Review

Local anesthesia as an alternative option in repair of recurrent groin hernias: An outcome study from the American College of Surgeons NSQIP® database

Kent Grosh, Kendall Smith, Saad Shebrain [*], John Collins

Department of Surgery, Western Michigan University Homer Stryker MD School of Medicine, USA

ABSTRACT

Introduction: There is a dearth of data about the benefits of local anesthesia (LA) and spinal anesthesia (SA) compared to general anesthesia (GA) in patients undergoing repair of recurrent groin (inguinal/femoral) hernias. We hypothesized that patients with recurrent hernias who undergo repair under LA and SA will have a better outcome.

Methods and procedures: Using the 2017 American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP)® database, patients who underwent open repair of recurrent groin hernias were identified and divided into three groups: GA, SA, and LA. Outcomes evaluated included 30-day mortality and morbidity, operative time, total hospital length of stay (LOS), and reoperation and readmission rates.

Results: A total of 2169 patients were identified of which 1847 (85.2%) were in GA, 53 (2.4%) in SA, and 269 (12.4%) in LA groups. Overall, no statistically significant differences in demographics and comorbidities between the three groups were identified. However, patients in GA were younger and healthier with lower ASA Class (I-II) as compared to SA and LA groups. Patients in SA had a higher rate of COPD, and their overall operative time was shorter. However, LA patients had shorter LOS, and most LA patients were discharged home on the same day compared to GA, SA (92.2% vs. 77.9%, and 73.6%, $p < 0.001$). No differences in 30-day mortality and morbidity or reoperation and readmission rates between the three groups were noted.

Conclusion: There is an underutilization of LA in patients undergoing open repair of recurrent inguinal hernia despite favorable outcomes, even in high-risk patients, when compared to GA and SA. Further prospective studies are needed to explore the potential barriers and cost-effectiveness of implementing LA as a primary anesthetic technique in inguinal hernia repair.

1. Introduction

In the United States, more than 800,000 surgical repairs for inguinal hernia are performed annually, affecting over 25% of men in their lifetime, although less than 2% of women over their lifetime [1] and accounting for $2.5 billion in annual national healthcare costs [2]. Despite being one of the most commonly performed surgical procedures in the United States, there is still wide variability in choice of anesthetic. Several recent studies have compared anesthetic technique for this procedure and recognized GA as the inferior choice. In comparison LA and SA, GA was found to have longer hospital stays, higher rates of postoperative complications and discomfort, and slower recovery [3–7].

Several studies have also demonstrated GA's association with higher rates of postoperative pain compared to SA [8,9]. Despite this evidence, GA continues to be widely used for this procedure, with LA or SA utilized far less frequently in spite of their favorable profiles [10].

Standardizing the anesthetic technique to maximize positive outcomes and minimize costs would benefit both the individual patient and the healthcare system at large. While several existing studies have compared anesthesia type for primary inguinal hernia repair, little data exists analyzing outcomes based on anesthesia type for open surgical repair of recurrent groin hernias. Recurrence occurs in 10–15% of cases [11], and while its prevalence is declining [12], it still presents a significant healthcare problem. Repair of a recurrent hernia can be

challenging, with increased risk of complications, higher failure rates, and re-recurrence occurring in up to 8.8% of cases [13,14]. Due to the increased complexity of this operation, GA may be perceived to be the preferable anesthetic technique. This study aims primarily to evaluate the outcomes in patients who underwent repair of recurrent groin hernias under GA, SA, and LA and determine if GA should be the anesthesia of choice.

2. Methods

2.1. Study population

We performed a retrospective, cohort study using the 2017 ACS NSQIP®. Patients who underwent open surgical repair of recurrent groin (inguinal/femoral) hernia were included. The ACS NSQIP® is a national database with blinded, risk-adjusted data including surgical outcomes from multiple participating institutions across the United States. Data included in the database include preoperative risk factors, intra-operative data, and the incidence of 30-day postoperative morbidity and mortality. Since data is abstracted from the database, as per IRB guidelines, individual patient consent was not obtained. The study was deemed to be exempt from review by the Institutional Review Board at Western Michigan University Homer Stryker M.D. School of Medicine.

