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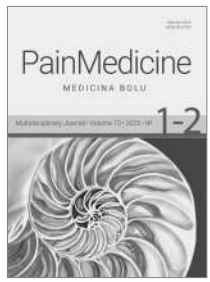

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An In-Depth Comparative Analysis of Hemodynamic Alterations Under General and Spinal Anesthesia During Hernia Repair Procedures

Haider Ahmed Jalab Salem Al-Khikani

Al-Taff University College, Karbala, Iraq

Abstract

Introduction: *Ensuring patient safety remains the foremost concern for anesthesia and critical care teams when determining the most suitable anesthetic approach, whether in terms of techniques, drugs, strategies, or guidelines. Among the available options, spinal anesthesia is one of the most widely used and effective methods for patients undergoing hernia repair.*

Subjects and methods: *This study involved a thorough and up-to-date assessment of patients undergoing herniotomy. A total of 100 patients were enrolled and divided equally into two groups: 50 received spinal anesthesia (SA) and 50 received general anesthesia (GA). Key parameters such as age, weight, pulse rate, and blood pressure changes were monitored. Patients aged between 20 and 90 years were allocated to the GA and SA groups for detailed preoperative, intraoperative, and postoperative follow-up.*

Results: *Findings indicate that hemodynamic stability was greater with SA (approximately 56 %) compared to GA (around 40 %). Blood pressure levels were higher in GA (32 %) versus SA (24 %), while hypotension occurred in 28 % of GA cases and 20 % of SA cases. Heart rate stability was also better with SA (56 %) compared to GA (32 %). An increased heart rate was observed in 34 % of SA patients and 60 % of GA patients. Overall, SA showed more consistent effects, with a heart rate reduction of 10 % compared to an 8 % reduction in GA.*

Conclusions: *Spinal anesthesia demonstrated superior outcomes compared to general anesthesia in maintaining stable blood pressure and ensuring minimal or normal heart rate fluctuations.*

Keywords: *Hemodynamic response, Blood pressure variation, Heart rate changes, Anesthesia techniques, Surgical outcomes*

Introduction

The requirement for anesthesia during surgery and the need for postoperative analgesics remain key challenges in the management of hernia repair. Both spinal and general anesthesia are commonly employed during open inguinal hernia procedures [1]. In pediatric patients, hypertension is associated with end-organ damage and may persist into adulthood, predisposing them to chronic hypertension and related complications, though its long-term impact in children is not yet fully understood [2]. In adults, hypertension is a major risk factor for renal impairment, coronary artery disease, and stroke. The American Society of Anesthesiologists recommends continuous monitoring of oxygenation, ventilation, circulation, and body temperature during anesthesia. Furthermore, measurement of both pre- and post-ductal oxygen saturation with two pulse oximeters is advised, as the development of a gradient between them may indicate worsening pulmonary hypertension [3]. Propofol, a widely used intravenous anesthetic, reduces systemic vascular resistance, preload, and myocardial contractility, leading to decreased arterial blood pressure. These effects are more pronounced at higher doses, in elderly patients, or in those with underlying cardiac disease. Injection site pain is common, with approximately 58 % of patients reporting discomfort, and rare cases of thrombophlebitis have also been documented [4]. Although mild to moderate hypertension prior to surgery generally does not increase anesthetic risk, uncontrolled high blood pressure should be addressed due to its association with greater intraoperative and postoperative complications [5]. Since Bassini's original description of inguinal hernia repair in 1887, numerous surgical techniques have been developed, including Shouldice, Darning, Modified Bassini, Lichtenstein mesh repair, and laparoscopic methods. In recent years, laparoscopic and Lichtenstein mesh repairs have gained popularity due to faster recovery times and lower recurrence rates [6]. General anesthesia carries specific risks, including failed endotracheal intubation and aspiration of gastric contents, which are among the leading causes of maternal morbidity and mortality. Patients at high risk of aspiration should be administered prophylactic medications, such as intravenous ranitidine (50 mg), metoclopramide (10 mg), or both, 1–2 hours before induction. Additional preventive measures include the administration of sodium citrate (30 mL) 30–45 minutes prior to anesthesia induction, and oral omeprazole (40 mg) as premedication [7]. The primary cardiovascular effect of propofol is hypotension, caused by reduced preload, cardiac contractility, and systemic vascular resistance due to inhibition of sympathetic vasoconstrictor tone. Although the sympathetic response to laryngoscopy and intubation often counteracts this hypotension, risk factors such as rapid injection, high doses, and advanced age further increase the likelihood of propofol-induced hypotension [8]. Inhalational anesthetics, such as sevoflurane and isoflurane in combination with nitrous oxide, have been studied for induction; however, they may not be suitable for achieving single vital-capacity breath inhalation in adult patients [9]. Comparative studies in children aged 1–3 years undergoing adenoidectomy demonstrated that hemodynamic responses were more favorable with sevoflurane than with halothane [10]. When selecting the optimal anesthetic for open inguinal hernia repair, the method must meet several essential criteria: it should be simple, safe, cost-effective, and associated with minimal postoperative complications. It should also ensure rapid recovery and provide effective pain relief [11]. Clinical pharmacology studies in obese patients suggest that the fat-free mass (FFM) scalar may be a more accurate parameter for determining bolus doses of anesthetic agents [12]. Additionally, postoperative hypotension has been identified as a risk factor for myocardial injury following non-cardiac surgery [13]. Propofol also appears to be the preferred induction agent for minimizing reflex bronchoconstriction. A randomized clinical trial demonstrated that children at risk of respiratory complications experienced fewer adverse events when anesthesia was induced with intravenous propofol compared to inhaled sevoflurane [21]. **Aim of the Study**: Because patients undergoing hernia surgery under spinal or general anesthesia often fail to achieve circulatory stability, this study was designed to develop clear strategies to address this challenge and minimize complications, thereby reducing morbidity and mortality.

