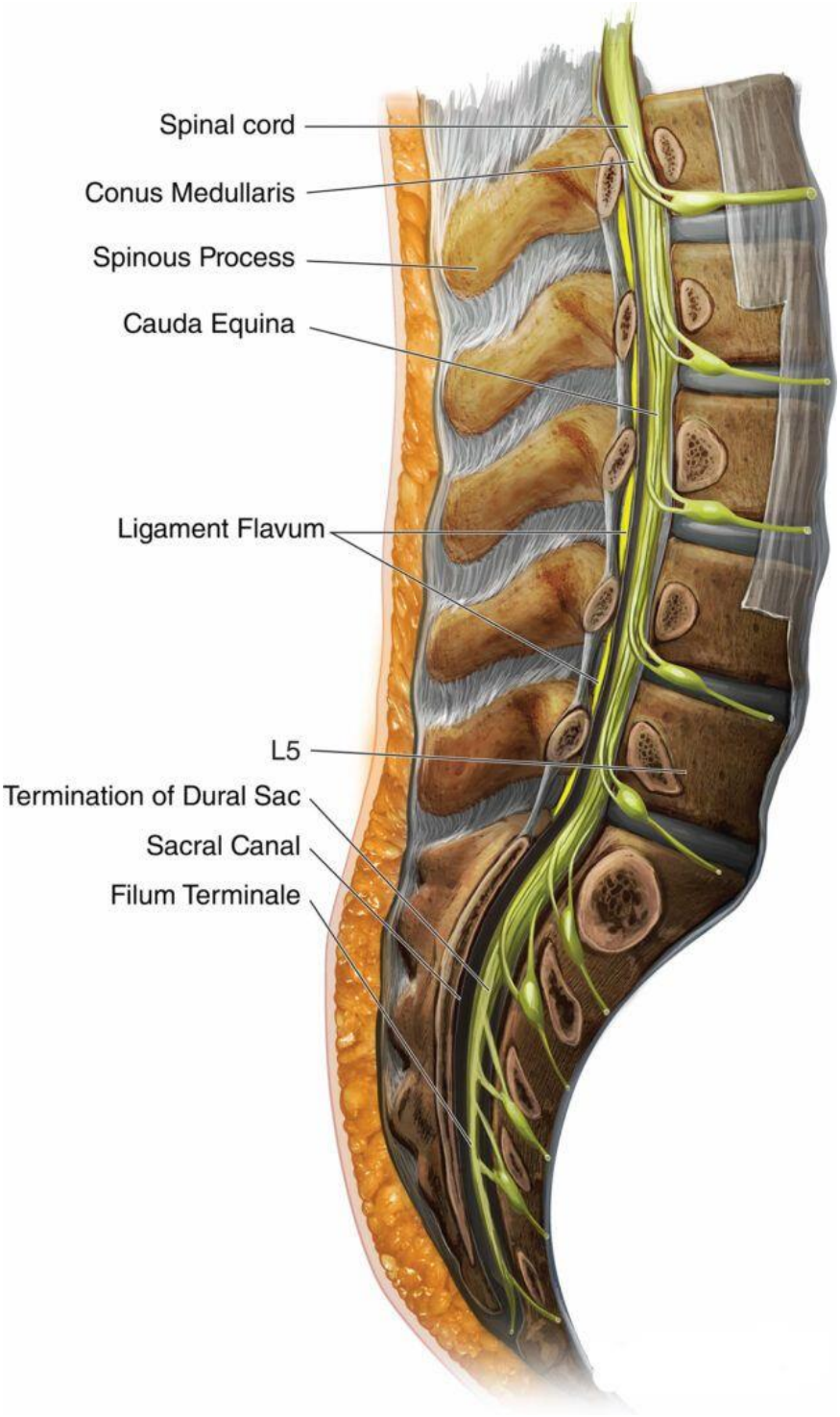


Figure 12: Cross section at the Lumbosacral level.

Surface Anatomy:

The midline is determined by palpating the spinous processes. The iliac crests typically align vertically with the fourth lumbar spinous process or the intervertebral space between the fourth and fifth lumbar vertebrae. A line can be drawn between the iliac crests to identify this interspace. It is essential to palpate the soft region between the spinous processes to identify the interspace. The L3–L4 or L4–L5 interspace may be utilized for spinal needle insertion, contingent upon the required anesthetic level for the surgery and the capacity to palpate the interspace. Due to the spinal cord typically terminating at the L1-L2 level, it is standard practice to avoid administering spinal anesthetic at or above this level. Segmental thoracic spinal anesthesia has been recently documented.

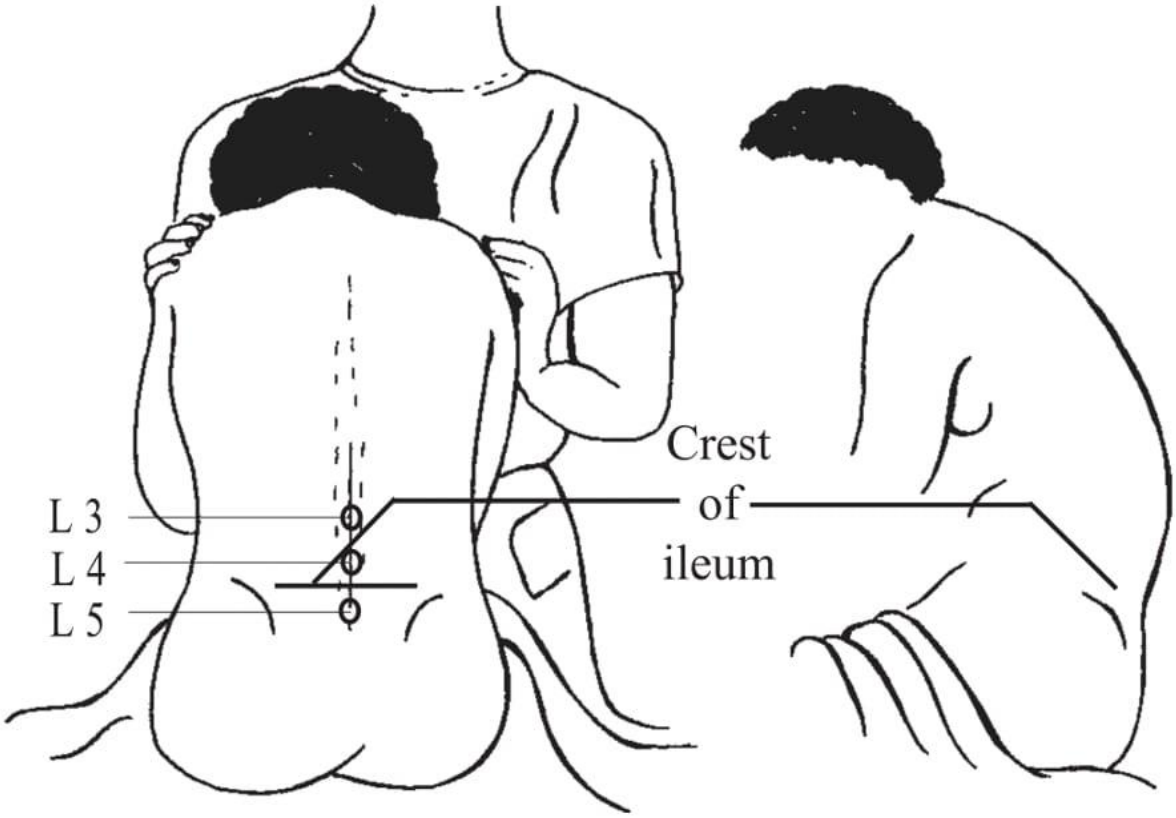


Figure 13: Intercristal line/Tuffier's line.

Discussing surface anatomy would be inadequate without addressing the dermatomes pertinent to spinal anesthesia. A dermatome is a region of skin supplied by sensory fibers from a single spinal nerve. The tenth thoracic (T10)

dermatome is associated with the umbilicus, the sixth thoracic (T6) dermatome with the xiphoid process, and the fourth thoracic (T4) dermatome with the nipples. To attain surgical anesthesia for a certain treatment, spinal anesthesia must achieve a designated dermatomal level.

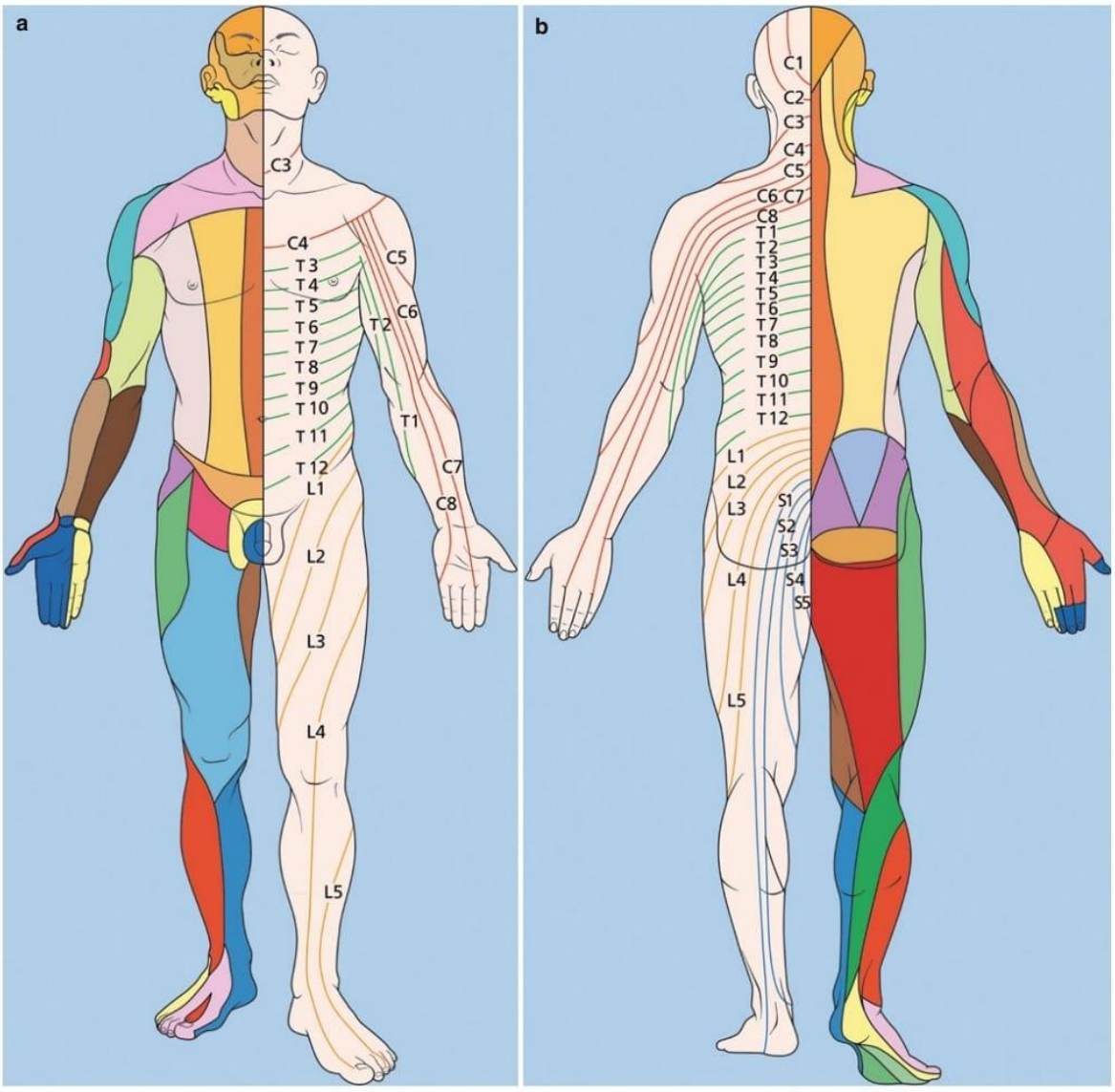


FIGURE 14: Spinal Dermatomes (a), cutaneous innervation (b).

Pharmacokinetics of Local Anesthetics in the Subarachnoid Space:

The pharmacokinetics of local anesthetics encompasses the absorption and excretion of the medication. Four parameters influence the absorption of local anesthetics from the subarachnoid space into neuronal tissue: (1) concentration of

local anesthetic in cerebrospinal fluid (CSF), (2) surface area of nerve tissue exposed to CSF, (3) lipid composition of nerve tissue, and (4) perfusion of nerve tissue.

The absorption of local anesthetic is maximal at the locus of maximum concentration in the cerebrospinal fluid and diminishes above and below this location. The absorption and distribution of local anesthetics following spinal injection are influenced by various parameters, including dosage, volume, baricity, and patient posture. Both the nerve roots and the spinal cord absorb local anesthetics upon injection into the subarachnoid region. Increased exposure of the nerve root surface area enhances the absorption of local anesthetic. The spinal cord possesses two pathways for the absorption of local anesthetics. The initial mechanism involves diffusion from the cerebrospinal fluid to the pia mater and then into the spinal cord, a process characterized by its gradual nature. Diffusion of local anesthetics affects only the most superficial layer of the spinal cord. The alternative mechanism for local anesthetic absorption involves diffusion into the Virchow-Robin spaces, which are the regions of pia mater encasing the blood arteries that infiltrate the central nervous system. The Virchow-Robin spaces interconnect with the perineuronal clefts encircling neuronal cell bodies in the spinal cord and extend into the deeper regions of the spinal cord.

The lipid composition influences the absorption of topical anesthetics. Tissues with high myelination in the subarachnoid space have elevated concentrations of local anesthetics post-injection. A greater degree of myelination correlates with an increased concentration of local anesthetic due to the elevated lipid content in myelin. An absence of myelin in a nerve root region elevates the risk of nerve injury in that area.

The rate of local anesthetic elimination from spinal cord tissue is governed by blood flow. The velocity of blood flow in the spinal cord correlates directly with the rate at which the anesthetic is eliminated. This may partially elucidate why the concentration of local anesthetics is higher in the posterior spinal cord compared to the anterior spinal cord, despite the anterior cord being more easily accessible via the Virchow-Robin gaps. Following the administration of a spinal anesthetic, blood flow to the spinal cord may either increase or decrease, contingent upon the specific local anesthetic used; for instance, tetracaine enhances cord flow, whereas lidocaine and bupivacaine diminish it, thereby influencing the elimination of the

local anesthetic.

The removal of local anesthetic from the subarachnoid space occurs through vascular absorption in both the epidural and subarachnoid spaces. Local anesthetics traverse the dura bidirectionally. Vascular absorption can occur in the epidural space, similar to the subarachnoid space. The vascular supply to the spinal cord comprises vessels situated on the spinal cord and within the pia mater. The rate of clearance of local anesthetics fluctuates due to the variability in arterial perfusion to the spinal cord.

The dispersion and reduction in concentration of local anesthetics depend on the region of highest concentration, which may be independent of the injection site. Numerous factors influence the dispersion of local anesthetics inside the subarachnoid region.

1. Baricity
2. Volume of the injectate
3. Position of the patient
4. Specific gravity of the injectate
5. Site of the injection
6. Position of the needle bevel
7. Decreased CSF volume/decreased subarachnoid space volume (increased abdominal pressure in pregnancy, due to gravid uterus compressing the inferior venacava leading to engorgement of subarachnoid veins)

Baricity is crucial in influencing the distribution of local anesthetic inside the spinal space and is defined as the density of the local anesthetic divided by the density of cerebrospinal fluid at 37°C. Local anesthetics may be classified as hyperbaric, hypobaric, or isobaric relative to cerebrospinal fluid (CSF), with baricity serving as the primary factor influencing the distribution of the anesthetic upon injection into the CSF. Hypobaric solutions possess a lower density than cerebrospinal fluid and tend to ascend against gravitational forces. Isobaric solutions possess a density equivalent to that of cerebrospinal fluid and typically maintain their position at the site of injection. Hyperbaric solutions possess more density than cerebrospinal fluid and typically adhere to gravitational forces post-injection.

Hypobaric solutions possess a baricity of less than 1.0 in comparison to

cerebrospinal fluid (CSF) and are often prepared by incorporating distilled sterile water with the local anesthetic. Tetracaine, dibucaine, and bupivacaine have all been utilized as hypobaric solutions in spinal anesthesia. Patient posture is crucial following the administration of a hypobaric spinal anesthetic, as the initial minutes dictate the distribution of anesthesia. In the Trendelenburg position, the anesthetic will disseminate caudally post-injection, whereas in the reverse Trendelenburg position, it will propagate cephalad following injection.
The baricity of isobaric solutions is precisely 1.0. Tetracaine and bupivacaine have both been effectively utilized for isobaric spinal anesthesia. Gravity does not influence the dispersion of isobaric solutions, in contrast to hypo- or hyperbaric local anesthetics. Consequently, patient location does not influence the dispersion of isobaric solutions. Injection may be administered in any position, after which the patient can be positioned appropriately for surgery.

Hyperbaric solutions possess a baricity exceeding 1.0. A local anesthetic solution can be become hyperbaric by the incorporation of dextrose or glucose. Bupivacaine, lidocaine, and tetracaine have all been utilized as hyperbaric solutions in spinal anesthesia. The location of the patient influences the distribution of the anesthetic. An individual in the Trendelenburg position would experience the anesthetic moving in a cephalad direction, and conversely for the opposite posture. The dosage and volume significantly influence the distribution of local anesthetics following spinal injection.

	Density	Specific gravity	Baricity
Water	0.9933	1.0000	0.9930
CSF	1.0003	1.0069	1.0000
Hypobaric Tetracaine 0.33%in water	0.9980	1.0046	0.9977
Lidocaine 0.5% in water	N/A	1.0038	0.9985
Isobaric Tetracaine 0.5% in 50% CSF	0.9998	1.0064	0.9995
Lidocaine 2% in water	1.0003	1.0066	1.0003

Bupivacaine 0.5% in water	0.9993	1.0059	0.9990
Hyperbaric			
Tetracaine 0.5% in 5% dextrose	1.0136	1.0203	1.0133
Lidocaine 5% in 7.5% dextrose	1.0265	1.0333	1.0265
Bupivacaine 0.5% in 8% dextrose	1.0210	1.0278	1.0207
Bupivacaine 0.75% in 8% dextrose	1.0247	1.0300	1.0227

TABLE 8: Density, Specificity and Baricity

Adjuvant	Dose (mcg)	Duration (h)	Side effects
Fentanyl	10-25	1-2	Itching, nausea, urinary retention, sedation, ileus, respiratory depression (delayed)
Sufentanil	1.25-5	1	
Morphine	125-250	4-24	
Epinephrine	100-200		Prolongs nerve exposure to LA, alpha adrenergic modulation
Phenylephrine	1000-2000		Hypotension, prolongs tetracaine but not bupivacaine, may cause TNS
Clonidine	15-150		Hypotension, sedation. Prolongs motor and sensory blockade

TABLE 9: **Spinal adjuvants**.

Drug	preparation	Dose(mg)	procedures	Duration	
				Plain	Epinephrine
2-Chloroprocaine	1%,2%,3%	30-60	Ambulatory T(8)	1-2	Not recommended
Lidocaine	2%	40-50	Ambulatory T(8)	1-2	Not recommended
Mepivacaine	1.5%	30(T9) 45 (T6) 60 (T5)	Ambulatory surgery, knee scope, TURP	1-2 1.5-3 2-3.5	Not recommended
Bupivacaine	0.75% in 8.25% dextrose	4-10 12-14 12-18	Perineum, LL surgeries Lower abdomen Upper abdomen	1.5-2	1.5-2.5
Bupivacaine	0.5%	7.5 10 15	Ambulatory LL THA, TKA Femur ORIF	1-2 2 3	 4-5
Ropivacaine	0.5%-0.75%	15-17.5 18-22.5	T10 level T8 level	2-3 3-4	Does not prolong block
Tetracaine	0.5% hyperbaric	4-8 10-12 10-16	Perineum/LL Lower abdomen Upper abdomen	1.5-2	3.5-4

TABLE 10: Spinal Anesthetics dose & duration.

EFFECTS OF SPINAL ANESTHESIA

Cardiovascular Effects of Spinal Anesthesia:

Spinal anesthesia is widely acknowledged to cause hypotension. A degree of hypotension often reassures the anesthesiologist that the nerve block is spinal in nature. Hypotension can lead to nausea and vomiting, ischemia of vital organs, cardiovascular collapse, and, in pregnant individuals, pose a risk to the fetus. Historically, there have been changes in the definitions, proposed mechanisms, and therapy of hypotension.

Defining hypotension is challenging. A study identified 15 distinct definitions of hypotension across 63 publications. Certain definitions employed a singular criterion (an 80% reduction from baseline), whereas others utilized combinations (an 80% decline from baseline or a systolic blood pressure below 100 mmHg). The prevalence of hypotension in a singular patient group ranged from 7.4% to 74.1% based on the definition applied.

Numerous proposed reasons for hypotension generated by spinal anesthesia include the direct circulatory effects of local anesthetics, relative adrenal insufficiency, skeletal muscle paralysis, ascending medullary vasomotor nerve blockade, and concomitant respiratory insufficiency. The principal injury, however, is the preganglionic sympathetic nerve blockade induced by spinal anesthesia. Consequently, the height of the nerve block dictates the degree of sympathetic block, which subsequently influences the variation in cardiovascular measures. This relationship is unpredictable. Sympathetic nerve block may range from two to six dermatomes above the sensory level and may be partial below this level. The abrupt sympathetic nerve block induced by spinal anesthetic allows minimal opportunity for cardiovascular compensation, which may explain the comparable sympathetic nerve block associated with epidural anesthesia, but with reduced hypotension.