Selection criteria included all adult patients (≥18 years) within the database who underwent open surgical repair of recurrent groin (inguinal and/or femoral) hernia identified by the use of the appropriate diagnosis ICD-10 code for inguinal (K40.xx), and femoral (K41.xx) hernias, as well as the CPT codes for open repair of reducible and incarcerated or strangulated inguinal hernia (CPT 49555, CPT 49557), and CPT codes for open repair of reducible and incarcerated or strangulated femoral hernia (CPT 49520, CPT 49521) (Fig. 1). Exclusion criteria included patients with unrelated diagnosis to groin hernias. The patients were divided into 3 groups: general anesthesia (GA), spinal anesthesia (SA), and local anesthesia (LA) with and without sedation.

The three groups were compared with regard to patient demographic characteristics and comorbidities. Outcomes of interest were compared and included 30-day mortality and morbidity (serious and overall), operative time, length of stay (LOS), and reoperation and readmission rates. Serious morbidity (SM), as defined in a previous study [15], includes organ-space surgical-site infection, wound disruption, cerebrovascular accident or stroke, myocardial infarction, cardiac arrest

requiring cardiopulmonary resuscitation, pulmonary embolism, ventilator dependence longer than 48 h (without preoperative ventilator dependence), acute renal failure (without preoperative renal failure or dialysis), bleeding complication defined by transfusions in excess of 4 units of packed RBCs, and sepsis and septic shock. Overall morbidity [15] includes any SM, or any of the following: superficial surgical-site infection (without preoperative wound infection), deep incisional surgical-site infection (without preoperative wound infection), pneumonia (without preoperative pneumonia), unplanned intubation (without preoperative ventilator dependence), progressive renal insufficiency (without preoperative renal failure or dialysis), urinary tract infection, and deep venous thrombosis.

2.2. Statistical analysis

Categorical variables were described as frequencies and analyzed by Chi-square or Fisher's exact test. Continuous variables with approximately normal distribution were described as mean (standard deviation) and examined by ANOVA followed by post hoc analysis when a statistically significant difference was noted in the global hypothesis. Additionally, for categorical variables, we used post hoc analysis involving pairwise comparisons using the z-test of two proportions and multiple Fisher's exact tests with a Bonferroni correction. Statistically significant was considered to be $p < 0.05$. Statistical analyses were performed using SPSS software (IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp).

3. Results

Of total 23,342 patients in the ACS NSQIP® database (2017) who underwent an open groin hernia repair, 2169 (9.3%) were recurrent hernias (Fig. 1.), of which 2110 (97.4%) were recurrent inguinal hernias and 59 (2.6%) were femoral hernias. GA was used in 1847 patients (85.2%), SA in 53 (2.4%), and LA (with or without sedation) in 269 (12.4%).