Subjects and Methods

One hundred patients in all had herniectomy operations in this study. They were split into two equal groups of fifty each, with one group having spinal anesthesia and the other general anesthesia. Numerous factors, such as the patients' age, weight, blood pressure variations, and pulse rate, were assessed. The subjects, who ranged in age from twenty to ninety, were divided into two groups: one for general anesthesia (GA) and another for spinal

anesthesia (SA). We created a list of variables that might be observed in the operating room and arranged them into three different time periods: before to, during, and following the surgery. Blood pressure measurements and related factors, such as cases of hypertension or hypotension, heart rate fluctuations, and mean arterial pressure (MAP), which may suggest the patient is in shock as a result of fluid depletion or cardiac problems, were among the data gathered. Inhaled anesthetics should be used with caution since they might cause hypotension. The amount of inhaled anesthetic needed to stop (50 %) of people from moving in response to a standardized stimulus, like surgery, is known as the minimum alveolar concentration, or MAC. This metric acts as a benchmark for experimental assessments and enables comparisons of the potencies of various anesthetic drugs. By numbing the lower body, spinal anesthesia significantly reduces pain during surgery while preserving patient consciousness, making it a good substitute for general anesthesia. Spinal anesthesia can be used for the majority of procedures performed below the waist. A spinal anesthetic is administered by an anesthetist using Bupivacaine, the most commonly used and recommended drug in surgical operations. On the other hand, compared to other induction agents, propofol, the preferred medication for general anesthesia, has a significant effect on systemic blood pressure. The main cause of this is the considerable vasodilation that occurs in the venous and arterial systems, which lowers preload and afterload. With increasing age, in individuals with reduced intravascular fluid capacity, and after fast delivery, the impact on systemic blood pressure becomes especially noticeable. Additionally, the inhibition of the normal baroreflex response exacerbates the hypotensive effects, resulting in a negligible rise in heart rate even in the presence of vasodilation.

Results

In study as seen the Patient Distribution Table 1 for Blood Pressure Change, Additionally, blood pressure is more constant in SA (about 56 %) compared to GA (about 40 %); yet, blood pressure increases more in GA (about 32 %) and decreases more in SA (24 %), whereas blood pressure decreases more in GA (about 28 %) and decreases more in SA (20 %). In terms of blood pressure, the figures demonstrate that spinal anesthesia is more stable than general anesthesia.