Sympathetic nerve block induces hypotension via influencing preload, afterload, contractility, and heart rate—essentially the drivers of cardiac output—and by reducing systemic vascular resistance. Preload diminishes due to venodilation induced by sympathetic nerve block, leading to blood pooling in the peripheries and reduced venous return. During sympathetic nerve block, the venous system is fully vasodilated and consequently dependent on gravity for venous return to the heart. Consequently, patient posture and aortocaval compression due to a gravid uterus significantly affect venous return during spinal anesthesia.

Sympathetic nerve block can diminish arterial vasomotor tone, hence reducing systemic vascular resistance (SVR) and afterload. Arterial vasodilation, in contrast to venodilation, does not reach its peak following spinal block, and vascular smooth muscle maintains a degree of autonomic tone post-sympathetic denervation. The loss of residual vascular tone due to hypoxia and acidosis may explain cardiovascular collapse following high spinal anesthesia in the absence of cardiorespiratory assistance. Despite vasodilation occurring below the spinal block, compensatory vasoconstriction transpires above, regulated by carotid and aortic arch baroreceptors. This is significant for two reasons. Initially, blockade at elevated dermatomal levels may lead to diminished compensation. Secondly, the administration of vasodilatory agents such as glyceryl trinitrate (GTN), sodium nitroprusside, or volatile anesthetics may disrupt this compensatory process, exacerbating hypotension or potentially leading to cardiac arrest.

An initial rise in cardiac output may occur due to reduced afterload. Conversely, cardiac output may diminish as a result of reduced preload. Certain studies indicate that carbon monoxide levels remain stable or experience a minor decrease throughout the initiation of spinal anesthesia. In senior patients, several studies have demonstrated a biphasic alteration in cardiac output, characterized by an initial increase within the first 7 minutes, succeeded by a decline. This may be ascribed to a decrease in afterload prior to a decrease in preload.

The impact of spinal anesthesia on heart rate is intricate. Heart rate may increase due to hypotension via the baroreceptor reflex or decrease from sympathetic nerve block of cardiac accelerator fibers arising from the T1–T4 spinal segments, or by the reverse Bainbridge reflex. The reverse Bainbridge reflex is characterized by a reduction in heart rate resulting from less venous return, as sensed by stretch receptors in the right atrium, and is less potent than the baroreceptor response. The Bezold-Jarisch reflex (BJR) is a reflex that reduces heart rate (HR). The BJR has been identified as a contributing factor to bradycardia, hypotension, and cardiovascular collapse during central neuraxial anesthesia, particularly spinal anesthesia.
The BJR is a cardioinhibitory reflex and is typically not a predominant reflex. The correlation with spinal anesthesia is likely minimal. The BJR has been implicated in bradycardia during spinal anesthesia, particularly subsequent to bleeding. Forceful contractions of a partially full heart may trigger the BJR. The likelihood is

greater with ephedrine compared to phenylephrine.
Young, healthy patients classified as American Society of Anesthesiologists class 1 exhibit an elevated risk of bradycardia. The utilization of beta-blockers also elevates the likelihood of bradycardia. The prevalence of bradycardia in the nonpregnant population is approximately 13%. Although bradycardia is typically well tolerated, asystole and second- and third-degree heart block may arise; therefore, it is prudent to remain cautious when monitoring a patient post-spinal anesthesia and to administer timely treatment.

Risk factors linked to hypotension encompass hypovolemia, preoperative hypertension, raised sensory nerve block height, age over 40 years, obesity, concurrent general and spinal anesthesia, persistent alcohol intake, increased BMI, and the urgency of non-obstetric surgery. Hypotension is less probable in women in labor than in those receiving elective cesarean sections.

Administration Management of hypotension subsequent to spinal anesthesia necessitates frequent (initially every minute) monitoring of blood pressure, alongside electrocardiogram (ECG), oxygen saturation, and fetal monitoring for pregnant patients. Invasive blood pressure monitoring should be considered for patients with substantial cardiac comorbidities. Fluid therapy must be administered to a dehydrated patient to restore volume before initiating spinal anesthesia. Nonpharmacological interventions for hypotension encompass positioning, leg compression, and uterus displacement. The Trendelenburg position can enhance venous return to the heart.

This position must not surpass 20° as excessive Trendelenburg can result in diminished brain perfusion and blood flow due to elevated jugular venous pressure. If the spinal anesthesia level is not stabilized, the Trendelenburg posture may modify the spinal anesthesia level, potentially resulting in an elevated level of anesthesia in patients administered hyperbaric local anesthetic solutions.

This can be mitigated by elevating the upper body with a pillow beneath the shoulders while maintaining the lower body above heart level. A Cochrane evaluation of pregnant women indicated that lower limb compression offers certain benefits, however the effectiveness of various treatments differed. Avoid aortocaval

compression caused by a gravid uterus. Complete lateral placement leads to reduced hypotension compared to left lateral tilt, while its practicality may be questionable. A wedge positioned behind the right hip or a slanted table can facilitate a left lateral tilt. The ideal angle of tilt is undetermined, and significant diversity may exist among various patients.

Conflicting perspectives exist on optimal fluid management during spinal anesthesia. Initial research indicated that crystalloid "preloading" before spinal block was efficacious. Recent studies demonstrated a negligible impact of preloading. Colloid preloading appears to be helpful; however, this must be weighed against the potential for allergic reactions and elevated expenditures. Rapid delivery of crystalloid fluid, termed "coloading," is more effective than preloading in avoiding hypotension following spinal anesthesia.

Hypotension can be mitigated by reducing the dosage of spinal local anesthetic. A review indicated that 5–7 mg of bupivacaine is adequate for cesarean delivery. Nevertheless, total motor nerve blockade was infrequent, the duration was constrained, and an epidural catheter for prompt supplemental dosages was required. A 2011 meta-analysis indicated that reduced dosages of bupivacaine correlated with diminished anesthetic efficacy, although resulted in less hypotension and nausea.
There are divergent views on the preferred vasopressor for spinal-induced hypotension. Ephedrine and phenylephrine have been the primary candidates; yet, alternative options have also been utilized. Ephedrine functions as both a direct and indirect agonist of α- and β-receptors. It was considered safer than phenylephrine due to its restriction of vasoconstriction in the uteroplacental circulation in preliminary animal experiments. Ephedrine exhibits a delayed beginning of action, is prone to tachyphylaxis, and has restricted effectiveness in managing hypotension. The heightened risk of fetal acidity is of greater concern. The correlation between this and inferior clinical results remains ambiguous. Phenylephrine is a direct agonist of the α1 receptor. It was effectively utilized for spinal anesthesia in New York throughout the 1960s, but subsequently declined in popularity because to apprehensions of inadequate tissue perfusion. Uteroplacental vasoconstriction was observed in imperfect pregnant animal models. Recent studies indicate that fetal acidity does not manifest when standard dosages are administered. Furthermore, phenylephrine appears to be more effective than ephedrine in alleviating hypotension and nausea. Phenylephrine has been

administered as a bolus or infusion for the preventative and reactive treatment of hypotension.

Phenylephrine is the choice of vasopressor at least in the obstetric settings.

Respiratory Effects of Spinal Anesthesia:

In individuals with normal lung physiology, spinal anesthesia little impacts pulmonary function. Lung volumes, resting minute ventilation, dead space, arterial blood gas tensions, and shunt fraction exhibit negligible alteration following spinal anesthesia. The primary respiratory consequence of spinal anesthesia manifests during a high spinal block, wherein vigorous exhalation is compromised due to the paralysis of abdominal and intercostal muscles. High spinal block results in a decrease in expiratory reserve capacity, peak expiratory flow, and maximal minute ventilation. Patients with obstructive pulmonary illness who depend on accessory muscle utilization for sufficient breathing must be closely monitored following spinal block. Patients exhibiting normal pulmonary function and a high spinal nerve block may report dyspnea; nevertheless, if they can articulate effectively in a normal voice, ventilation is typically sufficient. Dyspnea typically arises from the inability to perceive chest wall movement during inhalation, and simple reassurance is generally effective in alleviating the patient's anguish.

Arterial blood gas values remain unchanged during high spinal anesthesia in patients who are spontaneously inhaling ambient air. The primary impact of high spinal anesthesia is on expiration, as it compromises the muscles responsible for exhale. A high spinal typically spares the neck region, preserving the phrenic nerve and maintaining adequate diaphragmatic function, resulting in minimal impact on inspiration. Steinbrook and colleagues observed that spinal anesthesia did not significantly alter vital capacity, maximal inspiratory pressure, or resting end-tidal PCO2; nevertheless, an enhanced ventilatory reactivity to CO2 was noted with bupivacaine spinal anesthesia.

Gastrointestinal effects:

The sympathetic innervation of the abdominal organs originates from T6 to L2. Following sympathetic block and unopposed parasympathetic activity subsequent

to spinal block, secretions elevate, sphincters relax, and the intestine experiences constriction.
Enhanced vagal activity following sympathetic nerve blockade results in heightened gastrointestinal peristalsis, potentially inducing nausea. Nausea may also arise from gut ischemia caused by hypotension, leading to the production of serotonin and other emetogenic agents. The prevalence of IONV in nonobstetric surgery can reach 42% and may ascend to 80% in parturients.

Hepato-Renal blood flow:

Hepatic blood flow is correlated with arterial blood flow. Hepatic blood flow lacks autoregulation; hence, a drop in arterial blood flow following spinal anesthesia results in a corresponding reduction in hepatic blood flow. Maintaining the mean arterial pressure (MAP) following spinal anesthesia will ensure the preservation of hepatic blood flow. Patients with hepatic disease require meticulous monitoring, and their blood pressure must be regulated under anesthesia to preserve hepatic perfusion. No research has definitively demonstrated the superiority of regional over general anesthesia in individuals with hepatic illness. In patients with liver disease, either regional or general anesthesia may be administered, provided that the mean arterial pressure is maintained near baseline levels.

Renal blood flow is subject to autoregulation. The kidneys maintain perfusion when the mean arterial pressure exceeds 50 mm Hg. Transient reductions in renal blood flow may manifest when mean arterial pressure (MAP) falls below 50 mm Hg; however, even with prolonged declines in MAP, renal function normalizes upon the restoration of blood pressure.
Monitoring blood pressure is crucial following the administration of a spinal anesthetic, and the mean arterial pressure (MAP) should be maintained as near to baseline as feasible. Spinal anesthesia does not influence the autoregulation of renal blood flow. Research indicates that renal perfusion in sheep exhibits minimal alteration following spinal anesthesia.

Spinal Needles:

Various diameters and types of needles have been designed for spinal anesthesia. The currently utilized devices feature a snug, detachable stylet that inhibits skin and adipose tissue from obstructing the needle and potentially entering the

subarachnoid area.
The pencil-point needles (Sprotte and Whitacre) include a rounded, non-cutting bevel and a solid tip. The aperture is situated on the lateral aspect of the needle, 2–4 mm proximal to its tip. The needles featuring cutting bevels comprise the Quincke and Pitkin needles. The Quincke needle features a sharp tip and a medium-length cutting edge, whereas the Pitkin needle possesses a sharp point and a short bevel with cutting edges. The Greene spinal needle features a rounded tip and a non-cutting bevel. Pencil-point needles offer superior tactile feedback of the ligament layers but necessitate greater force for insertion compared to bevel-tip needles. The needle's bevel must be oriented longitudinally to reduce the occurrence of PDPH.

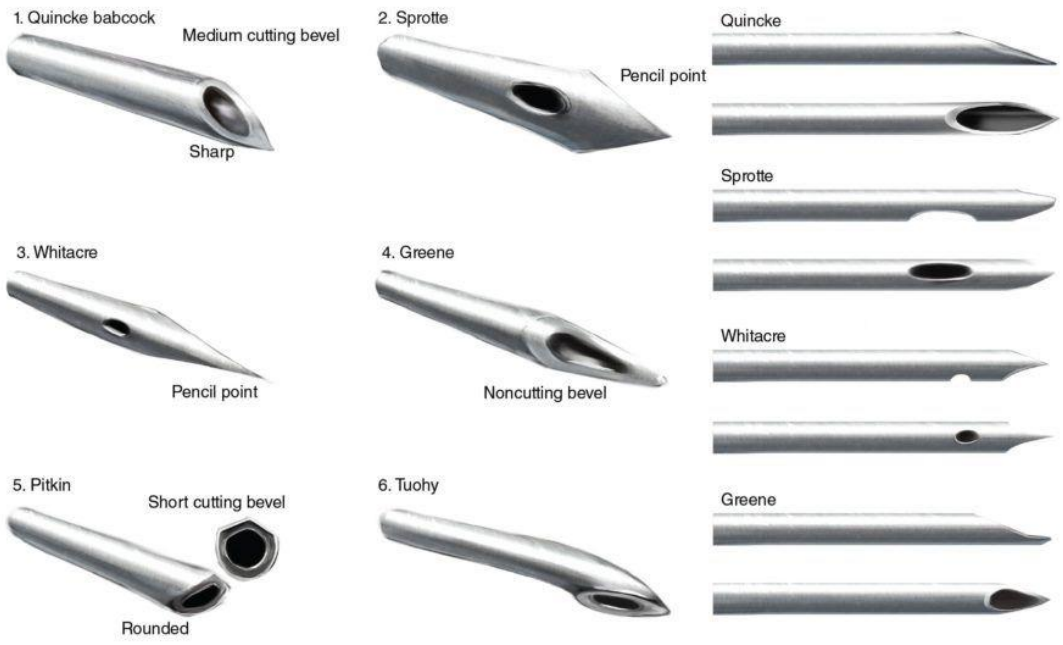


Figure 15: spinal needles.

Patient Positioning:

Sitting position

The anatomic midline is often easier to identify when the patient is sitting than when the patient is in the lateral decubitus position. The sitting position avoids the

potential rotation of the spine that can occur with the lateral decubitus position. Using a stool for a footrest and a pillow for the patient to hold can be valuable in this position. The patient should flex the neck and push out the lower back to open up the lumbar intervertebral spaces.

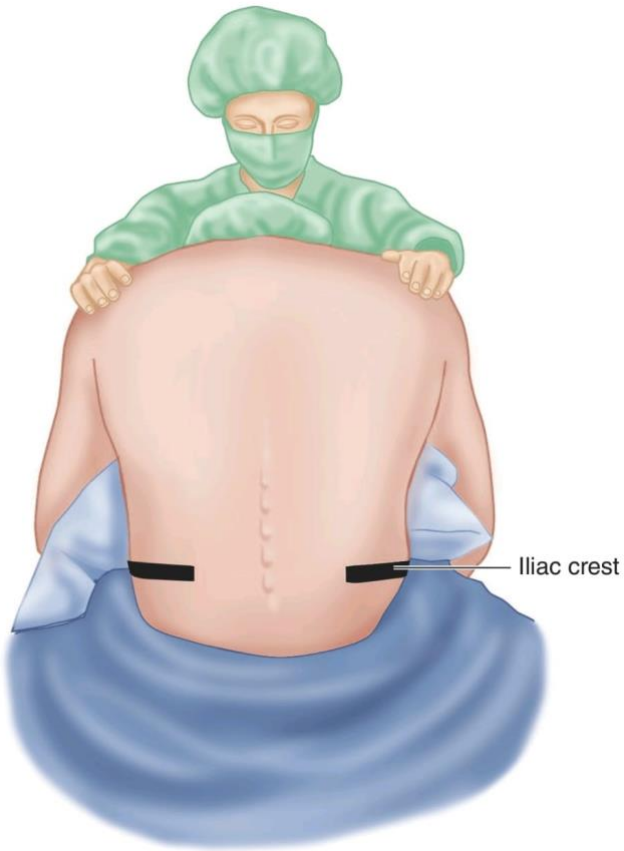


Figure 16: Sitting position.

Lateral decubitus position: A multitude of clinicians favor the lateral location for neuraxial blocks (Figure 45–14). Patients assume a lateral position with their knees flexed and drawn towards the abdomen or chest, resembling a "fetal position." A caregiver can support the patient in adopting and maintaining this position.

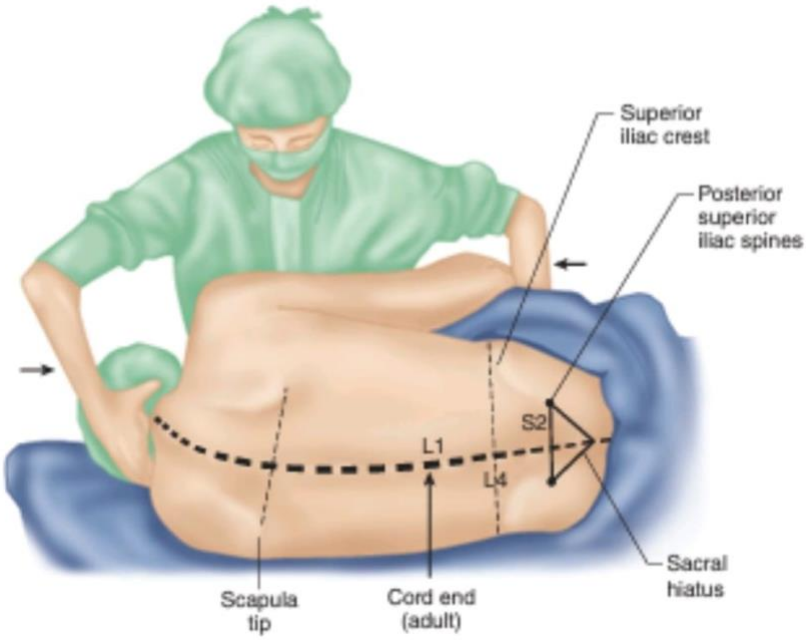


Figure 17: lateral Decubitus position.

TRANSVERSE ABDOMINIS PLANE BLOCK

The transversus abdominis plane (TAP) block is an innovative regional anesthesia method that delivers analgesia following abdominal surgery. The technique, first delineated as a seminal method in 2001 by Rafi [86], entails the injection of local anesthetic through the lumbar triangle into the transversus abdominis plane (TAP) situated between the transversus abdominis and internal oblique muscles. The injection specifically targets the nerves of the anterolateral abdominal wall. The method for accessing the TAP is advancing, with a described ultrasound-guided methodology that allows for identification of the TAP in the lateral abdominal wall.[87] The ultrasound-guided approach allows the needle trajectory to align with the ultrasound plane, potentially enhancing accuracy and safety. The ultrasound approach enables several injection sites based on the surgical type, with the three lateral abdominal muscles easily discernible adjacent to the midline rectus abdominis muscles. Ultrasound also enables the blockade of certain nerves, such as the selective ilioinguinal and iliohypogastric nerve blocks, as detailed in a cadaver study. The clinical indications for the TAP block are growing, with the landmark approach utilizing the triangle of Petit employed for postoperative analgesia following bowel, prostate, obstetric, and gynecological surgeries.[88]

Muscles of the Anterior Abdominal Wall

The anterior abdominal wall comprises four large, flat muscles on each side of the midline.The muscles include the external oblique, internal oblique, transversus abdominis, and rectus abdominis. Additionally, two lesser muscles, the cremaster and the pyrimidalis, are present. The EOM, IOM, and TAM terminate in a fibrous aponeurosis that extends to the midline. The aponeuroses on both sides converge at the midline to create a central structure known as the linea alba. The RAM is longitudinally shaped, positioned vertically on both sides of the linea alba, and encased in a fibrous structure known as the "rectus sheath."

Figure 18:
Innervation of the trunk and the abdominal wall.

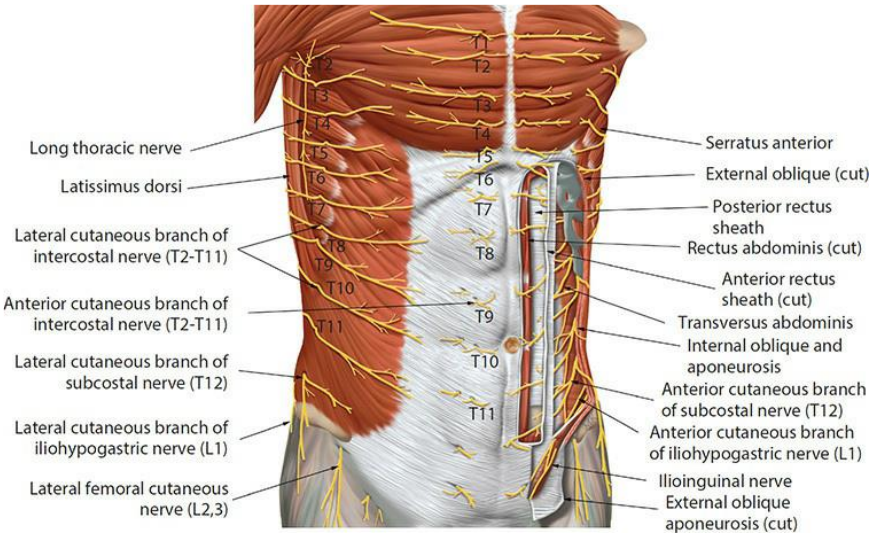
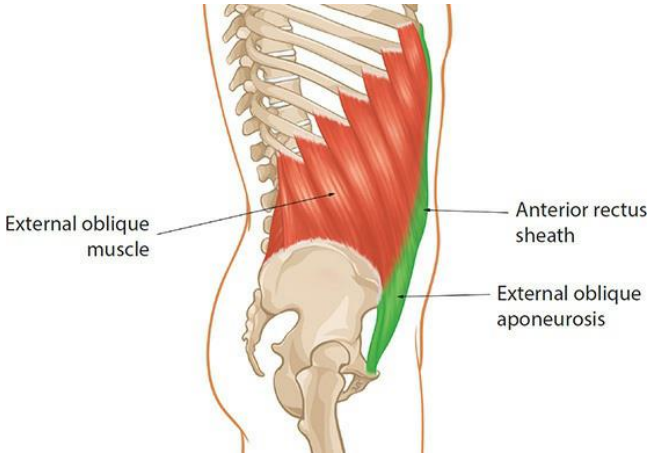


Figure 19:

The origin, insertion, and arrangement of the muscle fibers of the external oblique muscle.