Overall, the three groups shared similar demographic characteristics (Table 1 A). However, there were statistically significant differences among the three groups in the means of age, BMI, and presentations (Table 1 B). Patients in the GA group were younger, with mean [SD] (62.3 [15.4]), than those in the SA (72.1 [13.4]) and LA (67.3 [15.5]) groups. Post hoc analysis showed no statistically significant differences
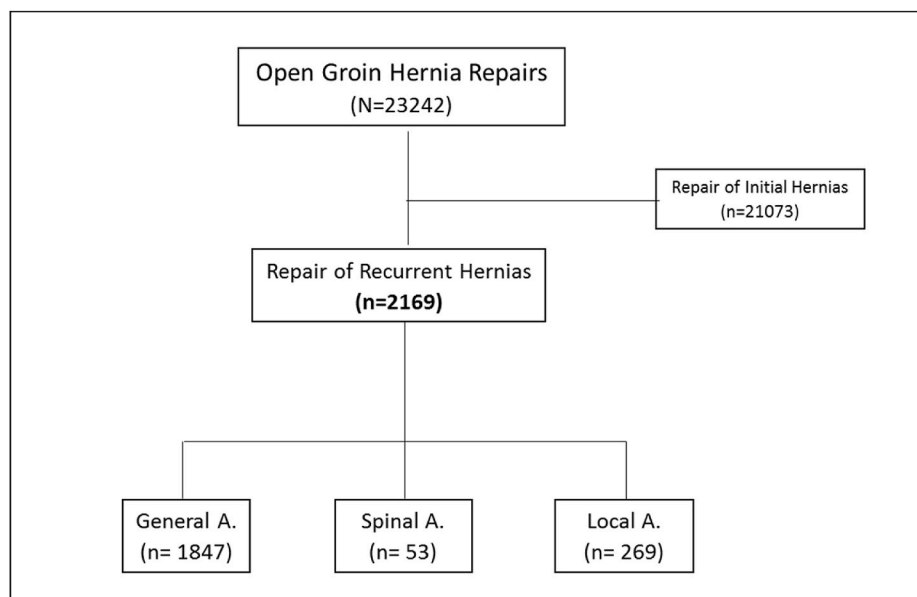

Fig. 1. Flow diagram of patients with recurrent groin hernia included in the study.

Table 1A
Preoperative demographic data and comorbidity.

Patient Demographics and medical Characteristics	General Anesthesia (n = 1847)	Spinal Anesthesia (n = 53)	Local Anesthesia (n = 269)	Total (n = 2169)	p-value
Gender, male, n (%)	1706 (92.4)	51 (96.2)	255 (94.8)	2012 (92.8)	0.219
Race, n (%)					0.456
White	1344 (72.8)	17 (32.1)	208 (77.3)	1559 (73.3)	
Black or African American	132 (7.1)	0 (0)	13 (4.8)	145 (6.7)	
Others/Unknown	371 (20)	36 (67.9)	48 (17.8)	455 (21)	
Comorbidity, n (%)					
Diabetes	177 (9.6)	10 (18.9)	25 (9.3)	212 (9.8)	0.078
Smoking	327 (17.7)	10 (18.9)	36 (13.4)	373 (17.2)	0.203
Dyspnea/ Moderate-At test	66 (3.5)	2 (3.8)	10 (3.7)	76 (3.6)	0.088
Functional status Partially/ Totally dependent	22 (1.2)	2 (3.8)	6 (2.3)	32 (1.4)	0.077
Ascites	6 (0.3)	0 (0)	1 (0.4)	7 (0.3)	0.908
CHF in 30 days before surgery	15 (0.8)	0 (0)	3 (1.1)	18 (0.9)	0.699
HTN requiring medical treatment	868 (47.0)	30 (56.6)	132 (49.1)	1030 (47.5)	0.330
Acute Renal Failure (Post-op)	2 (0.1)	0 (0)	0 (0)	2 (0.1)	0.840
Dialysis, Currently on dialysis	16 (0.9)	0 (0)	0 (0)	16 (0.7)	0.245
Disseminated cancer	9 (0.5)	1 (1.9)	1 (0.4)	11 (0.5)	0.796
Steroid Use for Chronic Conditions	43 (2.3)	2 (3.8)	8 (3.0)	53 (2.4)	0.666
Weight loss (>10% in last 6 Months)	1 (0.1)	0 (0)	0 (0)	1(0.0)	0.916
Bleeding Disorders	56 (3.0)	1 (1.9)	11 (4.1)	68 (3.1)	0.565
Transfusion ≥ 1 Unit PRBC 72h preop	1 (0.1)	0 (0)	0 (0)	1 (0.0)	0.916
Systemic Sepsis: SIRS/Sepsis	31 (1.7)	1 (1.9)	2 (0.7)	34 (1.6)	0.792

Table 1B
Preoperative demographic data and presentations.