Table 2 indicates that the heart rate in this study is more steady, with a percentage of 56 % in (SA) but 3221% in (GA) and 34 % in (SA) but 60 % in (GA). The percentage of drop in heart rate was 10 % in (SA) and around 8 % in (GA), and the impact of (SA) is more stable.

Additionally, we demonstrate that it is more consistent in SA (56 %), as opposed to GA (40 %). Blood pressure increases more in GA (32 %) than in SA (24 %), although it decreases more in GA (28 %) than in SA (20 %) in the absence of treatment.

Blood pressure is also more stable in SA (56 %), compared to GA (40 %) nonetheless, GA (32 %) has higher blood pressure, and GA (28 %) has higher blood pressure. Therefore, spinal anesthesia is superior and more stable in light of the data and statistics provided here.

In this study The age of patients ranged from (20) to over (90) years, with average of (48) years, the age group (26–40 years) show the peak incidence of this study which was (46 %) in GA and (44 %) in SA, followed by age group (41–55 years) which was (24 %) in the GA and (30 %) in SA group then age group (55 and more than55) which was (12 %) in GA and (18 %) in SA, while age group less (25 years) was the least number, it was (8 %) of the SA.

In this study the patients were selected Male and Female and the nobler of Male is (27) in general anesthesia

Table 1. Distribution of patients according to the change in Heart rate

№ of patient	Increase in hr	Remain	Decrease in hr	Total
(GA) GROUP	30	16	4	50
	60 %	32 %	8 %	100 %
(SA) GROUP	17	28	5	50
	34 %	56 %	10 %	100 %
TOTAL	47	44	9	100
	47 %	44 %	9 %	100 %

Table 2. Distribution of patients according to the change in blood pressure

№ of patient	Increase in blood pressure	Remain	Decrease in blood pressure	Total
(GA) GROUP	50 100 %	14 28 %	20 40 %	16 32 %
(SA) GROUP	50 100 %	10 20 %	28 56 %	12 24 %
TOTAL	100 100 %	24 24 %	48 48 %	28 28 %