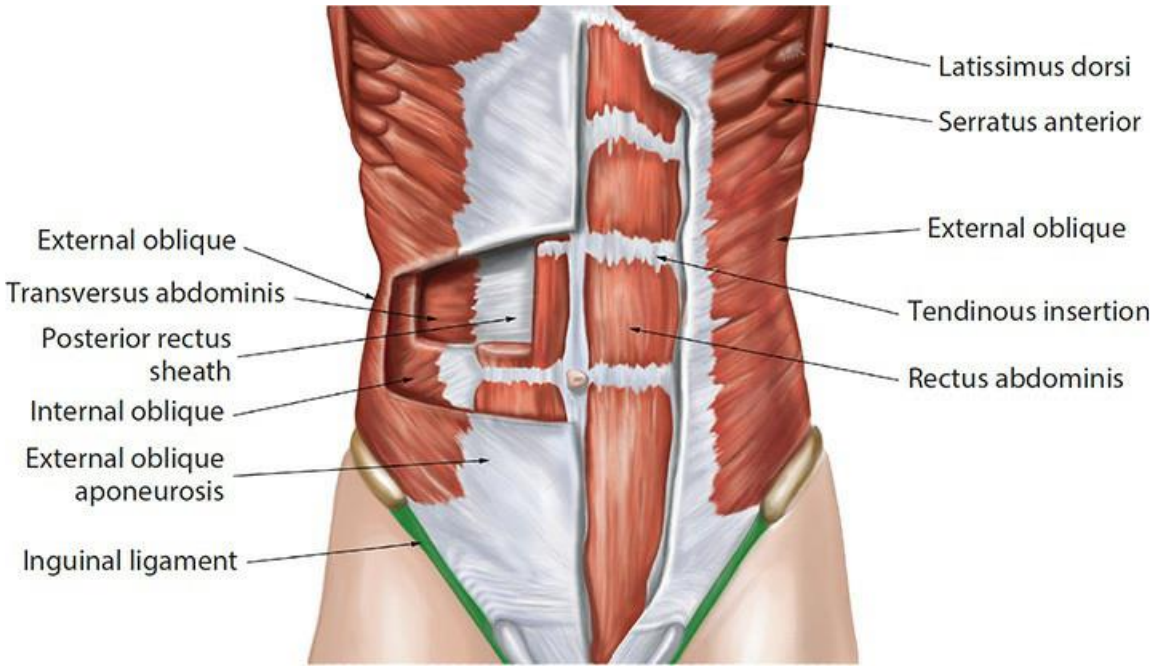


Figure 20: Muscles of the anterior abdominal wall and their aponeurosis.

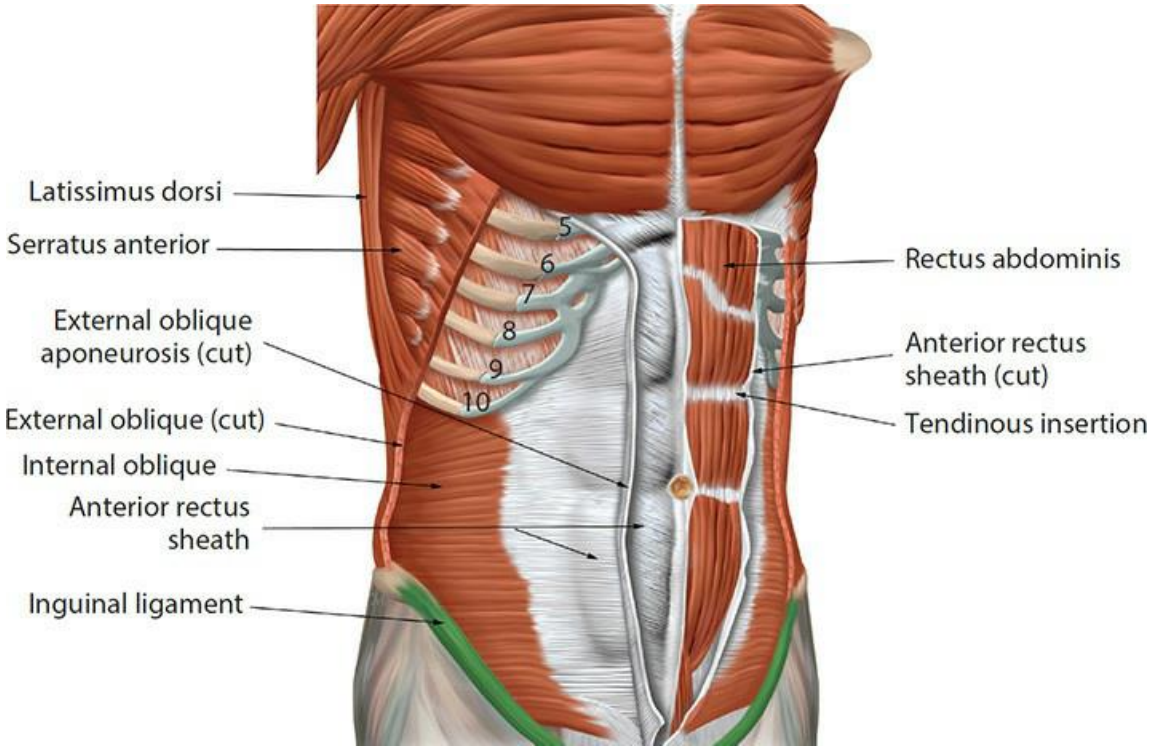


Figure 21: internal oblique muscle with its aponeurosis.

The EOM arises from eight muscular slips originating from the lower eight ribs. The superior slips of the extraocular muscles interdigitate with those of the serratus anterior muscle, whereas the inferior slips interdigitate with those of the latissimus dorsi muscle. The muscle fibers extend downward, forward, and medially, culminating in a large aponeurosis that is attached (from superior to inferior) to the xiphoid process, pubic symphysis, pubic crest, and the pectineal line of the pubis. The caudal fibers of the muscle attach to the anterior two-thirds of the outer lip of the iliac crest. The caudal portion of the external oblique aponeurosis is folded within itself, creating the inguinal ligament, and superior to the pubic tubercle lies a little triangular aperture known as the superficial inguinal ring. The external oblique aponeurosis contributes to the formation of the rectus sheath medial to the lateral edge of the rectus abdominis muscle.
The IOM arises from the lateral two-thirds of the inguinal ligament, the anterior two-thirds of the intermediate region of the iliac crest, and the posterior thoracolumbar fascia. The fibers of the IOM originate obliquely, ascending, advancing, and medially, intersecting the fibers of the EOM at right angles, ultimately terminating in an aponeurosis that connects to the xiphoid process, the seventh to ninth costal cartilage, linea alba, pubic crest, and pectineal line. The IOM aponeurosis additionally has a role in the development of the rectus sheath.

The transversus abdominis muscle originates from the lateral one-third of the inguinal ligament, the anterior two-thirds of the inner lip of the iliac crest, the posterior thoracolumbar fascia, and the inner surface of the lower six costal cartilages. The fibers of the transversus abdominis muscle are oriented horizontally forward and terminate in an aponeurosis that connects to the xiphoid process, linea alba, pubic crest, and pectineal line of the pubis. At the inferior aspect of the TAM, the lower fibers of the muscle amalgamate with the lower fibers of the IOM to create the conjoint tendon. The TAM aponeurosis contributes to the development of the rectus sheath.
The neurovascular systems of the abdominal wall are situated between the internal oblique muscle and the transversus abdominis muscle. The intermuscular plane, commonly known as the transversus abdominis plane, is a favored location for ultrasound-guided abdominal wall nerve blocks.

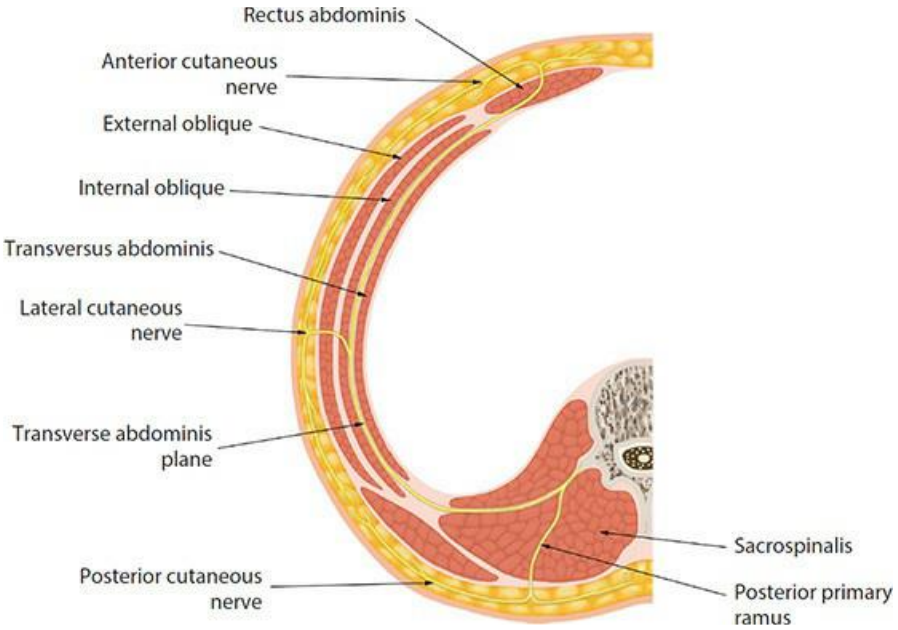


Figure 22: Course and divisions of Thoracolumbar nerve.

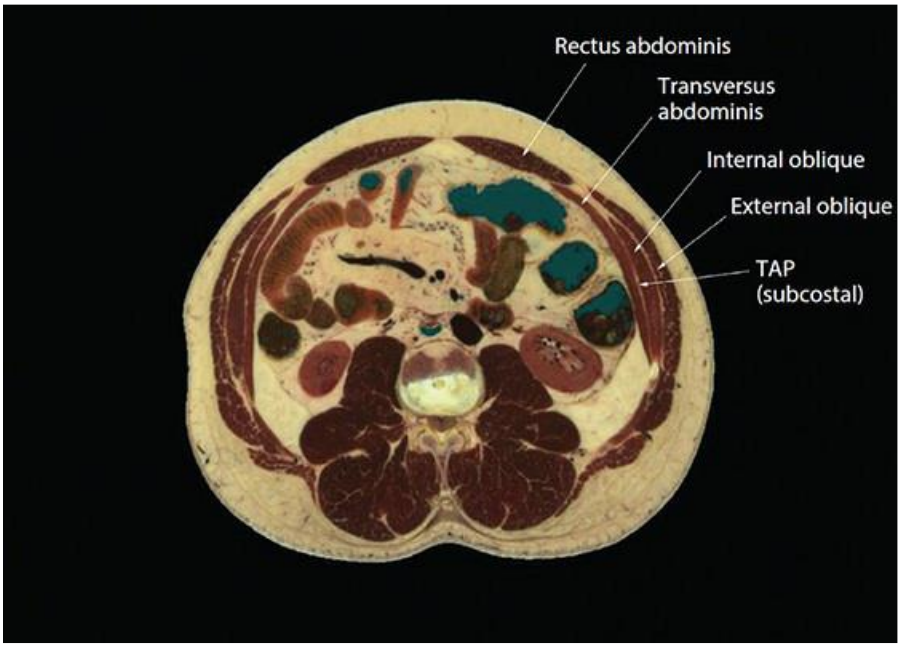


Figure 23: cross sectional cadaver anatomical section of the upper abdomen.

Nerves of the Anterior Abdominal Wall:

The skin and musculature of the abdominal wall receive innervation from the anterior primary rami of the lower six thoracic nerves (T7-T12) and the first lumbar nerve (L1) via the iliohypogastric and ilioinguinal branches. The anterior primary rami of the lower five intercostal nerves (T7-T11) exit their respective intercostal compartments and reside in a neurovascular plane between the internal oblique and transversus abdominis muscles. The intermuscular plane is also known as the transversus abdominis plane (TAP). The segmental nerves proceed anteriorly and medially toward the midline in the TAP, emitting their lateral cutaneous branches at the midaxillary line and penetrating the posterior lamina of the internal oblique aponeurosis anteriorly to access the rectus sheath. The nerves traverse the rectus sheath posterior to the rectus abdominis muscle and anterior to the epigastric arteries. Subsequently, they penetrate the rectus muscle and the anterior rectus sheath, emerging anteriorly as the anterior cutaneous branches that innervate the overlying skin. The lateral and anterior cutaneous branches innervate the abdominal skin from the midline to the anterior axillary line. T7 supplies sensory innervation to the epigastrium, T10 to the umbilicus, and L1 to the groin.

The subcostal nerve is the anterior primary ramus of the twelfth thoracic nerve and penetrates the abdomen posteriorly behind the lateral arcuate ligament of the diaphragm. It subsequently traverses laterally along the anterior border of the quadratus lumborum muscle and penetrates the transversus abdominis muscle to access the TAP. The continuation of the subcostal nerve's pathway resembles that of the other thoracolumbar nerves, with the exception that it innervates the pyramidalis muscle, and its lateral cutaneous branch innervates the superior and lateral portion of the gluteal region.
The first lumbar nerve (L1) bifurcates anterior to the quadratus lumborum muscle into the iliohypogastric and ilioinguinal nerves, which then penetrate the transversus abdominis muscle to access the transversalis fascia plane (TAP). The iliohypogastric nerve proceeds anteriorly within the transversus abdominis plane and penetrates the internal oblique muscle approximately 1 inch anterior to the anterior superior iliac spine. It subsequently becomes superficial by penetrating the external oblique aponeurosis near the superficial inguinal ring and innervates the skin of the suprapubic area. The lateral cutaneous branch of the iliohypogastric nerve innervates the superior and lateral portions of the gluteal area. The ilioinguinal nerve lacks a lateral cutaneous branch and also penetrates the internal oblique muscle. It subsequently traverses the inguinal canal across the spermatic

cord or the round ligament of the uterus, emerging via the superficial inguinal ring or the adjacent external oblique aponeurosis to innervate the skin of the upper and medial thigh and the genitalia.

Lateral (Midaxillary Line) Transverse Abdominis Plane:

The lateral (midaxillary) TAP denotes the neurovascular plane situated between the internal oblique and transversus abdominis muscles along the lateral abdominal wall. The thoracolumbar nerves (T10-L1) pass through the lateral (midaxillary) transversalis fascia.

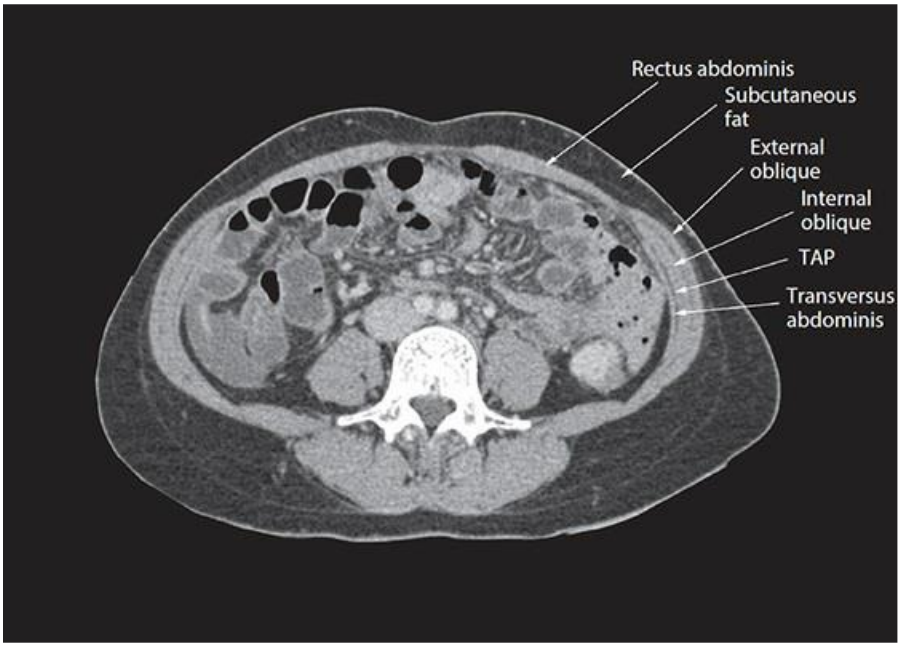


Figure 24: Transverse computed tomography of Abdomen.

Ultrasound Scan Technique:

Position: Patient is supine with the abdomen exposed between the subcostal edge and the iliac crest.
Operator and ultrasound apparatus: Right-handed operators utilizing the ultrasound transducer with their left hand and performing needle interventions with their right hand should position themselves on the patient's right side, with the ultrasound machine placed on the contralateral side and directly in front. This is the opposite for left-handed operators.

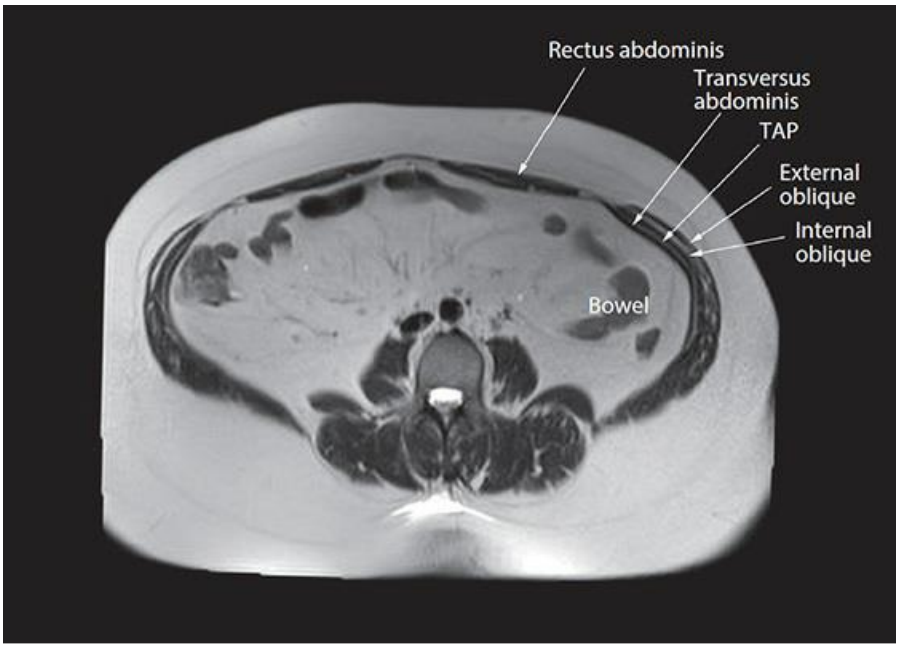


Figure 25: Transverse MRI of the abdomen.

Transducer selection: Linear array transducer with a high frequency range of 13-8 MHz.

Scanning methodology: The ultrasound transducer is positioned transversely across the lateral abdominal wall at the midaxillary line, situated between the costal border and the iliac crest. The objective is to delineate the three muscle strata of the lateral abdominal wall along with the fascial layers that interpose them in the ultrasonography. It may be essential to delicately maneuver the transducer in a craniocaudal orientation or to gently tilt or rotate the transducer to achieve an ideal ultrasound image.

Sonoanatomy: In a transverse ultrasound, the extraocular muscles (EOM), inferior oblique muscle (IOM), and transversus abdominis muscle (TAM) are discerned as three longitudinal, hypoechoic structures located beneath the skin and subcutaneous tissue. A hyperechoic fascial layer, likely the epimysium of the respective muscle, is observed between the three muscles. The EOM is the outermost (superficial) layer, the IOM is the intermediate layer, and the TAM is the innermost layer. The muscle thickness varies, with the transversus abdominis muscle (TAM) generally being the thinnest and appearing the darkest (hypoechoic) among the three muscles on the ultrasound. The TAP is situated between the IOM and TAM. Located beneath the transversalis fascia and the overlying peritoneum, both of which exhibit hyperechoic characteristics. Differentiating the fascia transversalis from the peritoneum on an ultrasonography is challenging; however,

the peritoneum can be recognized as a hyperechoic layer by noting the peristaltic movement of the bowel loops. The segmental thoracolumbar nerves are minor terminal branches that are challenging to delineate within the TAP using ultrasonography.

Occasionally, the terminal nerves may appear in the TAP as several flat, hyperechoic objects. The optimal approach involves identifying the distal nerves in the groin (iliohypogastric and ilioinguinal nerves) and subsequently tracing them back to the TAP using the trace back technique.

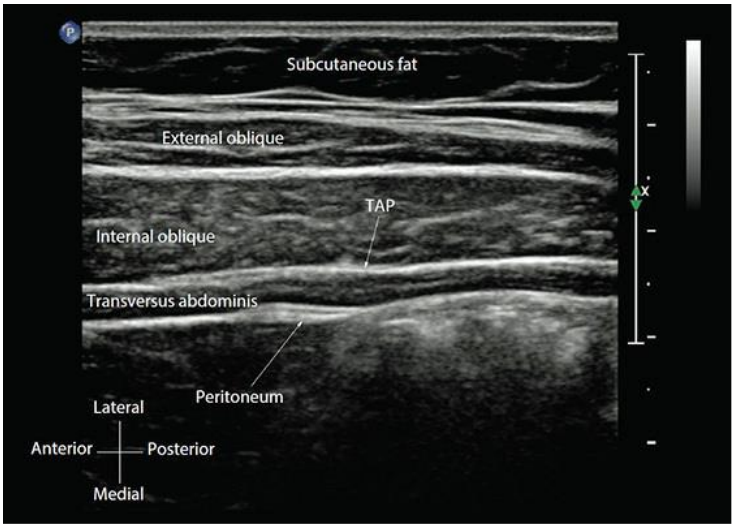


Figure 26: Transverse view of lateral abdominal wall showing TAP.