Patient Demographics and medical Characteristics	General Anesthesia (n = 1847)	Spinal Anesthesia (n = 53)	Local Anesthesia (n = 269)	Total (n = 2169)	p-value
Age, years, mean (SD)	62.3 (15.4)$_a$	72.1 (13.4)$_b$	67.3 (15.3)$_{b, c}$	63.2 (15.5)	<0.001*
BMI, Kg/m^2, mean (SD)	27.3 (4.9)$_a$	27.0 (4.3)$_{a, b}$	26.3 (3.6)$_b$	27.2 (4.7)	0.003*
COPD- History of severe	60 (3.2)$_a$	8 (15.1)$_b$	14 (5.2)$_a$	82 (3.8)	<0.001**
Hernia type, n (%)					
• Inguinal hernia	1795 (97.2)$_{a,b}$	49 (92.5)$_b$	266 (98.9)$_a$	2110 (97.3)	0.025**
• Femoral hernia	52 (2.8)$_{a, b}$	4 (7.5)$_b$	3 (1.1)$_a$	59 (2.7)	
Presentation, n (%)					
• Inguinal-reducible	1383 (74.9)$_a$	38 (71.7)$_{a, b}$	230 (85.5)$_b$	1651 (76.1)	0.002**
• Inguinal-complicated[a]	412 (22.3)$_a$	11 (20.8)$_{a, b}$	36 (13.4)$_b$	459 (21.2)	
• Femoral-reducible	24 (1.3)$_a$	1 (1.9)$_a$	1 (0.4)$_a$	26 (1.2)	
• Femoral-complicated[a]	28 (1.5)$_a$	3 (5.7)$_a$	2 (0.7)$_a$	33 (1.5)	
Emergency surgery	128 (6.9)$_a$	2 (3.8)$_{a, b}$	5 (1.9)$_b$	135 (6.2)	0.004**
Admission Status as out-patient	1543 (83.5)$_a$	42 (79.2)$_a$	257 (95.5)$_b$	1800 (85.5)	<0.001**
ASA (class III, IV)	721 (39.1)$_a$	35 (66.0)$_b$	110 (41.0)$_a$	866 (40.0)	<0.001**

SD, standard deviation; BMI, body mass index; COPD, chronic obstructive pulmonary disease; HTN, hypertension; CHF, congestive heart failure; PRBCs, packed red blood cells; ASA, American Society of Anesthesiologists.

*Each subscript letter denotes a subset of anesthesia whose means (SDs) do not differ significantly from each other at the 0.05 level *(e.g., there is statistically significant differences in mean (SD) age between GA, SA, and LA, but no statistically significant difference in mean (SD) age between SA and LA).*

**Each subscript letter denotes a subset of anesthesia whose column proportions do not differ significantly from each other at the 0.05 level.

[a] Irreducibility, obstruction, strangulation.

in the mean age between SA and LA (p = 0.06). Patients in LA had lower mean [SD] BMI (26.3 [3.6]) compared to both GA (27.3 [4.9]) and SA (27.0 [4.3]). However, in post hoc analysis, the difference was statistically significant between LA and GA (p < 0.001). No statistical difference in mean BMI between SA and LA (p = 0.54), and between GA and SA (p = 0.835). The rate of COPD was found to be highest in the SA group (8 patients, 15.1%), followed by LA (14 patients, 5.2%). Additionally, SA and LA had higher ASA class (III-IV) compared to GA.