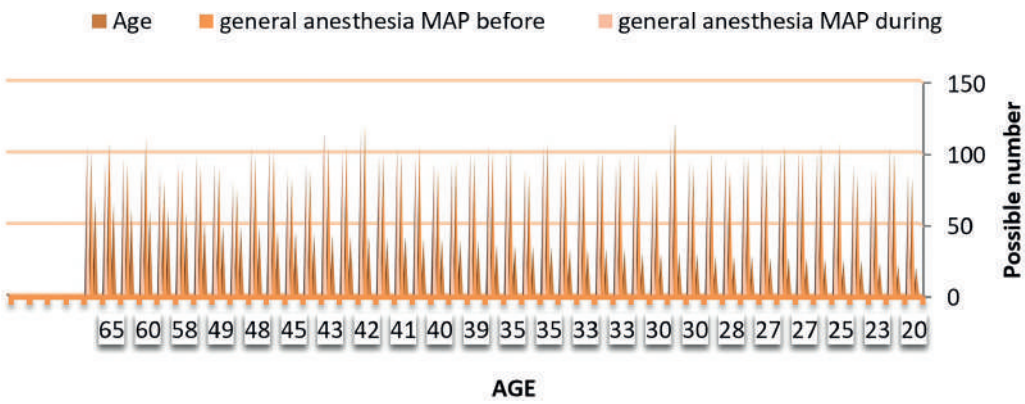

Figure 1. The relationship between age GA and Mean Arterial Pressure GA

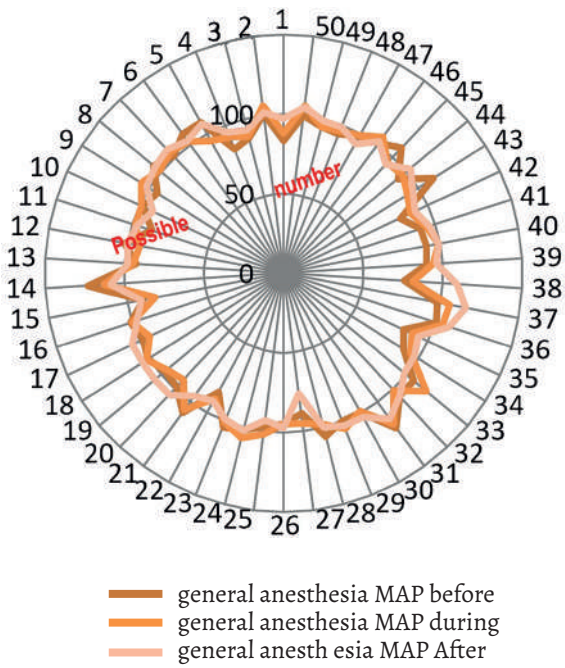

Figure 2. The Relationship Mean Arterial Pressure GA

and (33) person in spinal anesthesia about (54 %) in Male (66 %) in Female as see in Figure 4.

This infographic presents a new clinical recommendation for anesthesia in hernia repair inspired by the study conducted by Al-Khikani in 2025 it begins by highlighting the importance of proper diagnosis and preparation before surgery where medical staff must evaluate the patient's ASA classification review their blood pressure and heart rate and assess their risk of aspiration especially if general anesthesia is considered then the chart transitions to the selection of anesthesia where spinal anesthesia is marked as the preferred method for most patients due to its stable impact on blood pressure and heart rate using bupivacaine as the main drug while general anesthesia remains an option for patients who cannot tolerate spinal anesthesia or need deeper sedation using medications such as propofol sevoflurane and opioids the infographic then moves into the monitoring and safety section emphasizing the critical importance of maintaining mean arterial pressure between seventy and one hundred millimeters of mercury heart rate be-

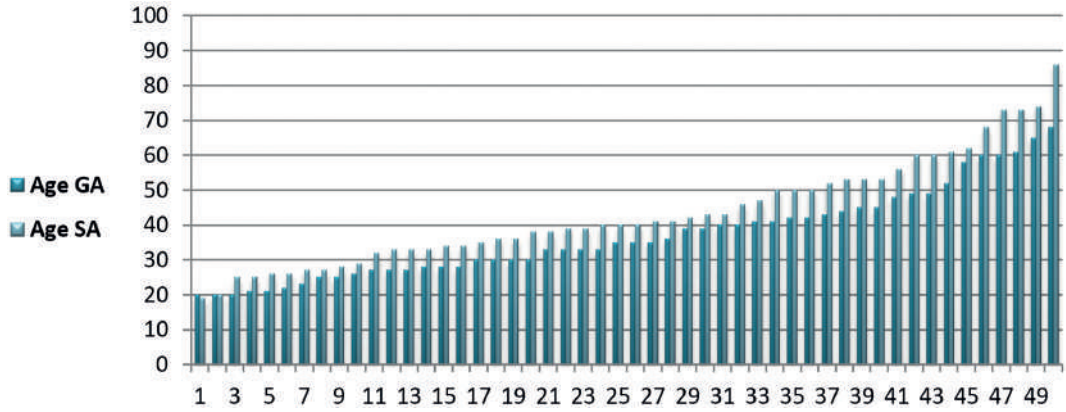

Figure 3. The Relationship Age (GA) vs (SA)