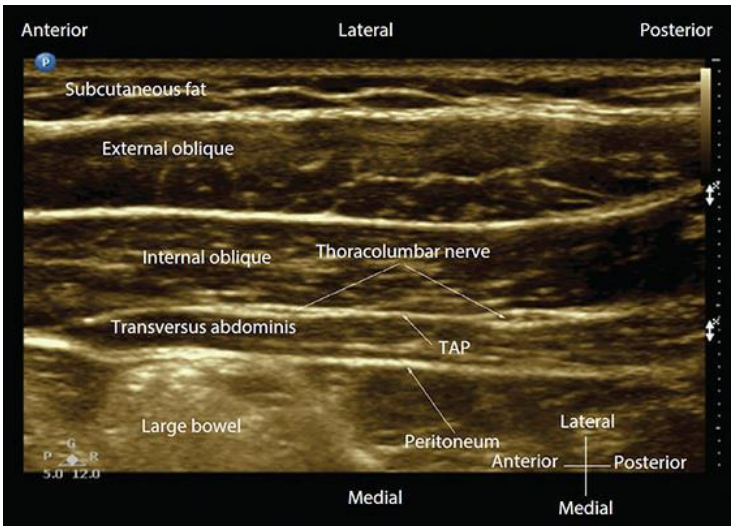


Figure 27: Transverse view of lateral abdominal wall showing TAP.

In a lateral (midaxillary) TAP block utilizing in-plane needle insertion, the needle insertion point (i.e., the medial distance from the transducer) can be ascertained by observing the depth of the TAP on the ultrasound monitor (depth scale). Normal saline may be utilized to hydrodissect the TAP to verify the accurate positioning of the needle tip prior to the administration of local anesthesia. A noticeable protrusion along the lateral abdominal wall, indicative of abdominal muscular paralysis, is frequently observed during the postoperative phase following a posterior TAP block.

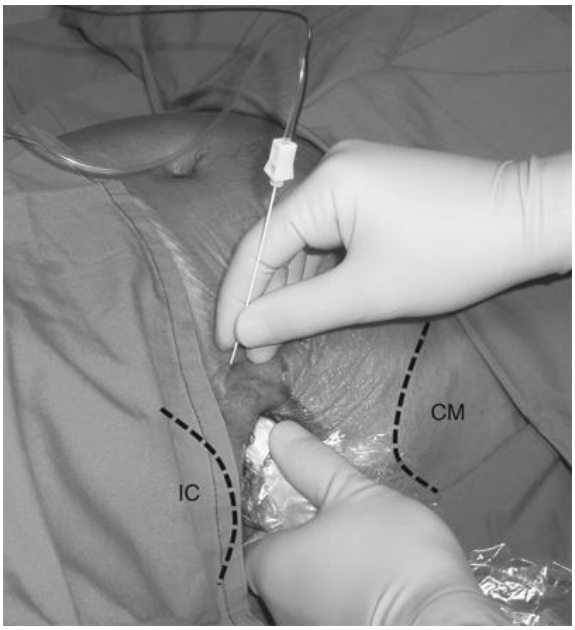


Figure 28: Probe placement

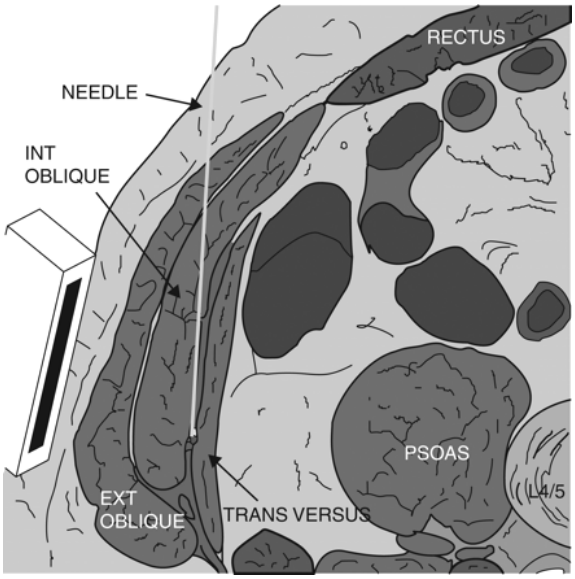


Figure 29: Needle trajectory in TAP block.

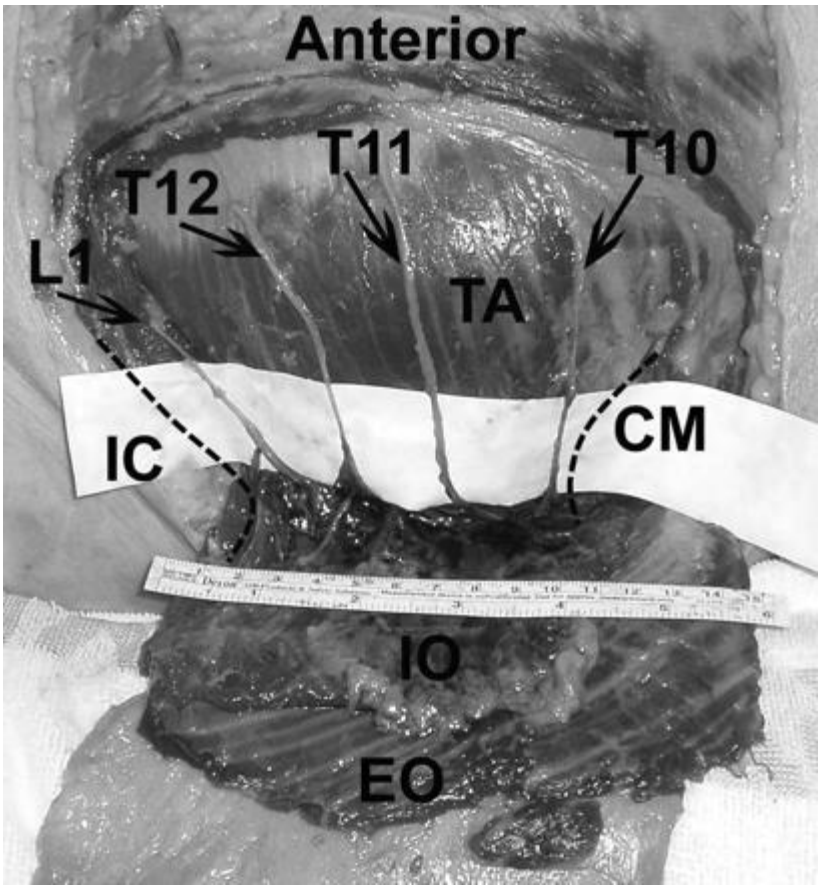


Figure 30: Nerves roots identified and involved in dye between the iliac crest and the costal margin. IC, iliac crest; CM, costal margin; TA, transversus abdominis muscle; IO, internal oblique muscle; EO, external oblique muscle; T10, 10th thoracic nerve root; T11, 11th thoracic nerve root; T12, 12th thoracic nerve root; L1, first lumbar nerve root.[134]

PHARMACOLOGY

BUPIVACAINE HCL:[90]

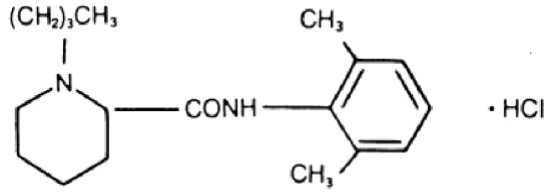


Figure 31: Structure of Bupivacaine HCL.

Bupivacaine Hydrochloride is a white crystalline powder that is freely soluble in 95 percent ethanol, soluble in water, and slightly soluble in chloroform or acetone.

Bupivacaine is a powerful local anesthetic distinguished by its unique properties within the amide class of local anesthetics, first identified in 1957. Local anesthetics are employed in regional anesthesia, epidural anesthesia, spinal anesthesia, and local infiltration. Local anesthetics often inhibit the formation of an

action potential in nerve cells by elevating the threshold for electrical stimulation. The advancement of anesthesia relies on parameters like the diameter, level of myelination, and conduction velocity of nerve fibers. In clinical practice, the sequence of nerve function loss is as follows.[90]
Nociception
Thermoreception
Touch
Proprioception
Skeletal muscle tone.

Pharmacodynamics:

All local anesthetics comprise three structural components: an aromatic ring, an interlinking group that is either an ester (procaine) or an amide (bupivacaine), and an ionizable amine group. Furthermore, all LAs possess two chemical features that dictate their activity: Lipid solubility and ionization constant (pKa)

The lipid solubility influences the potency, duration of effect, and plasma protein binding of local anesthetics. Local anesthetics penetrate nerve fibers in their neutral-free base form. The ionized and cationic forms obstruct conduction by their contact with the inner surface of the Na+ channel. Furthermore, local anesthetics with lower pKa exhibit a quicker beginning of action, indicating a greater proportion existing in an uncharged state, facilitating expedited diffusion to the cytoplasmic side of the Na+ channel.

Sodium channels are transmembrane proteins that transmit action potentials in axons, dendrites, and muscle tissue. They establish and sustain membrane potential in specific cardiac and neural cells. Na+ channels consist of one larger alpha subunit and one or two smaller beta subunits, varying by tissue type.

The alpha subunit, responsible for ion conduction and local anesthetic binding, comprises four analogous domains, each containing six alpha-helical membrane-spanning segments. The alpha-subunit's exterior surface is extensively glycosylated, facilitating the channel's appropriate orientation inside the cytoplasmic membrane. Unlike local anesthetics, scorpion poisons and tetrodotoxin bind to locations on the extracellular surface of the Na+ channel.

The conduction of nerve impulses occurs via the development of an action

potential along an axon; local anesthesia ensues when local anesthetics bind to the Na+ channel, inhibiting the Na+ permeability essential for the action potential. Local anesthetics specifically binds with open configuration of voltage-gated Na+ channels. Blockade of Na+ channels leads in diminished or abolished conduction in vascular smooth muscle, facilitating relaxation. This results in less pacemaker activity and an extended refractory period in the heart. This action is exclusive to bupivacaine because of its reduced dissociation rate from obstructed sodium channels, resulting in an extended maximal depolarization rate (Vmax) and the risk of ventricular arrhythmias. Additionally, LAs induce a dose-dependent myocardial depression and disrupt Ca2+ signaling in cardiac muscle by binding to and inhibiting cardiac voltage-gated Ca2+ and K+ channels.

Local anesthetics further bind to beta-adrenergic receptors and impede epinephrine-induced cAMP synthesis, which may elucidate the resistance of bupivacaine cardiovascular damage to conventional resuscitation protocols. Local anesthetics in the central nervous system (CNS) may induce heightened excitability, succeeded by subsequent depression.

Neuronal tissues have varying susceptibility to local anesthetics. Depolarizing currents in nerves propagate down the nodes of Ranvier, and blocking 2 to 3 nodes is necessary to entirely disrupt neuronal transmission. Smaller fibers possess reduced internodal lengths and, hence, are obstructed by local anesthetics more rapidly.

Pharmacokinetics:

Bupivacaine Hydrochloride exhibits a quick onset of action and provides prolonged anesthesia. The duration of anesthesia with Bupivacaine Hydrochloride is considerably longer than that of any other frequently utilized local anesthetic. A period of analgesia persists following the recovery of sensation, during which the requirement for potent analgesics diminishes.
The onset of action for dental injections typically ranges from 2 to 10 minutes, with anesthetic duration potentially extending two to three times longer than that of lidocaine and mepivacaine, lasting up to 7 hours in many individuals. The anesthetic effect is extended by the inclusion of epinephrine at a concentration of 1:200,000.
Local anesthetics exhibit variable degrees of binding to plasma proteins. Typically, a reduced plasma concentration of a drug correlates with an increased fraction of

the drug bound to plasma proteins.
Local anesthetics seem to traverse the placenta via passive diffusion. The rate and extent of diffusion are determined by (1) the extent of plasma protein binding, (2) the level of ionization, and (3) the degree of lipid solubility. The fetal/maternal ratios of local anesthetics seem to be inversely correlated with the extent of plasma protein binding, as only the free, unbound drug may undergo placental transfer. Bupivacaine Hydrochloride, characterized by a high protein binding capacity of 95%, exhibits a low fetal/maternal ratio ranging from 0.2 to 0.4. The degree of placental transfer is influenced by the drug's ionization and lipid solubility. Lipid-soluble, nonionized medicines easily permeate the fetal bloodstream from the maternal circulation.
Local anesthetics are transported to various bodily tissues based on the route of administration, with elevated concentrations observed in highly perfused organs, including the liver, lungs, heart, and brain.
Pharmacokinetic investigations of the plasma profile of Bupivacaine Hydrochloride following direct intravenous administration indicate a three-compartment open model. The first compartment is characterized by the swift intravascular dispersion of the medication. The second compartment signifies the distribution of the medicine throughout highly perfused organs, including the brain, myocardium, lungs, kidneys, and liver. The third compartment signifies the equilibration of the medication with inadequately perfused tissues, including muscle and adipose tissue.
The removal of drugs from tissue distribution mostly relies on the capacity of binding sites in the bloodstream to transport them to the liver for metabolism. Following the administration of Bupivacaine Hydrochloride for caudal, epidural, or peripheral nerve block in humans, peak plasma concentrations of bupivacaine occur within 30 to 45 minutes, then decreasing to negligible levels over the next three to six hours.
The pharmacokinetic properties of local anesthetics can be markedly influenced by hepatic or renal illness, the inclusion of epinephrine, factors affecting urine pH, renal blood flow, the method of drug administration, and the patient's age. The half-life of Bupivacaine Hydrochloride is 2.7 hours in adults and 8.1 hours in neonates.
In clinical tests, older individuals attained the peak distribution of analgesia and maximal motor blockage more swiftly than their younger counterparts. Geriatric patients demonstrated elevated peak plasma concentrations subsequent to the

administration of this medication. The overall plasma clearance was reduced in these patients.

Amide-type local anesthetics, including Bupivacaine Hydrochloride, are predominantly metabolized in the liver by conjugation with glucuronic acid. Individuals with hepatic illness, particularly those with severe hepatic impairment, may exhibit increased vulnerability to the possible toxic effects of amide-type local anesthetics.
Pipecoloxylidine is the primary metabolite of Bupivacaine Hydrochloride.
The kidney serves as the primary excretory organ for the majority of local anesthetics and their metabolites. Urinary excretion is influenced by urinary perfusion and variables that affect urine pH. Merely 6% of bupivacaine is eliminated intact in the urine.
Bupivacaine Hydrochloride, when provided at acceptable doses and concentrations, often does not cause irritation or tissue damage.

Indications:

Bupivacaine Hydrochloride is indicated for the provision of local or regional anesthetic or analgesia during surgical, dental, oral, diagnostic, therapeutic, and obstetrical procedures. Only the 0.25% and 0.5% concentrations are specified for obstetric anesthesia.
Insufficient experience with non-obstetrical surgical procedures in pregnant women precludes the recommendation of 0.75% Bupivacaine Hydrochloride concentration for this population.
Bupivacaine Hydrochloride is contraindicated for intravenous regional anesthetic (Bier Block).
The modes of administration and specified concentrations of Bupivacaine Hydrochloride are:

Subarachnoid block 0.5% Bupivacaine with 8.25% Dextrose
Local infiltration 0.25%
Peripheral nerve block at concentrations of 0.25% and 0.5%
Retrobulbar block 0.75%
Sympathetic block 0.25%
Lumbar epidural concentrations of 0.25%, 0.5%, and 0.75% (0.75% is contraindicated for obstetrical anesthesia)
Caudal 0.25% and 0.5%

Epidural test dose of 0.5% with epinephrine at a concentration of 1:200,000
Dental blocks at 0.5% concentration with epinephrine at a ratio of 1:200,000.

Adverse effects:

The dosage of bupivacaine is contingent upon the technique, tissue vascularity, anatomical region, number of segments to be anesthetized, required depth or duration of anesthesia, and the patient's physiological status. Bupivacaine may interact with ergot medicines for migraines, anticoagulants, antidepressants, or monoamine oxidase inhibitors. Immunological responses to local anesthetics are infrequent. Allergic responses to preservative-free amide-type local anesthetics are infrequent and typically unreported. A genuine anaphylactic response is more frequently associated with ester local anesthetics or preservatives; reactions to epinephrine-containing local anesthetics are sometimes erroneously identified as allergic reactions. Patients may also respond to preservatives like methylparaben, which are used in local anesthetics.

Methemoglobinemia is generally linked to benzocaine or prilocaine; yet, case studies indicate that bupivacaine may be involved in infrequent occurrences. Methemoglobinemia may be asymptomatic at low levels (1% to 3%), but concentrations between 10% and 40% can result in cyanosis, gray skin discolouration, tachypnea, dyspnea, exercise intolerance, weariness, dizziness, syncope, and weakness.

Common adverse effects encompass nausea, vomiting, chills, headache, back pain, dizziness, sexual dysfunction, restlessness, anxiety, vertigo, tinnitus, blurry vision, and tremors, which may precede more severe effects such as convulsions, myoclonic jerks, coma, and cardiovascular collapse.

Contraindications:

Contraindications encompass hypersensitivity to the drug or its constituents, hypersensitivity to amide anesthetics, infection at the injection site, obstetric paracervical block, obstetric anesthesia utilizing 0.75% concentration, intravenous regional anesthesia, and intra-articular continuous infusion. Clinicians must exercise caution in patients with sulfite hypersensitivity, hepatic impairment (since the liver metabolizes amides), renal impairment, compromised cardiac function,

heart block, hypovolemia, hypotension, and in old, debilitated, or severely unwell individuals.

Ropivacaine:[91]

Ropivacaine is a long-acting regional anesthetic structurally similar to Bupivacaine. It is a pure S(-) enantiomer, in contrast to Bupivacaine, which is a racemic mixture, designed to mitigate potential toxicity and enhance sensory and motor block characteristics.

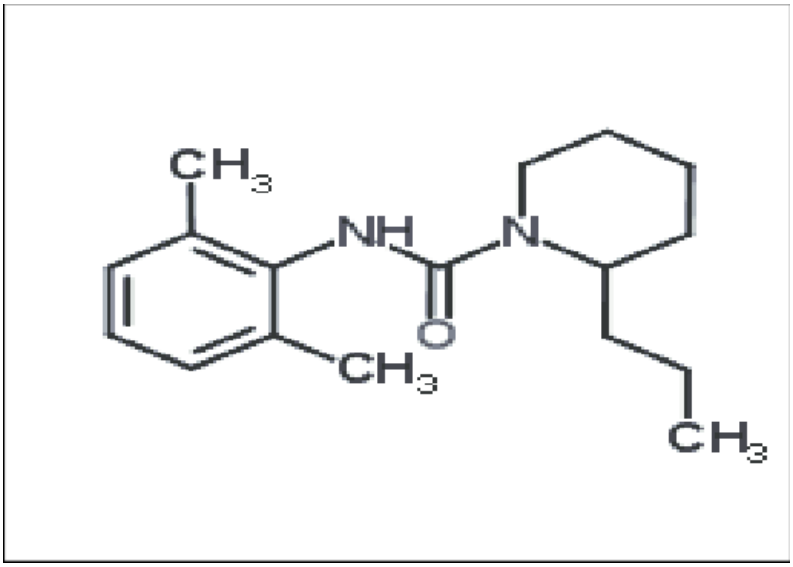


Figure 32: Structure of Ropivacaine

Pharmacodynamics:

Ropivacaine induces reversible suppression of sodium ion inflow, thereby obstructing impulse conduction in nerve fibers. This activity is enhanced by dose-dependent blockage of potassium channels. Ropivacaine exhibits lower lipophilicity compared to bupivacaine, resulting in reduced penetration of big myelinated motor fibers; hence, it selectively targets the pain-transmitting A β and C nerves rather than the Aβ fibers associated with motor function.

CNS and cardiovascular effects:

Ropivacaine exhibits lower lipophilicity compared to bupivacaine, and this, along with its stereoselective characteristics, results in a markedly elevated threshold for cardiotoxicity and CNS toxicity in both animal models and healthy human subjects.

The reduced lipophilicity of ropivacaine compared to bupivacaine is associated with the diminished cardiodepressant effects of both ropivacaine isomers relative to the bupivacaine isomers in animal investigations.

The central nervous system effects manifested prior to the onset of cardiotoxic symptoms during an intravenous infusion of local anesthetic (10 mg/min of ropivacaine or bupivacaine) in human subjects, prompting cessation of the infusion at that juncture. Notable alterations in cardiac function, including contractility, conduction time, and QRS width, were seen, with the increase in QRS width being much less pronounced with ropivacaine compared to bupivacaine.

Additional effects
Ropivacaine has demonstrated the ability to prevent platelet aggregation in plasma at concentrations of 3.75 and 1.88 mg/mL (0.375% and 0.188%), levels that may be present in the epidural space during infusion. Similar to other anesthetics, ropivacaine exhibits antibacterial activity in vitro, suppressing the proliferation of Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa.

Pharmacokinetics:

Absorption and distribution
The plasma concentration of ropivacaine is contingent upon the total dose given, the method of administration, the patient's hemodynamic and circulatory status, and the vascularity of the administration site.

Intravenous administration of ropivacaine in participants demonstrated linear and dose-proportional pharmacokinetics up to 80 mg. The absorption of 150 mg of ropivacaine from the epidural area is complete and exhibits a biphasic pattern. The average half-life of the early phase is roughly 14 minutes, succeeded by a slower phase with a mean absorption half-life of about 4.2 hours.

Ropivacaine exhibits a plasma protein binding rate of 94%, predominantly to α1-acid glycoprotein. The elevation in total plasma concentration after continuous epidural infusion of ropivacaine is attributed to an enhancement in protein binding and a resultant reduction in the clearance of ropivacaine.