GA patients had longer mean [SD] operative time (72 [35]), compared to SA (54 [28]) and LA (63[31]) and this was statistically significant in post-hoc analysis (p < 0.001). However, no statistically significant difference between SA and LA (p = 0.174). LOS data were extremely right-tailed skewed with a high proportion of 0's (i.e., LOS <24 h), and neither meet the assumptions of robust parametric (ANOVA) nor non-parametric tests (the Kruskal-Wallis H test, also called "one-way ANOVA on ranks"). Additionally, we attempted methods of transformations; however, due to the extreme skewness of the data,

none of the transformations provided satisfactory results to assume normality; therefore, we decided to categorize the LOS into three groups (LOS = 0 day or same day; LOS = 1 day; and LOS = 2 or more days, Table 2). Most patients in LA (92.2%) were discharged home on the same day, compared to GA (79.2%) and SA (73.6%). Only a small fraction of patients in LA (2.6%) required a hospital stay of 2 days or more compared to 11.3% in GA and 15.1% in SA (Fig. 2). We found moderate correlation between increased LOS and presentation of hernia with complication (i.e., irreducibility, obstruction, strangulation, [r = 0.45, p < 0.001]), high ASA class (r = 0.23, p < 0.001), and the need for emergency surgery (r = 0.48, p < 0.001). No differences in 30-day mortality and morbidity or reoperation and readmission rates between the three groups were noted (Table 2).

4. Discussion

Multiple studies have demonstrated better outcomes with the use of LA compared to GA for initial open inguinal hernia repair. This includes a correlation with reduced rates of short-term complications, improved cost efficiency, and quicker recovery as compared to patients operated on under GA [3–6,14]. Additional studies have also assessed SA in comparison to GA and LA. While SA is associated with less postoperative pain than GA [8,9], LA remains the superior choice because of fewer short-term complications than SA, including urinary retention and postoperative pain [16–18]. There are not only reduced complication rates but also improvements in long-term indicators of quality of life metrics such as a mobility, resumption of daily activities, and reduced

Table 2
30-days post-operative Outcomes.

30-days post-operative Outcomes	General Anesthesia (n = 1847)	Spinal Anesthesia (n = 53)	Local Anesthesia (n = 269)	Total (n = 2169)	p-value
30-day mortality	4 (0.2)	0 (0)	0 (0)	4 (0.2)	NA
Return to OR	20 (1.1)	0 (0)	3 (1.1)	23 (1.1)	0.747
Readmission within 30 days	40 (2.2)	0 (0)	6 (2.2)	46 (2.1)	0.554
Serious morbidity	21 (1.1)	0 (0)	2 (0.7)	23 (1.1)	0.629
Overall morbidity	40 (2.2)	0 (0)	5 (1.9)	45 (2.1)	0.533
Operative Time[a] mean (SD)	72 (35)a	54 (28)b	63 (31)c, b	71 (37)	<0.001*
Total Length of Hospital Stay					<0.001**
• 0 Day	1438 (77.9)a	39 (73.6)a	247 (92.2)b	1724 (79.5)	
• 1 Day	201 (10.9)a	6 (11.3)a,b	14 (5.2)b	221 (10.2)	
• 2 or more days	208 (11.3)a	8 (15.1)a	7 (2.6)b	223 (10.3)	

LOS, Total Length of Hospital Stay, SD, standard deviation, OR, Operating Room.

*Each subscript letter denotes a subset of anesthesia whose means (SDs) do not differ significantly from each other at the 0.05 level.

**Each subscript letter denotes a subset of anesthesia whose column proportions do not differ significantly from each other at the 0.05 level.
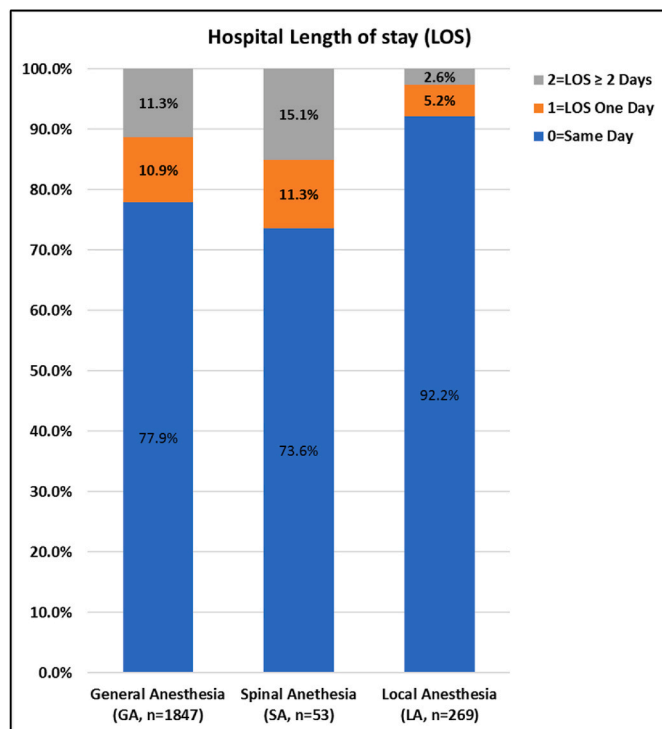
[a] In minutes.