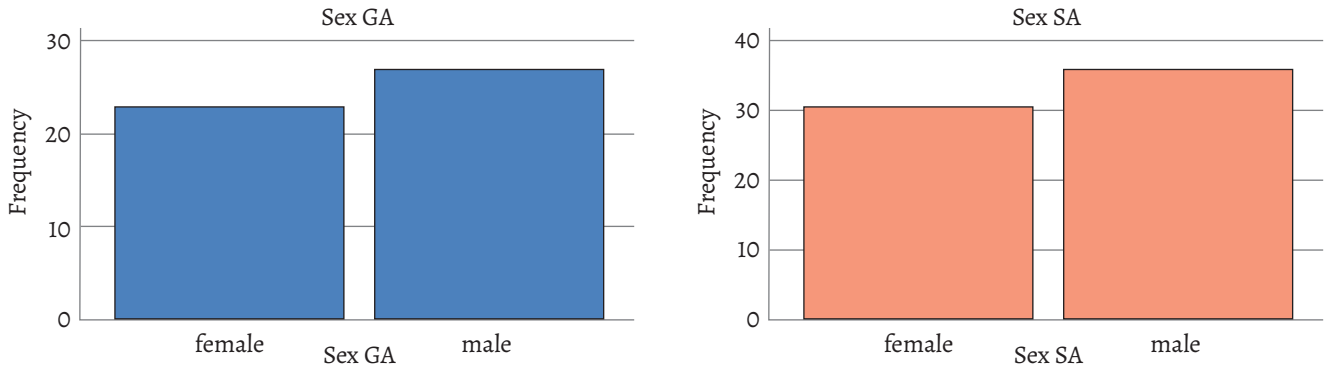

Figure 4. The Relationship sex (GA) vs (SA)

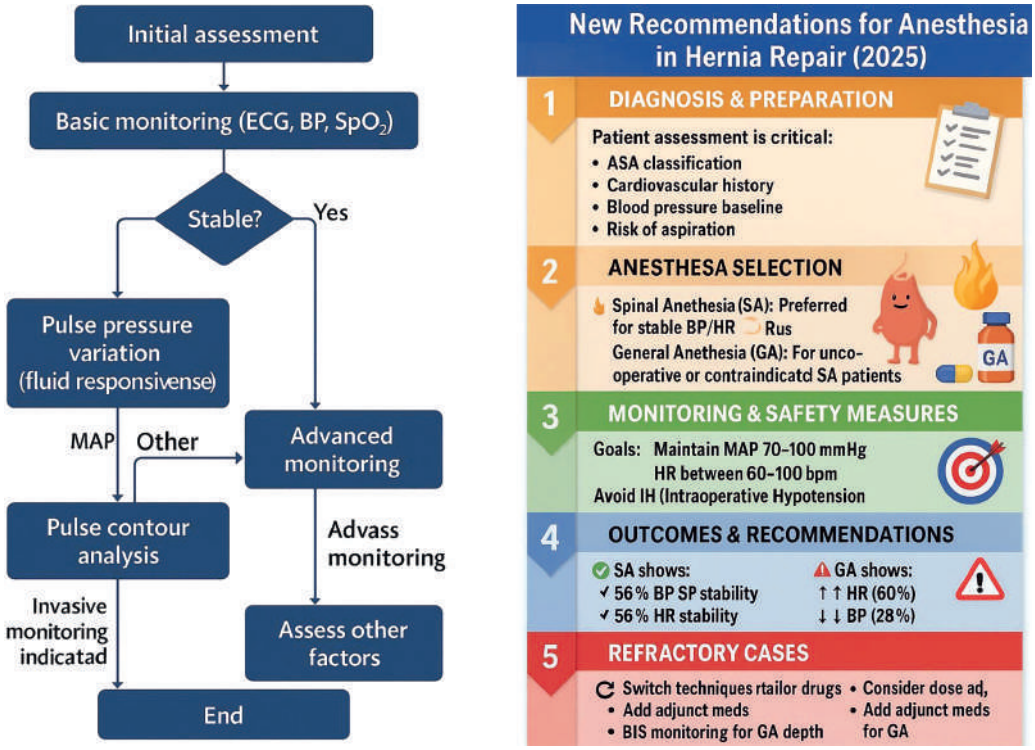

Figure 5. New Recommendations for Anesthesia in Hernia Repair (2025)

tween sixty and one hundred and avoiding intraoperative hypotension by monitoring every five to seven minutes and managing complications using fluids or vasopressors the infographic clearly demonstrates that spinal anesthesia shows greater stability with fifty six percent of patients maintaining stable blood pressure and heart rate compared to only forty percent in the general anesthesia group it also shows that heart rate increases were far more common under general anesthesia sixty percent versus thirty four percent with spinal anesthesia based on this the infographic recommends using spinal anesthesia especially in patients over fifty years old or those with cardiovascular conditions finally it presents solutions for refractory cases such as switching anesthesia type adjusting drug dosages or using brain function monitoring systems to evaluate depth of anesthesia overall the infographic provides a visually organized clinical pathway that transforms the scientific findings of the study into practical and applicable insights for anesthesiologists and surgical teams focusing on patient safety and optimal outcomes.