Ropivacaine swiftly traverses the placenta following epidural administration for cesarean delivery, leading to nearly complete balance of the free fraction of ropivacaine in both maternal and fetal circulation. The overall plasma concentration of ropivacaine was lower in the fetal circulation compared to the maternal circulation, indicating the binding of ropivacaine to α1-acid glycoprotein, which is present in higher concentrations in maternal plasma than in fetal plasma.

Metabolism and excretion:
Ropivacaine undergoes substantial hepatic metabolism, mostly by aromatic hydroxylation to 3'-hydroxy-ropivacaine by cytochrome P450 (CYP) 1A2 and N-dealkylation to 2',6'-pipecoloxylidide by CYP3A4. The kidney serves as the primary excretory organ for ropivacaine, responsible for 86% of the drug's urinary excretion following a single intravenous injection. The mean ± SD terminal half-life is 1.8 ± 0.7 hours following intravenous treatment and 4.2 ± 1.0 hours after epidural administration.

Dose and uses:

Dosage recommendations for ropivacaine in adults and children

Indication in adults	Concentration (%)	Volume	Dose
In adults			
Surgical anaesthesia			
Lumbar epidural	0.75	15-20 mL	113-150 mg
(Caesarean section)			
Lumbar epidural	0.75	15-25 mL	113-188 mg
(Other surgery)	1	15-20 mL	150-200 mg
Thoracic (Single block for postoperative pain relief)	0.75	5-15 mL	38-113 mg
Intrathecal administration	0.5	3-4 mL	15-20 mg
Peripheral nerve block*	0.75	10-40 mL	75-300 mg
Field block†	0.75	1-30 mL	7.5-225 mg
Postoperative pain			
Lumbar epidural (Continuous infusion)	0.2	6-10 mL/h	12-20 mg/h
Thoracic epidural (Continuous infusion)	0.2	6-14 mL/h	12-28 mg/h
Peripheral nerve block (Continuous infusion)	0.2	5-10 mL/h	10-20 mg/h
Field block†	0.2	1-100 mL	2-200 mg
Intra-articular injection	0.75	20 mL	150 mg
Labour pain (Lumbar epidural)			

MATERIALS AND METHODS

SOURCE OF DATA:

This study conducted in the Department of Anesthesiology, B.L.D.E. (Deemed to be University) Shri B. M. Patil Medical College, Hospital and Research Centre, Vijayapura.

METHOD OF COLLECTION OF DATA:

Study Design: A Randomized Controlled Trial.

Study Period: 18 months.

Sample Size and Randomization:

The anticipated Mean ± SD of Postoperative Pain at 24 hours in control group 3.50±1.76 and in ERAS group 2.46±1.58 respectively. The required minimum sample size is 50 per group (i.e. a total sample size of 100, assuming equal group sizes) to achieve a power of 90% and a level of significance of 5% (two sided), for detecting a true difference in means between two groups.

$$N = 2\left[\frac{(Z_{\propto}+z_{\beta})*S}{d}\right]^2$$

$Z_{\propto}$ Level of significance=95%
Z_{β} --power of the study=90%
d=clinically significant difference between two parameters
SD= Common standard deviation

Statistical Analysis

- The data obtained will be entered in a Microsoft Excel sheet, and statistical analysis will be performed using statistical package for the social sciences (Version 20).
- Results will be presented as Mean ± SD, counts and percentages and diagrams.
- For normally distributed continuous variables between two groups will be compared using independent t test for not normally distributed variables Mann Whitney U test will be used.

- Categorical variables between two groups will be compared using Chi square test.
- $p<0.05$ will be considered statistically significant. All statistical tests will be performed two tailed.

STUDY POPULATION

Parturient aged between 25 and 45, with a gestational age of 38 weeks, and scheduled for an elective caesarean delivery under spinal anaesthesia, the participant must be willing to take part in the study and have no history of significant cardiovascular, coagulation, or metabolic malfunction.

INCLUSION CRITERIA:

- Parturient scheduled for planned Caesarean delivery
- ASA grades I and II
- Maternal age 25 to 45 years

EXCLUSION CRITERIA

- Hypotension /Hypertension
- Obesity
- Fetal compromise
- Preterm gestation
- Coagulopathies
- Maternal age less than 25 years
- Allergy to study agents
- Contraindications to TAP block.

METHODOLOGY:

Pre-anaesthetic evaluation: Patients participated in the study after a thorough preoperative evaluation, which includes the following:

History:
History of underlying medical illness, previous history of surgery, previous anaesthetic exposure, and hospitalization was obtained.

Physical examination:
The patient's overall condition, including vital signs (heart rate, blood pressure, respiratory rate), height and weight, as well as an examination of the

cardiovascular system, respiratory system, central nervous system, and vertebral system. Additionally, an airway assessment was conducted using Mallampati grading which helped to predict the ease of intubation based on the visibility of the patient's oropharyngeal structures. This thorough preoperative assessment is crucial for determining the appropriate anesthetic plan and ensuring patient safety throughout the surgical process.
2. After explaining the procedure and its potential complications, informed written consent was obtained from the willing patients.

PROCEDURE:
Patients were randomized by computer-generated random numbers, and group allotment was concealed in sealed envelope covers. This randomized study conducted in our institute on 100 parturient undergoing Elective Cesarean Section.

The patients were divided into two groups: ERAS group and control group in 1:1 ratio by a computer-generated randomization sequence. According to the group assigned, they were managed with the ERAS protocol or routine protocol.

Control Group: Routine Protocol (RP)
ERAS Group: ERAS Protocol (EP)
Results will be recorded using a preset performance.

Once the patient was transferred to the preoperative holding area, the standard monitoring equipment was set up, which included a pulse oximeter, Non-invasive blood pressure monitoring and ECG leads. Baseline readings for heart rate, blood pressure, and oxygen saturation were recorded to ensure the patient’s stability before proceeding and a 20G IV cannula is secured.

Routine Protocol and ERAS Protocol:

	Routine Protocol	ERAS Protocol
Education/Counselling	There will not be any advance disclosure of perioperative information.	Details on the perioperative process, the pain management strategy, the requirement for early feeding, mobilization, lactation support services, discharge criteria, follow-up program, etc.
Preoperative oral intake	a six - hour fasting before surgery	fluid intake up to two hours before surgery
Standard Anaesthetic Protocol	Received Bupivacaine Heavy 0.5% 10mg with Buprenorphine 60mcg[15]	Received Bupivacaine Heavy 0.5% 10mg with Buprenorphine 60mcg[15]
Postoperative Pain management	After delivery Inj. Paracetamol 1g i.v Followed by Tab. Paracetamol 650mg P/O for the following 2 days.	Ultrasound Guided Bilateral TAP block after the closure of skin and dressing.
Breakthrough pain management	If VAS>3 or the patient asked for additional analgesics Inj. Tramadol hydrochloride 100mg i.v. as a rescue dose.	If VAS>3 or the patient asked for additional analgesics Inj. Tramadol hydrochloride 100mg i.v. as a rescue dose.
Prevention of PONV	Ondansetron 4mg i.v. given 30 minutes prior to surgery in preoperative area.	Granisetron 2mg i.v., immediately after the childbirth.
Intraoperative Uterotonics	As soon as the cord is clamped, Oxytocin 5U slow intravenous bolus followed by 10U diluted in 250ml NS slowly.	As soon as the cord is clamped, Oxytocin 5U slow intravenous bolus followed by 10U diluted in 250ml NS slowly.
Prophylactic Antibiotics	Ceftriaxone 1g i.v., and Metronidazole 500mg 30-60 min before incision.	Ceftriaxone 1g i.v., and Metronidazole 500mg 30-60 min before incision.
Perioperative fluid and blood pressure management	Crystalloid infusion is preferred for controlling hypotension. If required, phenylephrine 50 mcg/bolus.	Aim to not overhydrate. In order to combat hypotension, both fluids and vasopressors are used. Spinal anaesthesia is administered after prophylactic phenylephrine 50 mcg.

Preventing Intraoperative hypothermia	without a warm air blower, covering the bedding.	Before surgery, a warm air blower was used to warm the beds.
Postoperative oral intake	Until bowel movements like flatus or stools resume	Early oral intake should be initiated two hours after surgery and should begin with a light meal of less than 200 mL. It should then be gradually increased in accordance with gastrointestinal tolerance.
Postoperative mobilization	Mobilization according to the patient's preference	Depending on tolerance, self-umbilical massage. six hours following surgery, actively flipped over. On the first day following surgery, mobilization should start at the bedside and progress to walking through the ward.
Skin to skin breastfeeding	As per patient’s preference	Early skin-to-skin contact with the newborn is advised, right after returning to the ward. Breastfeeding within an hour of operation, as needed by the baby.

Table 11: ERAS protocol (EP) vs ROUTINE protocol (RP)

NOTE: Hypotension is defined as a decrease in blood pressure of below 80% of baseline.

Abbreviations: PONV, postoperative nausea and vomiting, ERAS, enhanced recovery after surgery, TAP, Transverse Abdominis Plane.

Bilateral Transverse abdominis Plane block will be given after the end of surgery using Ultrasound Guidance immediately. A Bolus dose of 20mL of Ropivacaine 0.5% with Dexamethasone will be injected on each side.

Patient is supine with the abdomen exposed between the subcostal edge and the iliac crest. The Bilateral side was marked and skin preparation was applied and allowed to dry. Proper monitors were applied.

Linear array transducer with a high frequency range of 13-8 MHz with strile probe cover, was placed over the three layers of the abdominal musculature and grossly identified using sterile coupling gel following institutional skin preparation. The three layers of the abdominal musculature were carefully identified in the sub-

costal/peri-umbilical/Ilioinguinal and iliohypogastric region. An echogenic block needle was then advanced maintaining an in-plane visualization throughout the procedure, under ultrasound guidance from lateral to medial or superior to inferior to come to rest just deep to the internal oblique muscle. Upon negative aspiration, 20mLs of Ropivacaine 0.5%, with 4mg of dexamethasone was administered safely and cautiously at each side. Aspiration every 5 cc was done to avoid potential intravascular injection. All injections were done without resistance and were free of blood. After the completion of the block the patient will be shifted to post-anesthesia care unit for monitoring.

The Visual Analog Scale (VAS) score (0, no pain; 10, most serious pain) will be evaluated postoperatively at 24th hour both at rest and motion and once at the 48th hour both at rest and motion, and the values will be recorded. At any point during the study if VAS>3 or if the patient requested extra analgesia Tramadol 100mg in 100 ml NS infusion over a period of 20 to 30 minutes will be given and will be recorded for analysis.

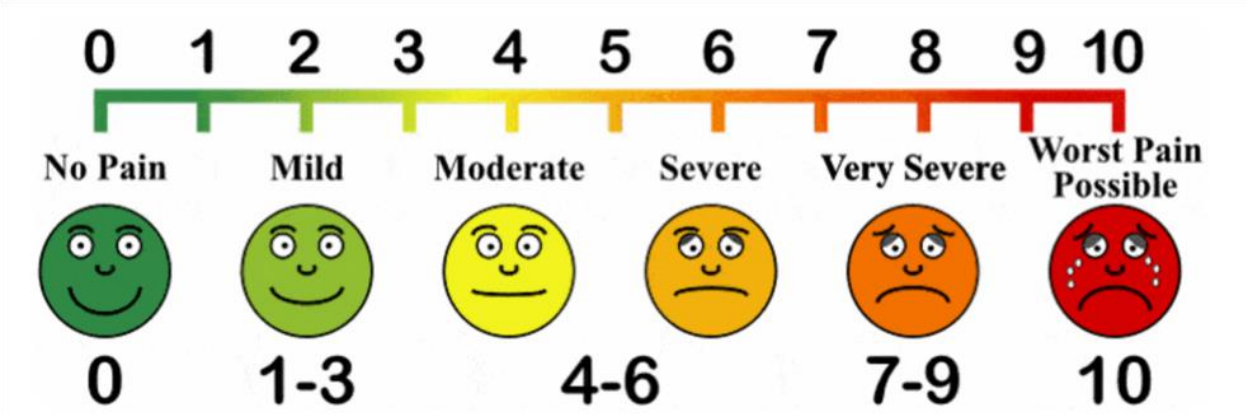


Figure 33: Visual Analogue Scale (VAS)

At the time of discharge, the maternal subjective experience has been assessed with a visual Analogue satisfaction scale. The VAS consisted of 1 ~ 10 points. Zero-point means not satisfied at all and 10-point means very satisfied.

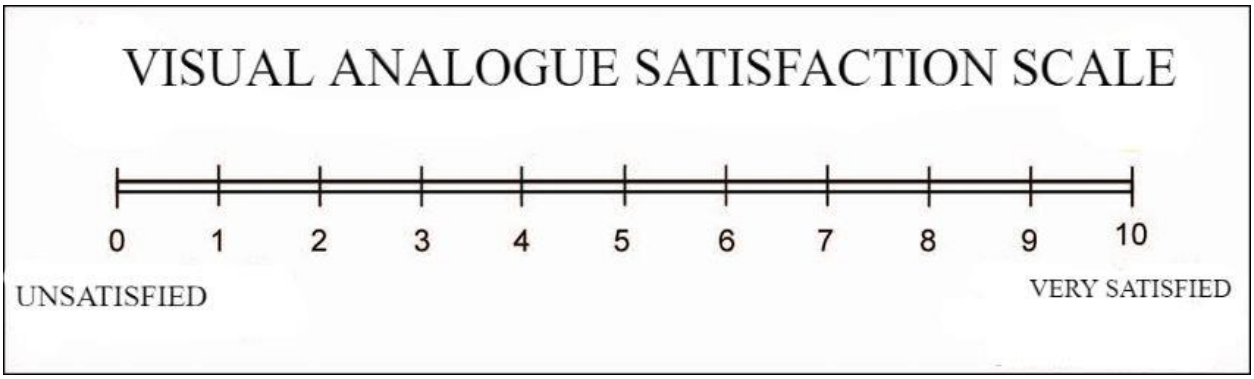


Figure 34: Visual Analogue Satisfaction Scale.

At the time of discharge, the details of total hospitalization cost will be obtained from the patient, after explaining that the details will be used in the study.

Figure 35: IOB Forced-Air Warming System

Figure 36: IOB Forced-Air Warming System

Figure 37: Cocoon patient warming blanket

Figure 38 & 39:Niscomed Infusion and Blood Fluid Warmer (NMIW-02)

Figure 40: Fluid warmer and forced air warmer.

RESULTS

1. **AGE:**

AGE	GROUP EP N=50	GROUP RP N=50	P value
25 to 27	24	24	0.633
28 to 31	19	16	
32 to 35	4	9	
36 to 39	3	1	

Table 12: Age distribution between the groups.

	Group EP	Group RP
Mean	28.48	28.18
Std. Deviation	3.2023	3.0619
Maximum	38	36
Minimum	25	25

Table 13: mean and std deviation between the groups.

Statistically insignificant as P value is more than 0.05

Mean age distribution between the groups were statistically insignificant, it was comparable between the groups as shown in the table.

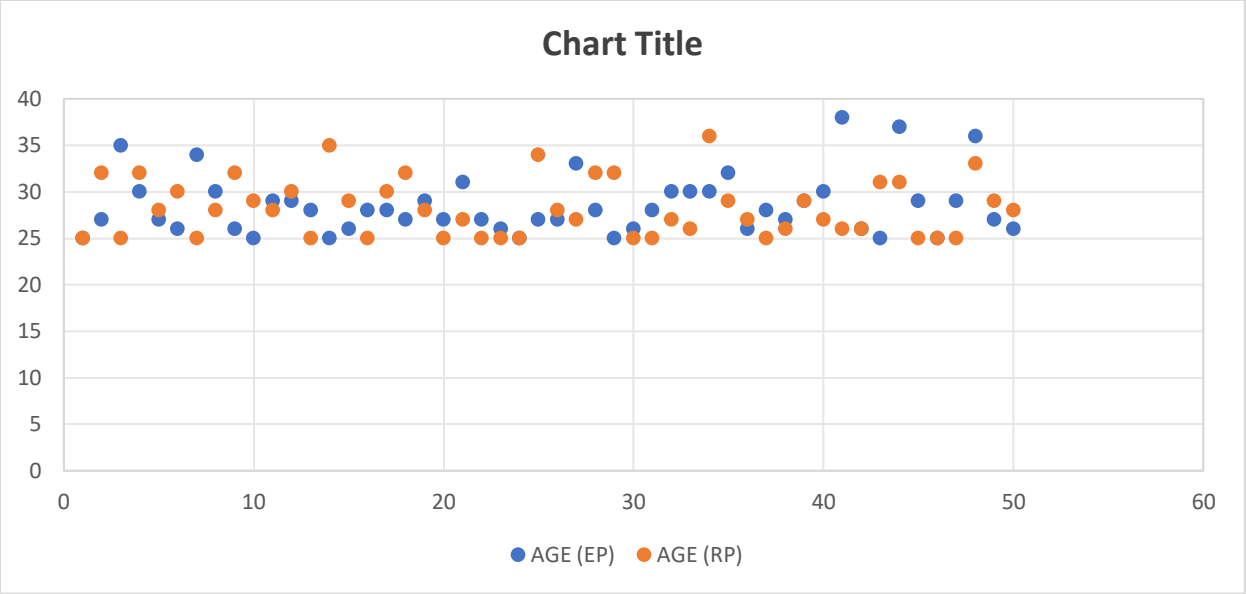


Chart 1: Age distribution among groups.

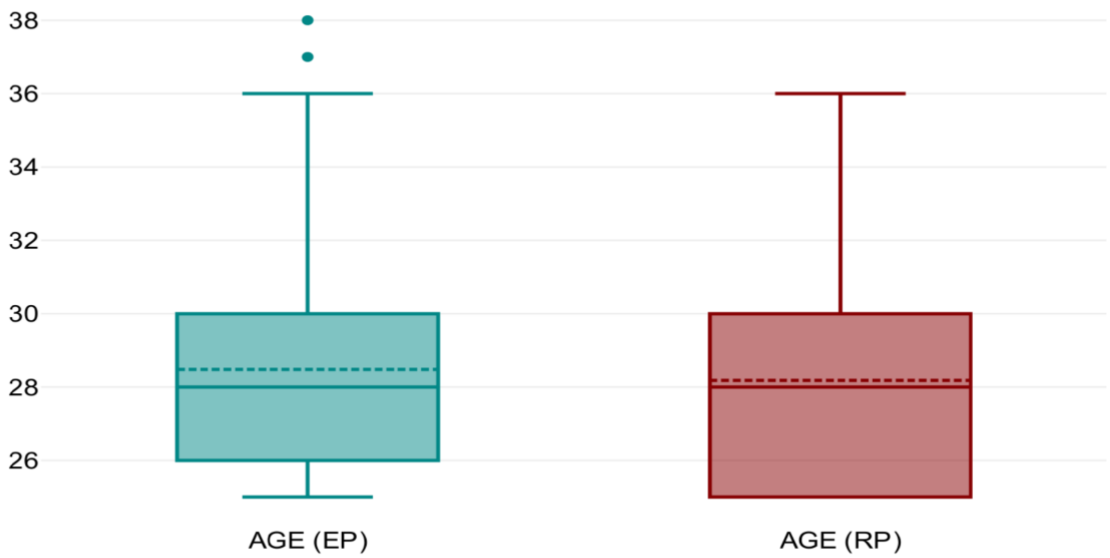


Chart 2: Mean and Std deviation among groups.

2. PARITY:

			GROUP		Total	P VALUE
			EP	RP		
PARITY	1	Count	7	9	16	0.591
		% within PARITY	43.8%	56.3%	100.0%	
	2	Count	19	22	41	
		% within PARITY	46.3%	53.7%	100.0%	
	3 or More	Count	24	19	43	
		% within PARITY	55.8%	44.2%	100.0%	
Total		Count	50	50	100	
		% within PARITY	50.0%	50.0%	100.0%	

Table 14: Parity comparison between the groups.

Statistically insignificant as P value is more than 0.05.

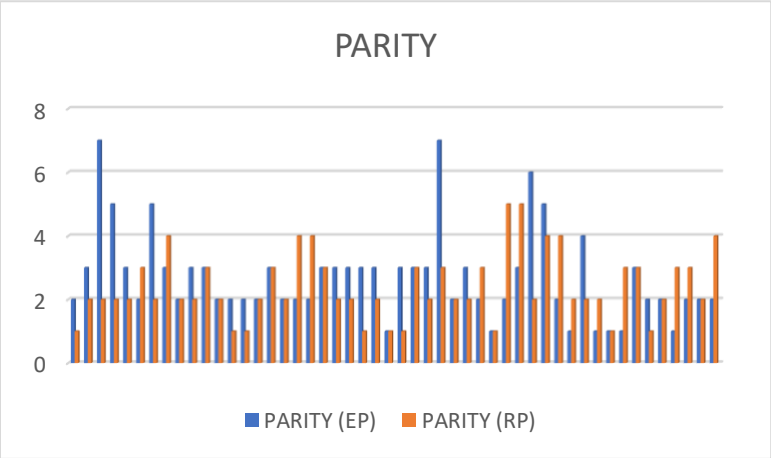


CHART 3: Parity comparison among the groups.

Parity distribution between the groups were statistically insignificant, it was comparable between the groups as shown in the table.

3. BODY MASS INDEX:

BMI	EP	50	26.462	2.6324	P value
	RP	50	28.238	3.3550	0.006

Table 15: Body Mass Index.

The distribution of Body Mass Index in both groups were comparable and the P value > 0.005.