Fig. 2. Hospital length of stay among general (GA), spinal (SA), and local anesthesia (LA).

discomfort from mesh sensation [5].

Our study focused on choice of anesthesia in repairing recurrent groin hernias which is a more challenging procedure than the initial repair. Local anesthesia without the use of endotracheal intubation has been demonstrated to be a viable alternative for initial inguinal hernia repair but has not been widely accepted for repair of recurrent hernias. Indeed, in our study, GA was the choice for the majority (85.2%) of the patients. In comparison, meta-analyses of studies focused on initial repair had a GA utilization rate close to 50% [6,7], supporting the observation that surgeons are hesitant to attempt open repair of recurrent inguinal hernias under LA.

Analysis of the data in our study demonstrates that LA and SA provide an alternative to GA for repair of recurrent inguinal hernias and are not associated with an increased complication risk despite the relative complexity of the operation. While patients for whom LA and SA was used tended to be older, have higher rates of COPD, and have higher ASA classes, there was no significant difference in complications between the two groups. Rates of common complications in this analysis, such as urinary tract infections and surgical-site infections, were consistent with those reported in similar studies [19]. The operative time was longer in GA compared to SA and LA. However, operative time was shorter in SA than LA. While LA is administered by the operating surgeon, we could not abstract data as to the location of providing SA. If the SA was administered by the anesthesiologist in the preoperative area or in the operating room, it could impact the total operating time.

Our study shows one clear benefit to the patients in the LA group, which is a shorter hospital length of stay. As open inguinal hernia is typically performed as an outpatient procedure, reduced operative time in repairing recurrent inguinal hernia may also help reduce delays in scheduling and increase efficiency of operating rooms. While cost of surgery was not measured directly in this analysis, both shorter length of stay and hospital time directly reduce healthcare costs. Moreover, GA requires more consumables and medication than LA and has consistently been shown to result in increased costs for a plethora of outpatient surgical procedures [7].

This study also demonstrated that the use of LA and SA was chosen far more frequently for patients who were older or with higher ASA class, implying that the potential primary determinant of anesthesia choice was the patient's ability to tolerate GA. This is in contrast to the common assumption in similar analyses that individual surgeon or patient preference is the primary determinant of anesthesia choice [6,7, 18]. If the patients in higher ASA class can do well under SA and LA, it is likely that healthier patients will do at least equally well or even better as compared to the use of GA. It is, however, important to acknowledge that surgeon preference may vary depending on the clinical setting (i.e., private practice, community hospital, or academic institution) and whether the surgeon bears the responsibility of teaching. From the surgeon's perspective, teaching a resident while the patient is awake may be challenging and a potential barrier as teaching may increase operative time, especially when training junior residents. In addition, the verbal communication between faculty and learner may be perceived to increase stress in the patient; therefore, many surgeons may feel more comfortable using GA, especially when faced with a potentially complex recurrent hernia repair.