Discussion

According to Courtney J Balentine inguinal hernia repair is the most common general surgical procedure performed in the United States and about fifteen to twenty percent of these surgeries are carried out under general anesthesia while nearly eighty percent are performed under local anesthesia and it was expected that as patients age the advantages of local anesthesia over general anesthesia in inguinal hernia repair would increase [15] According to Bay Nielsen regional anesthesia is associated with the highest morbidity whereas local infiltration demonstrates the lowest and the elective groin hernia repair procedure has a thirty day mortality rate of zero point twelve percent with patients who died within a week of surgery being disproportionately more likely to have received regional anesthesia [16] Rodgers and Anthony indicated that neuraxial blockade reduces major complications including postoperative mortality though further studies are needed to clarify the extent of these benefits and to determine whether they are directly related to avoiding general anesthesia or linked to reductions in all cause mortality deep vein thrombosis pulmonary embolism myocardial infarction blood transfusion needs pneumonia other infections respiratory depression and renal failure [17] David L Reich observed that severe hypotension following anesthesia induction occurs more often in the first five to ten minutes after induction than at other times and he concluded that alternative agents to propofol should be considered in patients older than fifty years with ASA physical status of three or more since nine percent of patients in routine practice developed clinically significant hypotension within the first ten minutes of induction [18] Al Khikani and colleagues investigated the effects of spinal and general anesthesia on hemodynamic stability in patients undergoing hernia repair and noted that spinal anesthesia was generally more stable than general anesthesia although potential complications may still arise and they emphasized that cardiovascular outcomes are not automatically guaranteed and must be optimized by accurate techniques and careful monitoring with prompt correction of any circulatory deviations.

Conclusions

While spinal anesthesia was more stable general anesthesia was associated with a marked rise in heart rate and mean arterial pressure increased significantly during general anesthesia in contrast to the more stable levels observed with spinal anesthesia and blood pressure also remained steadier with spinal anesthesia but increased noticeably with general anesthesia and maintaining hemodynamic stability is essential to preserve the balance between oxygen supply and demand in the heart and this balance can be achieved through several drugs and methods including fentanyl in combination with isoflurane sevoflurane or propofol and volatile anesthetics are known to provide cardioprotective effects in multiple ways [13] The scientific foundations and training methods are consistent with the most recent American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care and the Basic Life Support course offered by the American Heart Association is strongly recommended for healthcare providers and other staff members who need to be trained in CPR and essential cardiovascular life support procedures across various clinical environments [14] A significant proportion of patients who undergo general anesthesia experience intraoperative hypotension and this condition is linked to severe postoperative complications including myocardial injury renal failure and higher mortality risk [15] The use of angiotensin converting enzyme inhibitors or angiotensin receptor blockers in the perioperative period influences the renin angiotensin system and may lead to refractory hypotension following anesthesia [22] The synthetic vasopressin analogue terlipressin in a dose of one mil-

ligram has been applied in the treatment of refractory hypotension in patients previously taking angiotensin converting enzyme inhibitors or angiotensin receptor blockers [23] Vasopressin itself can also be used to manage hypotension caused by severe catecholamine deficiency or allergic reactions after pheochromocytoma excision [24].

Ethical Approval

Ethical clearance was granted by the Research Committee of Karbala Health Directorate under the supervision of the Center for Training and Human Development (Ref. no. 2024–03).