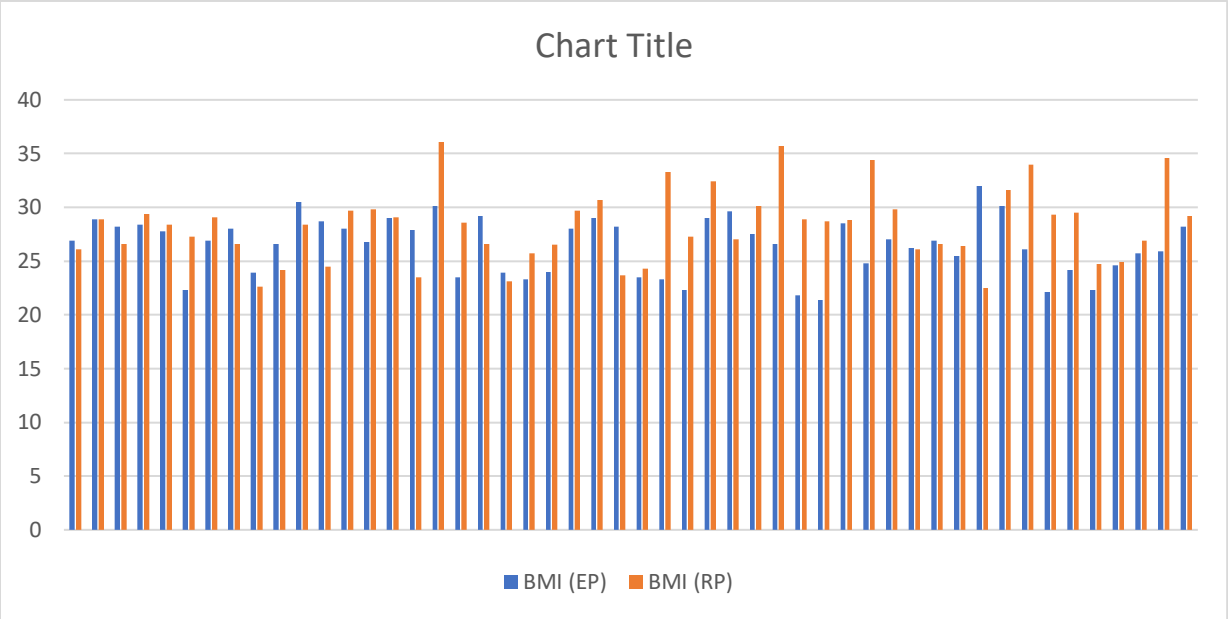


Chart 4: BMI.

4. Gestation:

			GROUP		Total	P value
			EP	RP		
GESTATION	SINGLE	Count	48	49	97	0.558
		% within GESTATION	49.5%	50.5%	100.0%	
	TWIN	Count	2	1	3	
		% within GESTATION	66.7%	33.3%	100.0%	
Total		Count	50	50	100	
		% within GESTATION	50.0%	50.0%	100.0%	

Table 16: Gestation.

The distribution of Gestation in both the groups were comparable and the P value is > 0.005.

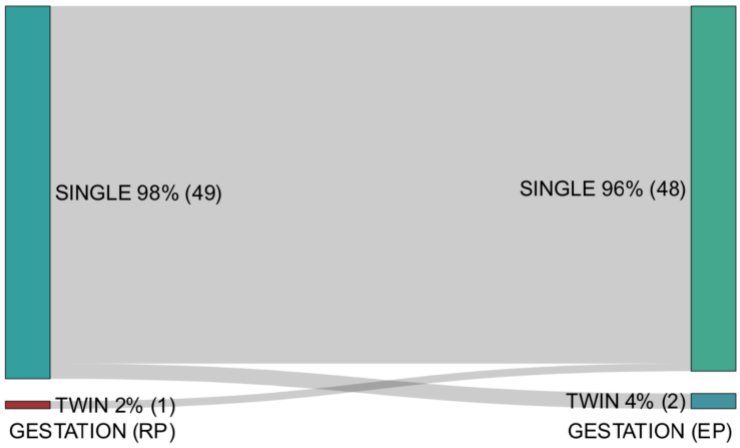


Diagram 2: Distribution of gestation between groups.

5. **Intraoperative vomiting:**

						P value
			GROUP			
			EP	RP	Total	
INTRAOPERATIVE VOMITING	NO	Count	49	50	99	0.315
		% within INTRAOPERATIVE VOMITING	49.5%	50.5%	100.0 %	
	YES	Count	1	0	1	
		% within INTRAOPERATIVE VOMITING	100.0 %	0.0%	100.0 %	
Total		Count	50	50	100	
		% within INTRAOPERATIVE VOMITING	50.0%	50.0%	100.0 %	

Table 17: Intraoperative Vomiting.

Between these two groups, only one patient in Group EP had a single episode of vomiting intraoperatively. No patients in Group RP had vomiting intraoperatively. Intraoperative vomiting among both these are comparable and the P value is > 0.005.

6. **Intraoperative shivering:**

Among the 50 patients in each group, 5 patients in Group EP and 17 patients in Group RP had experienced shivering during intraoperative period. There is significant difference in intraoperative shivering between these groups. The P value is 0.004 which is significant.

						P value
			GROUP			
			EP	RP	Total	
INTRAOPERATIVE SHIVERING	NO	Count	45	33	78	0.004
		% within INTRAOPERATIVE SHIVERING	57.7%	42.3%	100.0%	
	YES	Count	5	17	22	
		% within INTRAOPERATIVE SHIVERING	22.7%	77.3%	100.0%	
Total		Count	50	50	100	
		% within INTRAOPERATIVE SHIVERING	50.0%	50.0%	100.0%	

Table 18: Intraoperative Shivering.

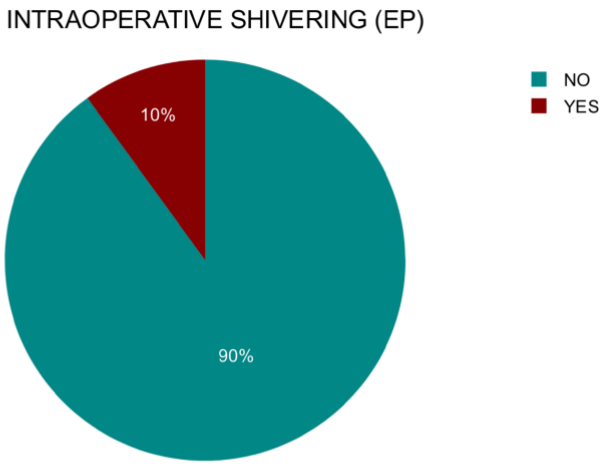


Chart 5: Shivering Group EP

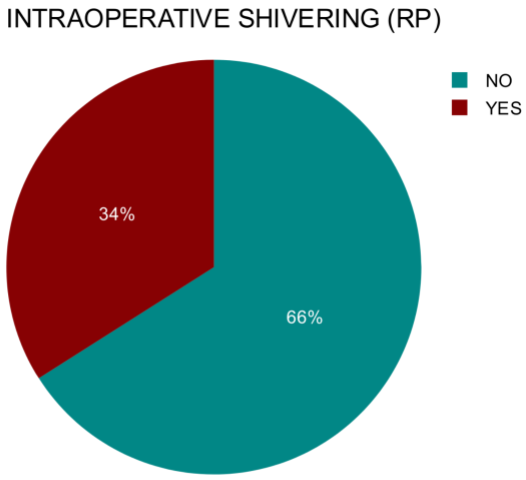


Chart 6: Shivering Group RP

7. **Intraoperative Hypotension.**

In Group EP, 10 patients out of total 50 patients had hypotension intraoperatively. In Group RP, 32 patients out of total 50 patients had Hypotension intraoperatively. The patients in Group RP had higher incidence of intraoperative Hypotension compared to Group EP.

The p value is <0.005, there is a significant difference in occurrence of Hypotension intraoperatively between these groups.

			GROUP			
			EP	RP	Total	P value
INTRAOPERATIVE HYPOTENSION	NO	Count	40	18	58	0.000
		% within INTRAOPERATIVE HYPOTENSION	69.0%	31.0%	100.0%	
	YES	Count	10	32	42	
		% within INTRAOPERATIVE HYPOTENSION	23.8%	76.2%	100.0%	
Total		Count	50	50	100	
		% within INTRAOPERATIVE HYPOTENSION	50.0%	50.0%	100.0%	

Table 19: Intraoperative Hypotension.

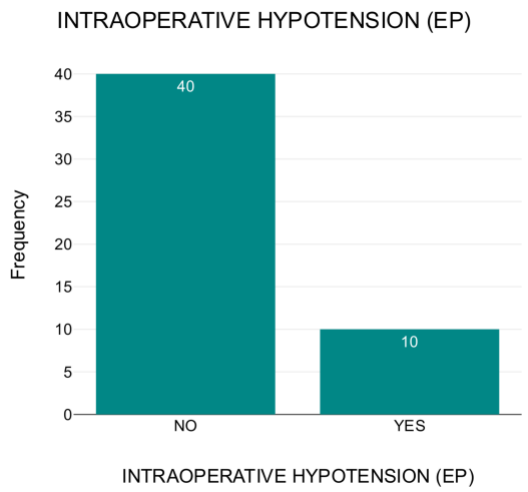


Chart 7: Hypotension Group EP

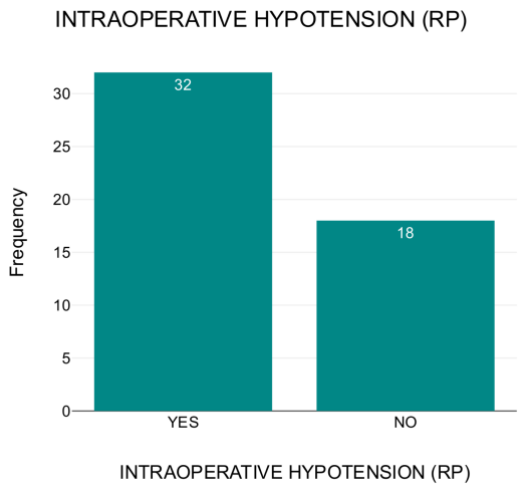


Chart 8: Hypotension Group RP

8. Intraoperative Nausea:

In Group EP, 5 patients out of total 50 patients had Nausea intraoperatively. In Group RP, 6 patients out of total 50 patients had Nausea intraoperatively. The p value is >0.005, there is no significant difference in occurrence of Nausea intraoperatively between these groups.

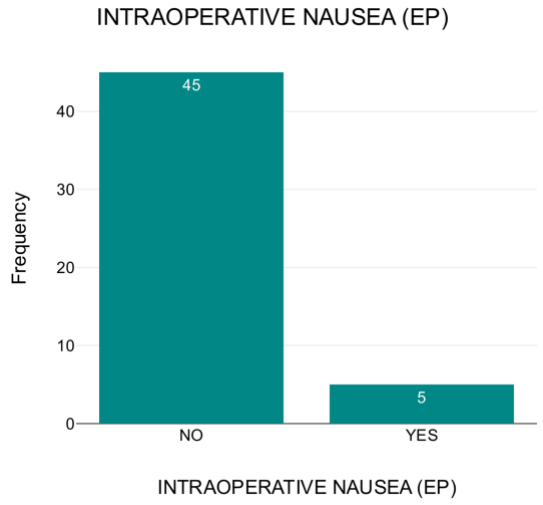


Chart 9: Nausea Group EP

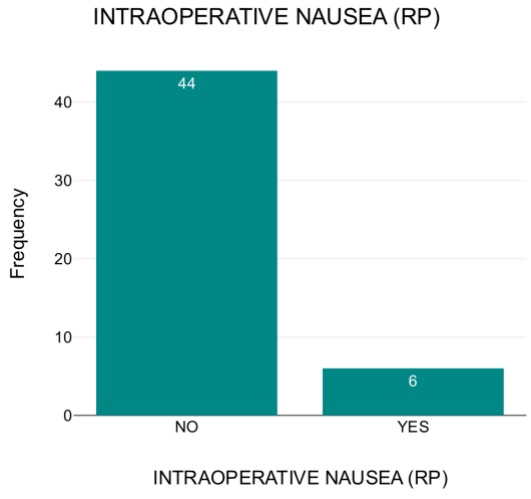


Chart 10: Nausea Group RP

INTRAOPERATIVE NAUSEA GROUP Crosstabulation						P value
			GROUP			
			EP	RP	Total	
INTRAOPERATIVE NAUSEA	NO	Count	45	44	89	0.749
		% within INTRAOPERATIVE NAUSEA	50.6%	49.4%	100.0 %	
	YES	Count	5	6	11	
		% within INTRAOPERATIVE NAUSEA	45.5%	54.5%	100.0 %	
Total		Count	50	50	100	
		% within INTRAOPERATIVE NAUSEA	50.0%	50.0%	100.0 %	

Table 20: Intraoperative Nausea.

9. Postoperative Nausea:

In Group EP, 9 patients out of total 50 patients had Nausea postoperatively. In Group RP, 17 patients out of total 50 patients had Nausea postoperatively. The **P** value is >0.005, there is no significant difference in occurrence of Nausea postoperatively between these groups.

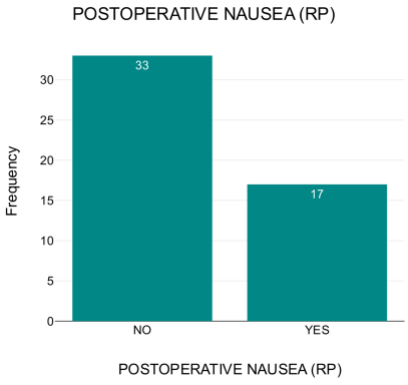


Chart 11: Postoperative Nausea (RP).

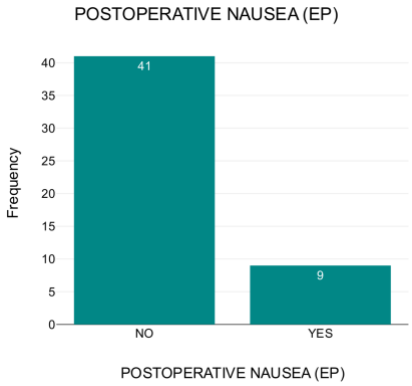


Chart 12: Postoperative Nausea (EP).

						P valve
			GROUP			
			EP	RP	Total	
POSTOPERATIVE NAUSEA	NO	Count	41	33	74	
		% within POSTOPERATIVE NAUSEA	55.4%	44.6%	100.0 %	
	YES	Count	9	17	26	
		% within POSTOPERATIVE NAUSEA	34.6%	65.4%	100.0 %	
Total		Count	50	50	100	
		% within POSTOPERATIVE NAUSEA	50.0%	50.0%	100.0 %	

Table 21: Postoperative Nausea.

10. **POSTOPERATIVE VOMITING:**

In Group EP, 3 patients out of total 50 patients had Vomiting postoperatively. In Group RP, 7 patients out of total 50 patients had Vomiting postoperatively. The **P** value is >0.005, there is no significant difference in occurrence of vomiting postoperatively between these groups.

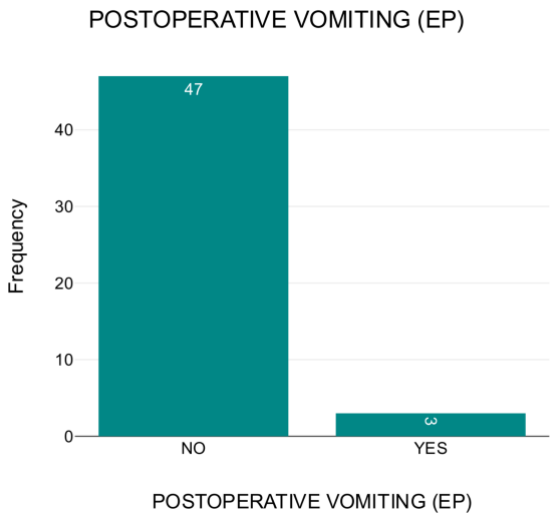


CHART 13: POST OPERATIVE VOMITING (EP)

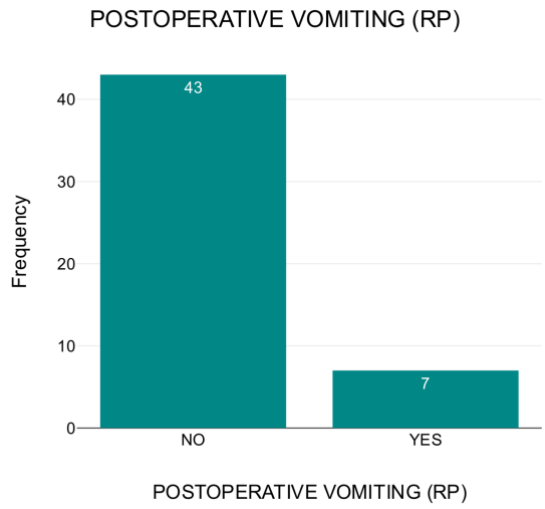


CHART 14: POST OPERATIVE VOMITING (RP)

						P value
			GROUP			
			EP	RP	Total	
POSTOPERATIVE VOMITING	NO	Count	47	43	90	0.182
		% within POSTOPERATIVE VOMITING	52.2%	47.8%	100.0 %	
	YES	Count	3	7	10	
		% within POSTOPERATIVE VOMITING	30.0%	70.0%	100.0 %	
Total		Count	50	50	100	
		% within POSTOPERATIVE VOMITING	50.0%	50.0%	100.0 %	

Table 22: Postoperative Vomiting.

11. Assessment of postoperative pain using Visual Analogue Scale:

CHARECTERISTICS VAS	**GROUP EP N=50**	**GROUP RP N=50**	**P value**
Rest in 24 hours	1.76 ± 0.8221	2.96 ± 0.9467	0.000
Motion in 24 hours	2.46 ± 0.8134	3.78 ± 0.8873	0.000
Rest in 48 hours	2.3 ± 0.8631	2.54 ± 0.9304	0.184
Motion 48 hours	2.98 ± 0.714	3.42 ± 0.9495	0.010

Table 23: Postoperative Pain assessment using VAS.

Postoperative pain was evaluated in patients 24 hours post-surgery at rest using the Visual Analog Scale (VAS). The mean VAS score in Group EP (1.76 ± 0.8221, P<0.005) was significantly lower than that in Group RP (2.96 ± 0.9467, P<0.005).

Postoperative pain was evaluated in patients 24 hours post-surgery at motion using the Visual Analog Scale (VAS). The mean VAS score in Group EP (2.46 ± 0.8134, P<0.005) was significantly lower than that in Group RP (3.78 ± 0.8873, P<0.005).

Postoperative pain was evaluated in patients 48 hours post-surgery at rest using the Visual Analog Scale (VAS). The mean VAS score in Group EP (2.3 ± 0.8631, P>0.005) was comparable to that in Group RP (2.54 ± 0.9304, P>0.005).

Postoperative pain was evaluated in patients 48 hours post-surgery at rest using the Visual Analog Scale (VAS). The mean VAS score in Group EP (2.98 ± 0.714, P>0.005) was comparable to that in Group RP (3.42 ± 0.9495, P>0.005).

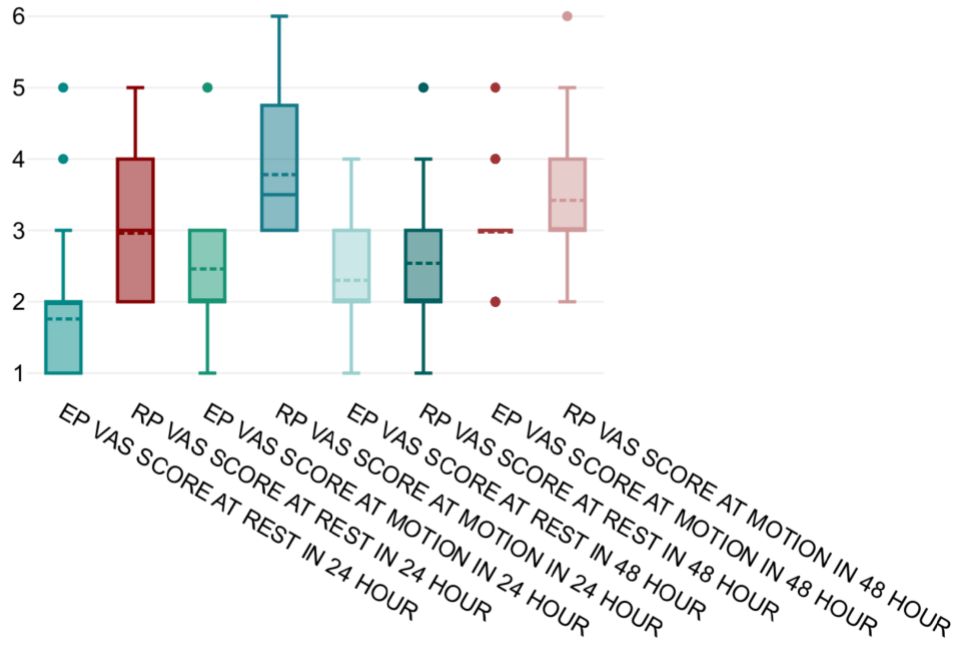


Chart 15: VAS score at 24 and 48 hours.