Our study has several limitations. First, it has all the limitations inherent in retrospective reviews. Second, potential data-coding errors could result in misclassification bias and, therefore, affect sample size. Third, due to limited access to data, it is difficult to determine the clinical setting (i.e., academic vs. community) where these procedures were performed; therefore, it is difficult to determine whether participation of surgical residents has any effect on operative time. Fourth, while the study included a large sample size of recurrent groin hernias, SA was the technique used least often, which may have led to underpowered comparison. One possible explanation to this may be related to the invasive nature of the technique, requiring special expertise dependent on the availability of an anesthesia team comfortable with

the technique. Fifth, the patient's subjective experience of intra-operative and postoperative pain was not included in the analysis. Patients may have a significant aversion to the possibility of being conscious or sedated during surgery and, thus, may have a strong preference for GA when given the option. However, previous analyses have reported similar patient satisfaction rates when comparing LA to GA for open inguinal repair [7], with similar rates of short- and long-term postoperative pain. Despite these limitations, this study demonstrates that LA has many benefits in recurrent groin hernia repair and is underutilized. We recommend a future study to identify potential barriers in implementing this technique in surgical clinical practice. Elimination of these barriers will improve clinical care in this group of patients.

5. Conclusion

There is underutilization of LA in patients undergoing open recurrent inguinal hernia repair despite favorable outcomes, even in high-risk patients, when compared to GA and SA. Increased use of LA is likely to decrease cost to the healthcare system and increase patient satisfaction. Further prospective studies are needed to document cost of the procedure and patient satisfaction.

Declaration of conflicting interests

The authors have no conflicts of interest.

Conflicts of interest

We all (author and Co-authors) declare that there are no conflicts of interest.

Corresponding Author: Saad Shebrain, MBBCh, MMM, FACS.

Co-Authors: Kendall Smith, BS, Kent Grosh, MD, John Collins, MD.

Sources of funding

This manuscript did not receive any funding.

Ethical Approval

This study was granted IRB exemption status by the Western Michigan University IRB Department. Informed consent was not necessary. No protected health information or other uniquely identifying information is included in this manuscript.

Consent

As stated in "Ethical Approval":Informed consent was not necessary. No protected health information or other uniquely identifying information is included in this manuscript.

Author contribution

Study conception and design: Shebrain, Collins. Acquisition of data: Shebrain. Analysis and Interpretation of data: Shebrain, Collins. Drafting of Manuscript: Grosh, Smith, Shebrain. Critical revision: Shebrain, Collins.

Registration of research studies—not applicabale

1. Name of the registry:
2. Unique Identifying number or registration ID:

3. Hyperlink to your specific registration (must be publicly accessible and will be checked):

Guarantor

Saad Shebrain, MBBCh, MMM, FACS, Address: Department of Surgery, Western Michigan University Homer Stryker MD School of medicine, 1000 Oakland Drive, Kalamazoo, MI 49008, Emil: saad.shebrain@med.wmich.edu, Tel: 269-337-6260.

Acknowledgment

He authors thank Duncan Vos, MS for providing advice about the analyzed data.

References

[1] M. Hammoud, J. Gerken, Inguinal hernia, in: StatPearls. Treasure Island (FL), StatPearls Publishing, 2020. September 8.

[2] I.M. Rutkow, Demographic and socioeconomic aspects of hernia repair in the United States in 2003, Surg. Clin. 83 (5) (2003) 1045, https://doi.org/10.1016/S0039-6109(03)00132-4, vi.

[3] M.K. Rafiq, B. Sultan, M.A. Malik, K. Khan, M.A. Abbasi, Efficacy of local anaesthesia in repair of inguinal hernia, J. Ayub Med. Coll. Abbottabad 28 (4) (2016) 755–757.

[4] T. Chen, Y. Zhang, H. Wang, et al., Emergency inguinal hernia repair under local anesthesia: a 5-year experience in a teaching hospital, BMC Anesthesiol. 16 (2016) 17, https://doi.org/10.1186/s12871-016-0185-2.

[5] C.R. Huntington, B.A. Wormer, T.C. Cox, et al., Local anesthesia in open inguinal hernia repair improves postoperative quality of life compared to general anesthesia: a prospective, international study, Am. Surg. 81 (7) (2015) 704–709.