Acknowledgement

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References

1. Callesen T. Inguinal hernia repair: anaesthesia, pain and convalescence. Dan Med Bull. 2003 Aug;50(3):203–18. PMID: 13677240.
2. Chaturvedi S, Lipszyc DH, Licht C, Craig JC, Parekh R. Pharmacological interventions for hypertension in children. Cochrane Database Syst Rev. 2014 Feb 1;(2):CD008117. doi: 10.1002/14651858.CD008117.pub2. PMID: 24488616 .
3. Aglio MDMS, Linda & Urman, Richard. (2017). Anesthesiology: Clinical Case Reviews. 10.1007/978–3-319–50141–3.
4. Forkin KT, Nemergut EC. Miller's anesthesia, 8th edition [Internet]. American Society of Anesthesiologists; 2016 [cited 2024 Jan 1]. Available from:https://pubHindiyah General Hospitals.asahq.org/anesthesiology/article/124/4/977/14379/Miller-s-Anesthesia-8th-Edition.
5. Wolfsthal SD. Is blood pressure control necessary before surgery? Med Clin North Am. 1993 Mar;77(2):349–63. doi: 10.1016/s0025–7125(16)30256–5. PMID: 8441300.
6. Mabula JB, Chalya PL. Surgical management of inguinal hernias at Bugando Medical Centre in northwestern Tanzania: our experiences in a resource-limited setting. BMC Res Notes. 2012 Oct 25;5:585. doi: 10.1186/1756–0500–5-585. PMID: 23098556; PMCID: PMC3526506.
7. Aitkenhead AR, I Moppett, J Thompson. Smith and Aitkenhead's Textbook of Anaesthesia. Elsevier Health Sciences; 2013.
8. Butterworth JF. Morgan and mikhail's clinical anesthesiology. 6th ed. McGraw-Hill Education; 2018.
9. Ti LK, Pua HL, Lee TL. Single vital capacity inhalational anaesthetic induction in adults--isoflurane vs sevoflurane. Can J Anaesth. 1998 Oct;45(10):949–53. doi: 10.1007/BF03012302. PMID: 9836031.
10. Meyler L, Aronson JK. Meyler's side effects of drugs used in anesthesia. Amsterdam: Elsevier Science; 2009.
11. Kingsnorth A, Leblanc KA, Sanders DL. Management of Abdominal Hernias. Cham: International Publishing; 2018.
12. Cortínez LI, Anderson BJ, Nick, Puga V, Natalia, Hernán Auad, et al. Dexmedetomidine pharmacokinetics in the obese. European Journal of Clinical Pharmacology. 2015 Sep 25;71(12):1501–8.
13. Liem VGB, Hoeks SE, Mol KHJM, Potters JW, Grüne F, Stolker RJ, et al. Postoperative Hypotension after Noncardiac Surgery and the Association with Myocardial Injury. Anesthesiology [Internet]. 2020 May 29;133(3):510–22. Available from: https://pubs.asahq.org/anesthesiology/article/133/3/510/108232/Postoperative-Hypotension-after-Noncardiac-Surgery
14. Kaplan JA, Augustine's JGT, Manecke GR, et al, eds. Kaplan's Cardiac Anesthesia for Cardiac and Noncardiac Surgery. 7th ed.Philadelphia, PA: Elsevier; 2017:731–769.L .
15. Pardo M. Miller's Basics of Anesthesia. Elsevier Health Sciences; 2022.
16. Benes J, Simanova A, Tovarnicka T, Sevcikova S, Kletecka J, Zatloukal J, Pradl R, Chytra I, Kasal E. Continuous non-invasive monitoring improves blood pressure stability in upright position: randomized controlled trial. J Clin Monit Comput. 2015 Feb;29(1):11–7. doi: 10.1007/s10877–014–9586–2. Epub 2014 May 20. PMID: 24841333.
17. Balentine CJ, Meier J, Berger M, Reisch J, Cullum M, Lee SC, Skinner CS, Brown CJ. Using Local Anesthesia for Inguinal Hernia Repair Reduces Complications in Older Patients. J Surg Res. 2021 Feb;258:64–