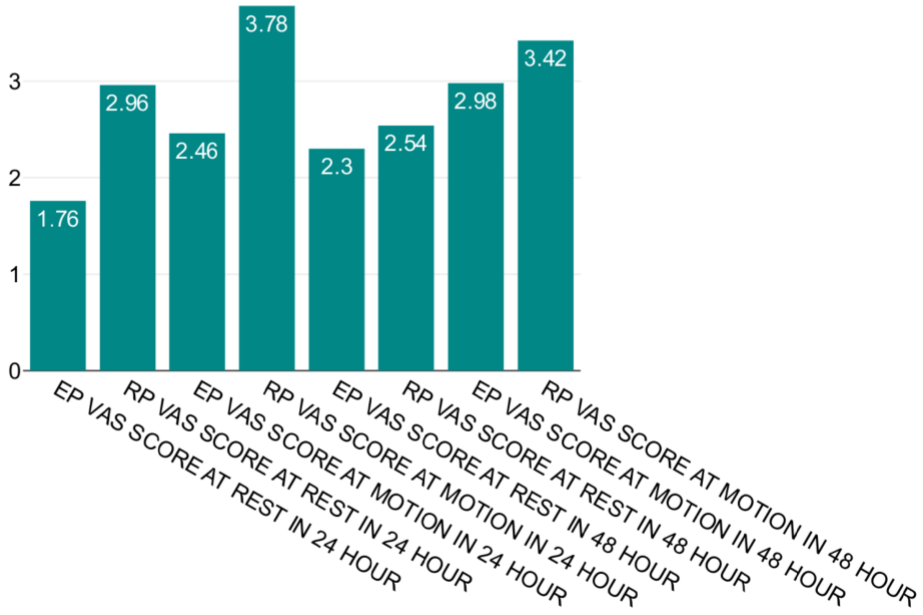


Chart 16: Postoperative VAS score.

12. Requirement of extra Analgesics and Opioid consumption:

CHARECTERISTICS	GROUP EP N=50	GROUP RP N=50	P value
Opioid consumption at 24 hours	2 (4%)	25 (50%)	0.000
Opioid consumption at 48 hours	8 (16%)	19 (38%)	0.013
Requirement of extra analgesics	9 (18%)	32 (64%)	0.000

Table 24: Requirement of extra Analgesics and Opioid consumption.

The number of patients required opioids at 24 hours in Group EP and Group RP was 2(4%) and 25 (50%) respectively. The number of patients required opioids in Group EP is significantly lower than that in Group RP with a P value less than 0.005.

The number of patients required opioids at 48 hours in Group EP and Group RP was 8 (16%) and 19 (38%) respectively. The number of patients required opioids in Group EP and Group RP is comparable with a P value greater than 0.005.

The requirement for Extra analgesics in Group EP 9 (18%) is significantly lower than that in Group RP 32 (64%) with a P value less than 0.005.

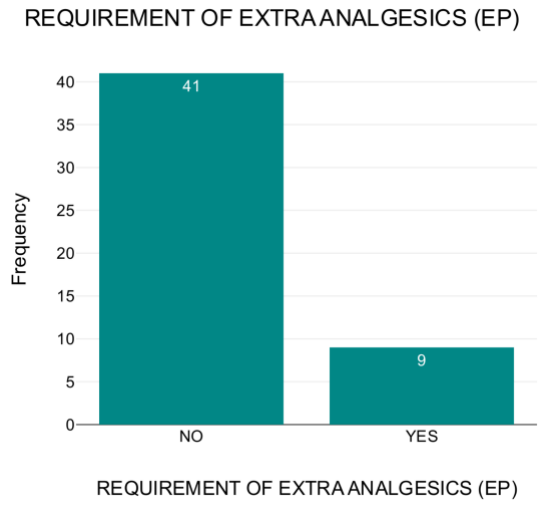


Chart 17: requirement of extra analgesics in Group EP.

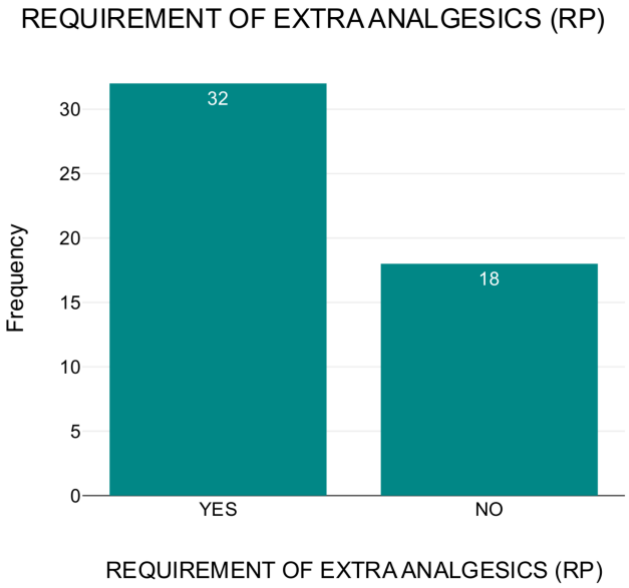


Chart 18: requirement of extra analgesics in Group RP.

13. Satisfaction VAS:

CHARACTERISTICS	GROUP EP N=50	GROUP RP N=50	P VALUE
SATISFACTION VAS	6.18 ± 0.8965	4.76 ± 0.6247	0.000
LENGTH OF STAY IN DAYS	3.76 ± 0.7969	4.68 ± 0.7126	0.000
POSTOPERATIVE LENGTH OF STAY IN DAYS	3.04 ± 0.7273	3.94 ± 0.7117	0.000
AVEREGE COST OF HOSPITALIZATION IN RUPEES	6606 ± 925.4299	7100 ± 852.1617	0.007

Table 25: Satisfaction VAS, Length of stay and average cost of hospitalization.

The Satisfaction VAS in Group EP (6.18 ± 0.8965) is significantly higher than that of in Group Rp (4.76 ± 0.6247) with a P value lesser than 0.005.

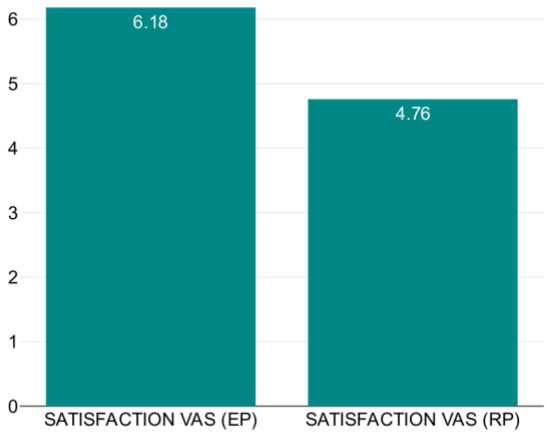
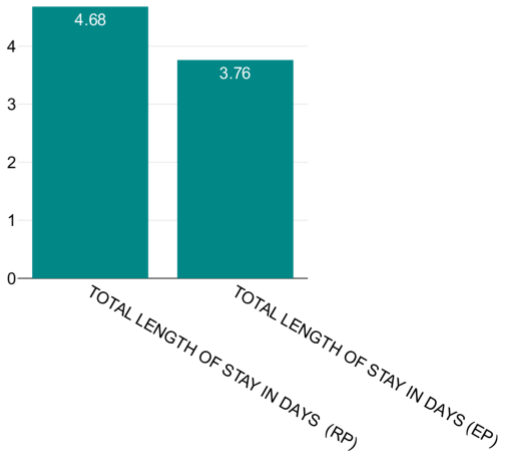


Chart 19: Satisfaction VAS

14. Length of Stay:

The total length of stay (days) in hospital in Group EP (3.76 ± 0.7969) is significantly lower than that of in Group RP (4.68 ± 0.7126) with a P value of lesser than 0.005.

Chart 20: Total length of stay in days.



The postoperative length of stay (Days) in hospital in Group EP (3.04 ± 0.7273) is significantly lower than that of in Group RP (3.94 ± 0.7117) with a P value lesser than 0.005.

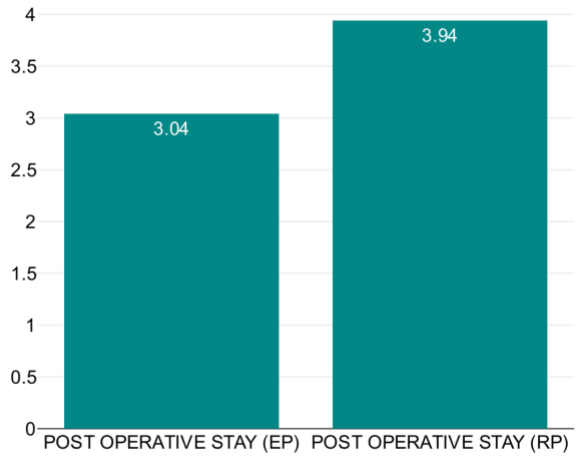


Chart 21: Post operative stay.

The average cost of hospitalization in rupees in Group EP (6606 ± 925.4299) and Group RP (7100 ± 852.1617) is comparable with a P value greater than 0.005.

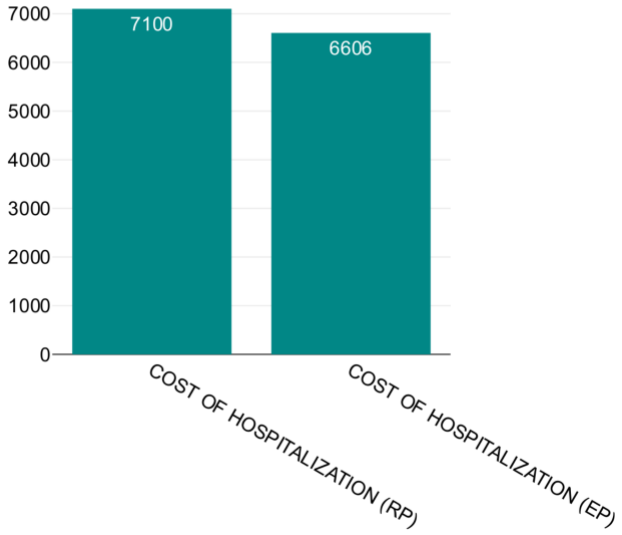


Chart 22: Cost of hospitalization.

DISCUSSION

Indeed, giving birth to a child represents a profound joy for woman. But for those mothers whose choose to deliver by Cesarean section either by choice or maternal and fetal conditions, the happiness is short-lived due to various reasons. Post operative pain, sedation, other complications such as Shivering, nausea and vomiting prevents the mother from actively engaging with the newborn to hold, to feed which is not only a concern for the mother, but is also detrimental for the well-being of new born.

To address these short comings associated with following traditional routine protocols in cesarean delivery, we decided to study the implementation of ERAS (CD) Enhanced Recovery After Surgery in Cesarean delivery. Numerous studies on ERAS showed more promising and encouraging results in patients undergoing elective colonic or rectal resection,[92] in emergency laparotomy,[93] in benign gynecological surgeries.[94]

Inadequate management of acute pain in surgical patients leads to various adverse outcomes, such as increased morbidity, diminished physical function and quality of life, delayed recovery, extended opioid use during and post-hospitalization, and increased healthcare costs.[95]

In our study, patients enrolled in ERAS protocol (EP) received Bilateral Transverse Abdominis Plane block and compared the analgesic effects of the USG-TAP block, utilizing 20 ml of 0.5% ropivacaine and 1 ml of dexamethasone, administered as 21 ml each to the left and right sides, totaling 42 ml, following a cesarean section conducted under spinal anesthesia.

This study demonstrated that in elective cesarean sections performed under spinal anesthesia with a Pfannenstiel incision, a TAP block using 42 mL of 0.5% ropivacaine 1 ml of dexamethasone (21 mL on each side) effectively reduced pain intensity and analgesic consumption over a 24-hour postoperative period. Thus, better postoperative analgesia helped in early mobilization of the patients.

Ripoles et al. [96] conducted a multicenter review study demonstrating that TAP block decreases the requirement for analgesia and VAS scores within the first 24 hours post-operatively. Our study demonstrated that the TAP block effectively decreases meperidine consumption and lowers VAS scores following cesarean section.

In our study, patients enrolled in ERAS protocol (EP) received prophylactic intermittent boluses of Phenylephrine 100mcg, and compared the incidence of hypotension with Group (RP). Prophylactic phenylephrine bolus effectively prevented post spinal anesthesia hypotension for 80% of patients during cesarean section intraoperatively which is consistent with study conducted by Guo L et al. [97]

In our study, patients enrolled in ERAS protocol (EP) were warmed actively using forced air warmer and passively by using fluid warmer and compared the incidence of intraoperative shivering with group RP. Combined use of forced air warmer and fluid warmer effectively reduced the incidence of shivering in group EP.

The result is consistent with study conducted by Jun et al,[98] the integration of pre-anaesthetic forced-air warming with warmed intravenous fluid infusions demonstrates efficacy in preventing hypothermia and shivering during caesarean delivery under spinal anaesthesia.

In our study patients enrolled in both group RP and EP, the maternal subjective experience has been assessed with a visual Analogue satisfaction scale at the time of discharge. The patients in Group EP had a significantly better satisfaction with a mean score of 6.18 when compared with group RP with a mean score of 4.76.

The above result is consistent with Karki et al [99] to evaluate patient satisfaction regarding the Enhanced Recovery After Surgery (ERAS) protocol in elective Caesarean Section, the most prevalent surgical procedure globally. Most women were satisfied with the surgical experience and would prefer to undergo surgery under the same protocol in the future.

In our study, patients enrolled in ERAS protocol (EP) had a significant lesser total length of stay and postoperative length of stay 3.76 days and 3.04 days respectively, when compared with group Rp with a total length of stay and post operative length of stay 4.68 days and 3.94 days respectively. The result is consistent with study conducted by Mullman et al. [100]

In our study, we applied the focused elements of enhanced of enhanced recovery after surgery for cesarean delivery, and we found that implementation of this protocol resulted in better postoperative pain control, intraoperative hemodynamic stability, reduced incidence of shivering and postoperative complications, decreased post operative opioid consumption that reduced the adverse effects associated with opioids, reduced length of postoperative hospital stay, early mobilization and better patient satisfaction. However further studies are required to implement all the elements of enhanced recovery protocol and inclusion of ilioinguinal and iliohypogastric nerve with TAP block for superior postoperative analgesia.

CONCLUSION

The implementation of Enhanced Recovery After Surgery protocol for perioperative care in cesarean delivery, showed better outcomes with maternal pain management, reduced intraoperative complications such as Hypotension and shivering, reduced opioid consumption, early mobilization, reduced length of stay and significantly better satisfaction among the patients. Thus ERAS protocol can be continued to be a part of standard management for individuals undergoing cesarean delivery at our institution.

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Azadi Ka Amrit Mahotsav

BLDE

(DEEMED TO BE UNIVERSITY)

Declared as Deemed to be University u/s 3 of UGC Act, 1956

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The Constituent College

SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA

BLDE (DU)/IEC/ 956/2023-24 10/4/2023

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this University met on **Saturday, 18th March, 2023 at 11.30 a.m. in the CAL Laboratory, Dept. of Pharmacology,** scrutinized the Synopsis/ Research Projects of Post Graduate Student / Under Graduate Student /Faculty members of this University /Ph.D. Student College from ethical clearance point of view. After scrutiny, the following original/ corrected and revised version synopsis of the thesis/ research projects has been accorded ethical clearance.

TITLE: "A PROSPECTIVE RANDOMISED CONTROLLED TRIAL TO STUDY THE BENEFIT OF ENHANCED RECOVERY AFTER SURGERY (ERAS) ADOPTION IN ACUTE PAIN MANAGEMENT AFTER ELECTIVE CAESAREAN DELIVERY".

NAME OF THE STUDENT/PRINCIPAL INVESTIGATOR: DR.SANKARNARAYANAN R

NAME OF THE GUIDE: DR.SHIVANAND KARIGAR, ASSOCIATE PROFESSOR, DEPT. OF ANAESTHESIOLOGY.

Dr. Santoshkumar Jeevangi
Chairperson
IEC, BLDE (DU),
VIJAYAPURA
Chairman,
Institutional Ethical Committee,
BLDE (Deemed to be University)
Vijayapura

Dr.Akram A. Naikwadi
Member Secretary
IEC, BLDE (DU),
VIJAYAPURA
MEMBER SECRETARY
Institutional Ethics Committee
BLDE (Deemed to be University)
Vijayapura-586103. Karnataka

Following documents were placed before Ethical Committee for Scrutinization.

- Copy of Synopsis/Research Projects
- Copy of inform consent form
- Any other relevant document

SAMPLE INFORMED CONSENT FORM

B.L.D.E. (DU) SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTER, VIJAYAPURA - 586103, KARNATAKA

TITLE OF THE PROJECT: A prospective randomized controlled trial to study the advantage of implementation of enhanced recovery after surgery (ERAS) in acute pain management during elective caesarean delivery.

PRINCIPAL INVESTIGATOR: Dr. SANKARNARAYANAN R
Department of Anesthesiology
BLDE (DU) Shri B M Patil Medical College & Research Center,
Solapur Road, Vijayapura-03
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9944981869.

PG GUIDE: Dr. Shivanand Karigar
M.D ANAESTHESIOLOGY
Professor
Department of Anesthesiology
BLDE (DU) Shri B M Patil Medical College & Research Center, Solapur Road Vijayapura-03

CO-GUIDE: Dr. Shreedevi Kori
M.S. Obstetrics and Gynecology
Associate Professor
Department of Obstetrics & Gynecology
BLDE (DU) Shri B M Patil Medical College & Research Center, Solapur Road Vijayapura-03

PURPOSE OF RESEARCH:

I have been informed that this study compares the advantage of implementation of Enhanced Recovery After Surgery (ERAS) in acute pain management during elective caesarean delivery.

I have been explained the reason for doing this study and selecting me/my ward as a subject for this study. I have also been given the free choice of either being included or not in the study.

PROCEDURE:

I understand that I will participate in the study to compare the efficacy between ERAS protocol for Cesarean delivery and Routine protocol.

RISKS AND DISCOMFORTS:

I understand that my ward may experience some discomfort during the Procedure, and I know that necessary measures will be taken to reduce them.

BENEFITS:

I understand that my ward participating in this study will help find the efficient protocol that will be beneficial for the patients in reducing the intraoperative nausea, vomiting, Shivering, hypotension, postoperative pain, length of hospital stay, Hospitalization cost and also improved Patient satisfaction.

CONFIDENTIALITY:

I understand that medical information produced by this study will become a part of this hospital records and will be subjected to the confidentiality and privacy regulation of this hospital.
Suppose the data are used for publication in the medical literature or teaching purposes. No names will be used in that case, and other identities such as photographs and audio and video tapes will be used only with my special written permission. I understand that I may see the picture and videotapes and hear audiotapes before giving consent.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at any time. Dr. SANKARNARAYANAN R is available to answer my questions or concerns. I know that I will be informed of any significant new findings discovered during this study, which might influence my continued participation. If during this study or later I wish to discuss my involvement in or concerns regarding this study with a person not directly involved, I am aware that the hospital's social worker is available to talk with me. And that a copy of this consent form will be given to me for a keep for careful reading.

REFUSAL OR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary. I may refuse to participate or withdraw consent and discontinue participation in the study at any time without prejudice to my present or future care at this hospital.
I also understand Dr. SANKARNARAYANAN R will terminate my participation in this study at any time after she has explained the reason for doing so and has helped arrange for my continued care by my physician or therapist if this is appropriate.

INJURY STATEMENT:

I understand that in the unlikely event of injury to me/my ward resulting directly from my participation in this study, such damage will be reported promptly. Medical treatment would be available to me, but no further compensation will be provided.
I understand that by my agreement to participate in this study, I am not waiving my legal rights. I have explained
to_____ the purpose of this research, the procedure required and the possible risk and benefits, to the best of my ability in patients own language.

DATE Dr. SANKARNARAYANAN R (investigator)

PATIENT/PARENT SIGNATURE Witness

STUDY SUBJECT CONSENT STATEMENT:

I confirm that Dr. SANKARNARAYANAN R has explained to me the purpose of this research, the study procedure I will undergo, and the possible discomforts and benefits I may experience in my own language.
I have explained all the above in detail in my language, and I understand the same. Therefore I agree to consent to participate as a subject in this research project.

_____ _____
(Participant) (Date)

_____ _____
(Witness to above signature) (Date)

SCHEME OF CASE TAKING

PROFORMA:

STUDY: A prospective randomized controlled trial to study the advantage of implementation of enhanced recovery after surgery (ERAS) in acute pain management during elective caesarean delivery.