[6] M. Argo, J. Favela, T. Phung, S. Huerta, Local vs other forms of anesthesia for open inguinal hernia repair: a meta-analysis of randomized control trials, Am. J. Surg. 218 (5) (2019) 1008–1015, https://doi.org/10.1016/j.amjsurg.2019.06.024.

[7] L. Verstraete, N. Becaus, H. Swannet, W. Ceelen, L. Duchateau, N. Speybroeck, Long-term outcome after Lichtenstein hernia repair using general, locospinal, or local anaesthesia, Acta Chir. Belg. 115 (2) (2015) 136–141, https://doi.org/10.1080/00015458.2015.11681083.

[8] C. Sarakatsianou, S. Georgopoulou, I. Baloyiannis, et al., Spinal versus general anesthesia for TAPP repair of inguinal hernia: interim analysis of a controlled randomized trial, Am. J. Surg. 214 (2) (2017) 239–245.

[9] D. Yildrim, A. Hut, S. Uzman, et al., Spinal anesthesia is safe in laparoscopic total extraperitoneal inguinal hernia repair. A retrospective clinical trial, Wideochir Inne Tech Maloinwazyjne 12 (4) (2017) 417–427.

[10] S. Tabiri, K.W. Russell, F.E. Gyamfi, A. Jalali, R.R. Price, M.G. Katz, Local anesthesia underutilized for inguinal hernia repair in northern Ghana, PLoS One 13 (11) (2018), e0206465, https://doi.org/10.1371/journal.pone.0206465.

[11] HerniaSurge Group, International guidelines for groin hernia management, Hernia 22 (1) (2018) 1–165, https://doi.org/10.1007/s10029-017-1668-x.

[12] B. Zendejas, T. Ramirez, T. Jones, et al., Incidence of inguinal hernia repairs in Olmsted County, MN: a population-based study, Ann. Surg. 257 (3) (2013) 520–526, https://doi.org/10.1097/SLA.0b013e31826d41c6.

[13] F. Kockerling, C. Kruger, I. Gagarkin, et al., What is the outcome of re-recurrent vs recurrent inguinal hernia repairs? An analysis of 16,206 patients from the Herniamed Registry, Hernia 24 (4) (2020) 811–819, https://doi.org/10.1007/s10029-020-02138-1.

[14] T. Bisgaard, M. Bay-Nielsen, H. Kehlet, Re-recurrence after operation for recurrent inguinal hernia. A nationwide 8-year follow-up study on the role of type of repair, Ann. Surg. 247 (4) (2008) 707–711, https://doi.org/10.1097/SLA.0b013e31816b18e3.

[15] A.M. Ingraham, M.E. Cohen, C.Y. Ko, B.L. Hall, A current profile and assessment of north american cholecystectomy: results from the american college of surgeons national surgical quality improvement program, J. Am. Coll. Surg. 211 (2) (2010) 176–186, https://doi.org/10.1016/j.jamcollsurg.2010.04.003.

[16] D. Prakash, L. Heskin, S. Doherty, R. Galvin, Local anaesthesia versus spinal anaesthesia in inguinal hernia repair: a systematic review and meta-analysis, Surgeon 15 (1) (2017) 47–57.

[17] A. Goel, A. Bansal, A. Singh, Comparison of local versus spinal anesthesia in long standing open inguinal hernia repair, Internal Surg. J. 4 (11) (2017) 3701–3704.

[18] N. Shafique, H.U. Rashid, M.I. Raja, M. Saeed, Comparison of efficacy of spinal anaesthesia and sub-fascial local anaesthetic inguinal field block for open inguinal hernia repair – a single institutional experience, J. Ayub Med. Coll. Abbottabad 27 (1) (2015) 197–200.

[19] P. Sanjay, A. Woodward, Inguinal hernia repair: local or general anaesthesia? Ann. R. Coll. Surg. Engl. 89 (5) (2007) 497–503, https://doi.org/10.1308/003588407X202056.