72. doi: 10.1016/j.jss.2020.08.054. Epub 2020 Sep 28. PMID: 33002663; PMCID: PMC7968932.
18. Bay-Nielsen M, Kehlet H. Anaesthesia and post-operative morbidity after elective groin hernia repair: a nation-wide study. Acta Anaesthesiol Scand. 2008 Feb;52(2):169–74.doi:10.1111/j.1399–6576.2007.01514.x. Epub 2007 Nov 12. PMID: 17999709.
19. Rodgers A, Walker N, Schug S, McKee A, Kehlet H, van Zundert A, Sage D, Futter M, Saville G, Clark T, MacMahon S. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. BMJ. 2000 Dec 16;321(7275):1493. doi: 10.1136/bmj.321.7275.1493. PMID: 11118174; PMCID: PMC27550.
20. Reich DL, Hossain S, Krol M, Baez B, Patel P, Bernstein A, Bodian CA. Predictors of hypotension after induction of general anesthesia. Anesth Analg. 2005 Sep;101(3):622–628. doi: 10.1213/01.ANE.0000175214.38450.91. PMID: 16115962.
21. Ramgolam A, Hall GL, Zhang G, Hegarty M, Ungern-Sternberg BS von. Inhalational versus Intravenous Induction of Anesthesia in Children with a High Risk of Perioperative Respiratory Adverse EventsA Randomized Controlled Trial. Anesthesiology: The Journal of the American Society of Anesthesiologists [Internet]. 2018 Jun 1 [cited 2020 Jul 14];128(6):1065–74. Available from: https://anesthesiology.pubs.asahq.org/article.aspx?articleid=2674300
22. Bertrand M, Godet G, Meersschaert K, Brun L, Salcedo E, Coriat P. Should the Angiotensin II Antagonists be Discontinued Before Surgery? Anesthesia & Analgesia. 2001 Jan;92(1):26–30.
23. Boccara G, Ouattara A, Godet G, Dufresne E, Bertrand M, Riou B, et al. Terlipressin Versus Norepinephrine to Correct Refractory Arterial Hypotension after General Anesthesia in Patients Chronically Treated with Renin-Angiotensin System Inhibitors. Anesthesiology. 2003 Jun 1;98(6):1338–44.
24. Augoustides JG, Abrams M, Berkowitz D, Fraker D. Vasopressin for Hemodynamic Rescue in Catecholamine-resistant Vasoplegic Shock after Resection of Massive Pheochromocytoma. Anesthesiology. 2004 Oct;101(4):1022–4.

Поглиблений порівняльний аналіз гемодинамічних змін під час загальної та спінальної анестезії при хірургічних втручаннях з приводу грижі

Хайдер Ахмед Джалаб Салем Аль-Кхікані

Коледж університету Аль-Тафф, Кербала, Ірак

Анотація.

Вступ: *Забезпечення безпеки пацієнта залишається головним завданням команд анестезіології та інтенсивної терапії при виборі найбільш відповідного анестезіологічного підходу — технік, препаратів, стратегій чи клінічних протоколів. Серед доступних методів спінальна анестезія є одним із найбільш широко застосовуваних і ефективних варіантів для пацієнтів, яким виконують операцію з приводу грижі.*

Матеріали та методи: *У цьому дослідженні проведено ретельну та актуальну оцінку стану пацієнтів, які підлягали герніотомії. Загалом було включено 100 пацієнтів, яких рівномірно поділили на дві групи: 50 отримували спінальн у анестезію (СА), а 50 — загальну анестезію (ЗА). Моніторували такі ключові параметри, як вік, маса тіла, частота пульсу та зміни артеріального тиску. Пацієнтів віком від 20 до 90 років включено до груп ЗА та СА для детального передопераційного, інтраопераційного та післяопераційного спостереження.*

Результати: *Результати показали, що гемодинамічна стабільність була вищою при застосуванні СА (приблизно 56 %) порівняно із ЗА (близько 40 %). Показники артеріального тиску були вищими у групі ЗА (32 %) порівняно із СА (24 %), тоді як гіпотензія спостерігалась у 28 % випадків ЗА та у 20 % випадків СА. Стабільність частоти серцевих скорочень також була кращою у СА (56 %) порівняно із ЗА (32 %). Підвищення ЧСС відзначалося у 34 % пацієнтів групи СА та у 60 % пацієнтів групи ЗА. Загалом СА забезпечувала більш стабільні результати, зокрема зниження ЧСС на 10 % у порівнянні з 8 % при ЗА.*

Висновки: *Спінальна анестезія продемонструвала кращі результати порівняно із загальною анестезією у підтриманні стабільного артеріального тиску та мінімальних або нормальних коливань частоти серцевих скорочень.*

Ключові слова: *гемодинамічна відповідь, варіації артеріального тиску, зміни частоти серцевих скорочень, методи анестезії, результати хірургічного лікування*