Patient Details

Name Age Sex Height
Weight
Ward Group allotted by randomization: RP /EP

Diagnosis
Surgical Procedure

Past History

General Physical Examination:
Parlor Icterus Cyanosis Clubbing Lymphadenopathy
Edema

Mallampatti Grade:
Vital parameters:
Pulse Blood Pressure Respiratory Rate
Temperature

Systemic Examination
CVS
RS
CNS
PA

Investigations

Hemoglobin: TLC: Platelet count:
Urine routine: HIV: HbsAg:
ASA grade

Parameters:

TABLE 27 - Preoperative Characteristics of the Patients

Characteristics	GROUP RP	GROUP EP
Age (years)		
ASA Physical Status		
Parity 1 2 3 and more		
Gestation Single Twins		
Preoperative complications		

TABLE 28 Postoperative Pain VAS

CHARACTERISTICS	GROUP RP	GROUP EP
Rest in 24 h		
Motion in 24 h		
Rest in 48 h		
Motion in 48 h		
Requirement of extra Analgesics		
Total dosage of Opioids in 48 h		

TABLE 29 Opioid Consumption in postoperative period

TIME	GROUP RP	GROUP EP
At 24 h		
At 48 h		

TABLE 30 Intraoperative and Postoperative conditions

Characteristics	Group RP	Group EP
Intraoperative		

Nausea		
Vomiting		
Shivering		
Hypotension		
Blood loss		
Postoperative discomfort in 48 h	Group RP	Group EP
Nausea		
Vomiting		

TABLE 31 Satisfaction VAS, Length of Stay and the cost of Hospitalization

Characteristics	GROUP RP	GROUP EP
Satisfaction VAS		
Length of stay (d)		
Postoperative length of stay (d)		
Cost of hospitalization		

BIO-DATA

Guide Name	:	Dr. Shivanand L Karigar
Date of Birth	:	20/07/1982
Education	:	MBBS. (2006 passing year), MD ANAESTHESIOLOGY 2011 passing year from JNMC, BELGAUM
Designation	:	Professor Department of Anaesthesiology
Teaching	:	UG Teaching- 12 Years PG Teaching-12 Years
Research Projects:		1 completed, one ongoing
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INVESTIGATOR:

Name	:	Dr. SANKARNARAYANAN R
Date of birth	:	31-12-1988
Qualification	:	Doctor of Medicine – Equivalent to Indian MBBS Jalal Abad State University Kyrgyzstan
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MASTER CHART

NAME	AGE	SEX	GROUP	ASA PHYSI	PARITY	GESTATIO	VAS SCORI	VAS SCORI	VAS SCORE	VAS SCORI	REQUIREM	OPIOID CO	OPIOID CC	INTRAOPEI	INTRAOPE	INTRAOPE	INTRAOPEI	POSTOPER	POSTOPER	SATISFACT	LENGTH O	POST OPEF	COST OF H	Height (cm	weight (kg)	BMI
GURU ANA	25	F	EP	II	2	SINGLE	2	3	1	2	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	5	4	3	6340	166	74	26.9
SALMA	27	F	EP	II	3	SINGLE	1	2	2	2	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	5	4	3	6560	159	73	28.9
SUJATA	35	F	EP	II	7	SINGLE	2	3	3	3	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	6	3	3	5900	153	66	28.2
SUREKHA	30	F	EP	II	5	TWIN	1	1	2	2	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	7	3	3	6050	158	71	28.4
PREMA	27	F	EP	II	3	SINGLE	1	2	2	3	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	6	3	3	6800	154	66	27.8
VIJYALAKS	26	F	EP	II	2	SINGLE	1	1	2	2	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	7	3	3	6190	164	60	22.3
KAVERI	34	F	EP	II	5	SINGLE	1	1	2	2	NIL	NIL	NIL	YES	NO	NO	NO	NO	NO	6	2	2	5500	166	74	26.9
PAVITHRA	30	F	EP	II	3	SINGLE	1	2	2	3	NIL	NIL	NIL	NO	NO	YES	NO	NO	NO	5	4	2	4800	157	69	28
SANGAMV	26	F	EP	II	2	SINGLE	3	3	2	3	NIL	NIL	NIL	NO	NO	YES	NO	NO	NO	7	4	2	6400	153	56	23.9
SHOBHA	25	F	EP	II	3	SINGLE	1	2	2	3	NIL	NIL	NIL	NO	NO	YES	NO	NO	NO	7	4	4	7450	161	69	26.6
PUSHPA	28	F	EP	II	3	SINGLE	1	2	2	3	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	6	3	2	5890	164	82	30.5
SANGEETA	29	F	EP	II	2	SINGLE	1	2	2	3	NIL	NIL	NIL	NO	YES	NO	YES	NO	NO	7	4	4	6250	154	68	28.7
PUSHPA	28	F	EP	II	2	SINGLE	1	1	2	2	NIL	NIL	NIL	NO	NO	NO	NO	YES	YES	6	3	3	5900	168	79	28
SERIN	25	F	EP	II	2	SINGLE	1	2	1	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	7	3	2	4900	151	61	26.8
SAVITA	26	F	EP	II	2	SINGLE	2	2	1	3	NIL	NIL	NIL	YES	NO	YES	NO	NO	NO	7	4	3	6550	153	68	29
BASAMMA	28	F	EP	II	3	SINGLE	1	2	2	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	8	3	2	6250	155	67	27.9
ANITA	28	F	EP	II	2	SINGLE	1	2	2	4	YES	NIL	TRAMADO	NO	NO	NO	NO	YES	YES	6	4	3	7200	163	80	30.1
SEEMA	27	F	EP	II	2	SINGLE	2	3	3	4	YES	NIL	TRAMADO	NO	NO	NO	YES	YES	NO	7	2	2	5600	169	67	23.5
GANGA	29	F	EP	II	2	SINGLE	2	3	1	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	6	4	3	7670	158	73	29.2
RASHMI	27	F	EP	II	3	SINGLE	1	2	1	3	NIL	NIL	NIL	NO	NO	NO	NO	YES	NO	7	3	3	6800	161	62	23.9
SAVITRI	31	F	EP	II	3	SINGLE	2	3	4	5	YES	NIL	TRAMADO	NO	NO	NO	YES	NO	NO	7	4	4	6800	171	68	23.3
DANAMMA	27	F	EP	II	3	SINGLE	2	3	1	2	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	7	5	3	8200	158	60	24
NAGAMMA	26	F	EP	II	3	SINGLE	2	3	1	2	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	7	3	2	5900	157	69	28
PARIMALA	25	F	EP	II	3	SINGLE	2	3	2	3	NIL	NIL	NIL	YES	NO	NO	NO	NO	NO	6	3	2	5870	164	78	29
PREMA	27	F	EP	II	1	SINGLE	4	5	2	3	YES	TRAMADO	NIL	NO	NO	NO	NO	YES	NO	6	4	3	7250	161	73	28.2
SWARNA	27	F	EP	II	3	SINGLE	2	3	3	4	YES	NIL	TRAMADO	NO	NO	NO	NO	YES	NO	7	3	3	6750	157	58	23.5
REKHA	33	F	EP	II	3	SINGLE	2	3	2	2	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	8	4	3	6900	159	59	23.3
KAMALABA	28	F	EP	II	3	SINGLE	5	5	4	5	YES	TRAMADO	TRAMADO	NO	NO	NO	NO	YES	YES	7	4	3	7900	160	57	22.3
SHOBHA	25	F	EP	II	7	SINGLE	2	3	3	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	7	4	4	8050	166	80	29
SUSHMITA	26	F	EP	II	2	SINGLE	1	2	3	3	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	6	4	3	6450	158	74	29.6
BHUVANES	28	F	EP	II	3	SINGLE	3	3	2	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	6	3	3	5900	155	66	27.5
BHAGYASH	30	F	EP	II	2	SINGLE	1	2	2	3	NIL	NIL	NIL	YES	NO	NO	NO	NO	NO	6	4	4	6500	161	69	26.6
JYOTI	30	F	EP	II	1	SINGLE	2	3	3	3	NIL	NIL	NIL	NO	NO	YES	NO	YES	NO	6	3	2	6100	166	60	21.8
AISHWARY	30	F	EP	II	2	SINGLE	2	2	2	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	4	5	4	5650	159	54	21.4
DEEPA	32	F	EP	II	3	SINGLE	1	2	3	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	6	3	2	5860	160	73	28.5
PREMA	26	F	EP	II	6	SINGLE	2	2	3	3	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	5	5	4	9450	153	58	24.8
FIRDUS	28	F	EP	II	5	SINGLE	1	2	4	4	YES	NIL	TRAMADO	NO	NO	NO	NO	NO	NO	7	4	3	6800	170	78	27
LAKSHMI	27	F	EP	II	2	SINGLE	2	2	3	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	6	4	3	7440	155	63	26.2
BORAMMA	29	F	EP	II	1	SINGLE	1	2	3	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	5	4	3	7400	166	74	26.9
DRAKSHAY	30	F	EP	II	4	SINGLE	2	3	1	2	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	6	5	4	6840	156	62	25.5
BHARATI	38	F	EP	II	1	SINGLE	2	3	3	3	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	4	5	4	6600	162	84	32
JANGAMA	26	F	EP	II	1	SINGLE	2	2	2	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	6	3	3	5890	163	80	30.1
BORAMMA	25	F	EP	II	1	SINGLE	2	3	3	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	6	3	2	5680	159	66	26.1
RENUKA	37	F	EP	II	3	SINGLE	2	3	1	2	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	5	4	3	8340	162	58	22.1
NAMATA	29	F	EP	II	2	SINGLE	2	3	3	3	NIL	NIL	NIL	YES	NO	NO	NO	NO	NO	6	5	4	6800	169	69	24.2
SUMITRA	25	F	EP	II	2	SINGLE	2	2	3	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	7	5	4	7940	168	63	22.3
HEMA	29	F	EP	II	1	SINGLE	3	3	3	4	YES	NIL	TRAMADO	NO	NO	NO	NO	YES	NO	5	5	4	7890	160	63	24.6
RUCHA	36	F	EP	II	2	SINGLE	1	2	3	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	5	5	4	6430	165	70	25.7
AARTI	27	F	EP	II	2	SINGLE	2	2	2	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	6	4	3	5510	156	63	25.9
SHILPA	26	F	EP	II	2	TWIN	2	3	4	4	YES	NIL	TRAMADO	NO	NO	NO	YES	NO	NO	8	4	4	6230	161	73	28.2
SHWETHA	25	F	RP	II	1	SINGLE	3	5	3	3	YES	TRAMADO	NIL	NO	NO	YES	YES	NO	NO	5	5	4	6500	154	62	26.1
MALAVIKA	32	F	RP	II	2	SINGLE	3	4	3	3	YES	TRAMADO	NIL	NO	NO	YES	YES	NO	NO	5	5	5	7400	151	66	28.9
JAYASHREE	25	F	RP	II	2	SINGLE	4	5	4	4	YES	TRAMADO	TRAMADO	NO	NO	YES	NO	YES	YES	5	4	4	7100	169	76	26.6
PRABHAM	32	F	RP	II	2	SINGLE	2	3	3	5	YES	NIL	TRAMADO	NO	NO	NO	YES	NO	NO	5	5	4	7700	171	86	29.4
SHAILA	28	F	RP	II	2	SINGLE	2	3	3	3	NIL	NIL	NIL	YES	NO	NO	NO	NO	NO	5	5	5	7300	157	70	28.4
TRIVENI	30	F	RP	II	3	SINGLE	3	3	2	3	NIL	NIL	NIL	NO	NO	YES	YES	NO	NO	4	5	4	7700	160	70	27.3
AMRUTHA	25	F	RP	II	2	SINGLE	3	4	3	5	YES	TRAMADO	TRAMADO	NO	NO	NO	YES	YES	YES	5	6	5	7400	171	85	29.1
ASHA	28	F	RP	II	4	SINGLE	4	4	3	3	YES	TRAMADO	NIL	NO	NO	NO	YES	NO	NO	5	4	4	6900	168	76	26.6
PREMA	32	F	RP	II	2	SINGLE	3	3	2	3	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	4	5	4	6450	167	63	22.6
LAXMI	29	F	RP	II	2	SINGLE	2	3	3	5	YES	NIL	TRAMADO	NO	NO	NO	NO	YES	NO	4	5	4	6250	170	70	24.2
ASHWINI	28	F	RP	II	3	SINGLE	2	3	3	3	NIL	NIL	NIL	YES	NO	NO	YES	NO	NO	5	4	3	6100	156	69	28.4
SANA	30	F	RP	II	2	SINGLE	4	5	2	3	YES	TRAMADO	NIL	NO	NO	NO	YES	NO	NO	4	6	5	7950	169	70	24.5
VAJRAMM	25	F	RP	II	1	SINGLE	2	3	4	5	YES	NIL	TRAMADO	NO	NO	YES	NO	NO	NO	5	5	4	7450	163	79	29.7
BAGAVVA	35	F	RP	II	1	SINGLE	3	4	2	3	YES	TRAMADO	NIL	NO	NO	NO	NO	NO	NO	5	5	5	7200	151	68	29.8
SHANTA	29	F	RP	II	2	SINGLE	2	3	1	2	NIL	NIL	NIL	NO	NO	NO	NO	YES	NO	5	5	4	7800	155	70	29.1
AYESHA	25	F	RP	II	3	SINGLE	3	4	3	3	YES	TRAMADO	NIL	NO	NO	YES	NO	NO	NO	5	5	4	7600	170	68	23.5
AMBHIKA	30	F	RP	II	2	SINGLE	2	3	1	3	NIL	NIL	NIL	NO	NO	YES	NO	NO	NO	5	3	3	5200	157	89	36.1
POOJA RA	32	F	RP	II	4	SINGLE	4	4	2	3	YES	TRAMADO	NIL	NO	NO	NO	YES	NO	NO	5	5	4	6800	153	67	28.6
BHAGYASH	28	F	RP	II	4	SINGLE	2	3	4	5	YES	NIL	TRAMADO	NO	NO	NO	NO	NO	YES	5	3	3	5300	169	76	26.6
SAVITRI	25	F	RP	II	3	SINGLE	2	3	1	2	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	5	4	4	7300	153	54	23.1
VIJAYALAK	27	F	RP	II	2	SINGLE	3	4	2	3	YES	TRAMADO	NIL	NO	NO	NO	NO	NO	NO	5	4	3	5900	165	70	25.7
JYOTI RAJ	25	F	RP	II	2	SINGLE	2	3	3	4	YES	TRAMADO	TRAMADO	NO	NO	NO	YES	YES	4	4	3	6150	159	67	26.5
ASHA PAT	25	F	RP	II	1	SINGLE	2	3	2	3	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	5	4	3	6150	162	78	29.7
MEENAKI	25	F	RP	II	2	SINGLE	2	3	2	3	NIL	NIL	NIL	NO	NO	YES	YES	NO	NO	4	5	4	6850	150	69	30.7
MEGHA	34	F	RP	II	1	SINGLE	5	5	3	4	YES	TRAMADO	TRAMADO	NO	NO	NO	NO	YES	NO	4	6	5	8650	155	57	23.7
PALLAVI	28	F	RP	II	1	SINGLE	4	5	3	4	YES	TRAMADO	TRAMADO	NO	NO	NO	YES	YES	YES	4	5	5	6700	161	63	24.3
BHAGYASH	27	F	RP	II	3	SINGLE	4	5	2	3	YES	TRAMADO	TRAMADO	NO	NO	NO	YES	YES	NO	4	4	4	7700	152	77	33.3
SHREEDEV	32	F	RP	II	2	SINGLE	2	3	1	2	NIL	NIL	NIL	NO	NO	YES	YES	NO	NO	4	4	3	6400	170	79	27.3
RENUKA	32	F	RP	II	3	SINGLE	3	3	2	3	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	4	4	4	8050	150	73	32.4
PUSPHA P	25	F	RP	II	2	SINGLE	4	5	3	4	YES	TRAMADO	TRAMADO	NO	NO	NO	YES	YES	NO	5	5	4	8400	160	69	27.0
BHAGYASH	25	F	RP	II	2	SINGLE	2	3	2	2	NIL	NIL	NIL	YES	NO	NO	YES	NO	NO	5	5	5	8290	159	76	30.1
ASEELA NA	27	F	RP	II	3	SINGLE	2	3	2	2	NIL	NIL	NIL	NO	NO	NO	YES	NO	NO	5	4	3	5900	156	87	35.7
SANGEETA	26	F	RP	II	1	SINGLE	4	5	2	3	YES	TRAMADO	NIL	NO	NO	NO	YES	NO	NO	5	4	3	5900	151	66	28.9
TALASARA	36	F	RP	II	5	SINGLE	4	5	5	6	YES	TRAMADO	TRAMADO	YES	NO	YES	NO	YES	NO	5	5	3	6400	167	80	28.7
YAMANAM	29	F	RP	II	5	SINGLE	3	4	2	3	YES	TRAMADO	NIL	NO	NO	NO	YES	NO	NO	5	4	3	6950	158	72	28.8
TEJASHWI	27	F	RP	II	2	SINGLE	5	6	3	5	YES	TRAMADO	TRAMADO	YES	NO	NO	NO	YES	YES	4	5	5	6820	160	88	34.4
SHABANA	25	F	RP	II	4	SINGLE	2	3	3	3	NIL	NIL	NIL	NO	NO	YES	YES	NO	NO	4	5	4	6900	151	68	29.8
POOJA PRA	26	F	RP	II	4	SINGLE	5	4	5	5	YES	TRAMADO	TRAMADO	NO	NO	NO	NO	YES	YES	5	5	3	7060	153	61	26.1
ROOPA BE	29	F	RP	II	2	SINGLE	2	3	2	3	NIL	NIL	NIL	N O	NO	NO	YES	YES	NO	5	5	5	8900	168	75	26.6
DAKSHAYA	27	F	RP	II	2	SINGLE	2	3	3	4	YES	NIL	TRAMADO	NO	NO	NO	YES	YES	NO	5	5	5	8470	158	66	26.4
ARATI ING	26	F	RP	II	2	SINGLE	3	3	2	4	YES	NIL	TRAMADO	NO	NO	NO	YES	YES	NO	5	4	4	7150	166	62	22.5
POOJA SOI	26	F	RP	II	1	SINGLE	4	5	3	4	YES	TRAMADO	TRAMADO	NO	NO	YES	NO	YES	NO	5	5	4	7340	160	81	31.6
NAVYA BA	31	F	RP	II	3	SINGLE	3	4	2	3	YES	TRAMADO	NIL	NO	NO	NO	NO	YES	NO	5	4	3	8100	159	86	34
PRIYANKA	31	F	RP	II	3	SINGLE	2	3	1	2	NIL	NIL	NIL	NO	NO	YES	YES	NO	NO	4	6	4	7900	160	75	29.3
RANJITA	25	F	RP	II	1	TWIN	2	4	2	3	YES	TRAMADO	NIL	NO	NO	NO	YES	NO	NO	4	4	3	7970	153	69	29.5
SNEHA BA	25	F	RP	II	2	SINGLE	3	4	2	3	YES	TRAMADO	NIL	NO	NO	YES	YES	NO	NO	4	5	4	6970	152	57	24.7
RAJESHWA	25	F	RP	II	3	SINGLE	4	5	3	4	YES	TRAMADO	TRAMADO	YES	NO	YES	YES	NO	NO	5	5	4	7950	159	63	24.9
NAGARATI	33	F	RP	II	3	SINGLE	3	3	2	3	NIL	NIL	NIL	NO	NO	NO	NO	NO	NO	6	4	4	6600	168	76	26.9
PRABAVAT	29	F	RP	II	2	SINGLE	2	3	4	4	YES	NIL	TRAMADO	NO	NO	NO	NO	YES	NO	6	5	4	6380	154	82	34.6
ASHA BHA	28	F	RP	II	4	SINGLE	3	3	2	3	NIL	NIL	NIL	NO	NO	YES	NO	NO	NO	7	5	4	6900	158	73	29.2

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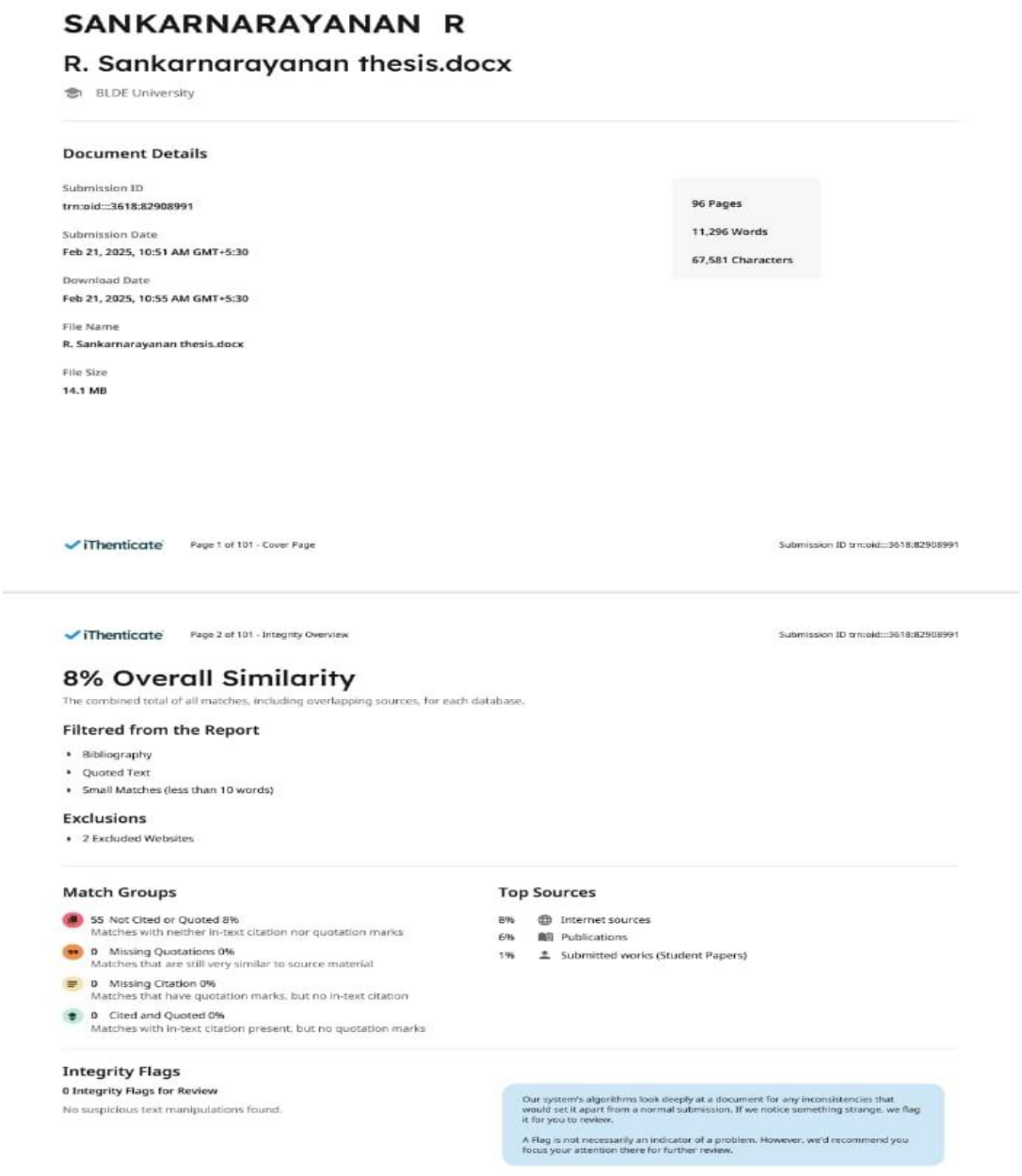

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