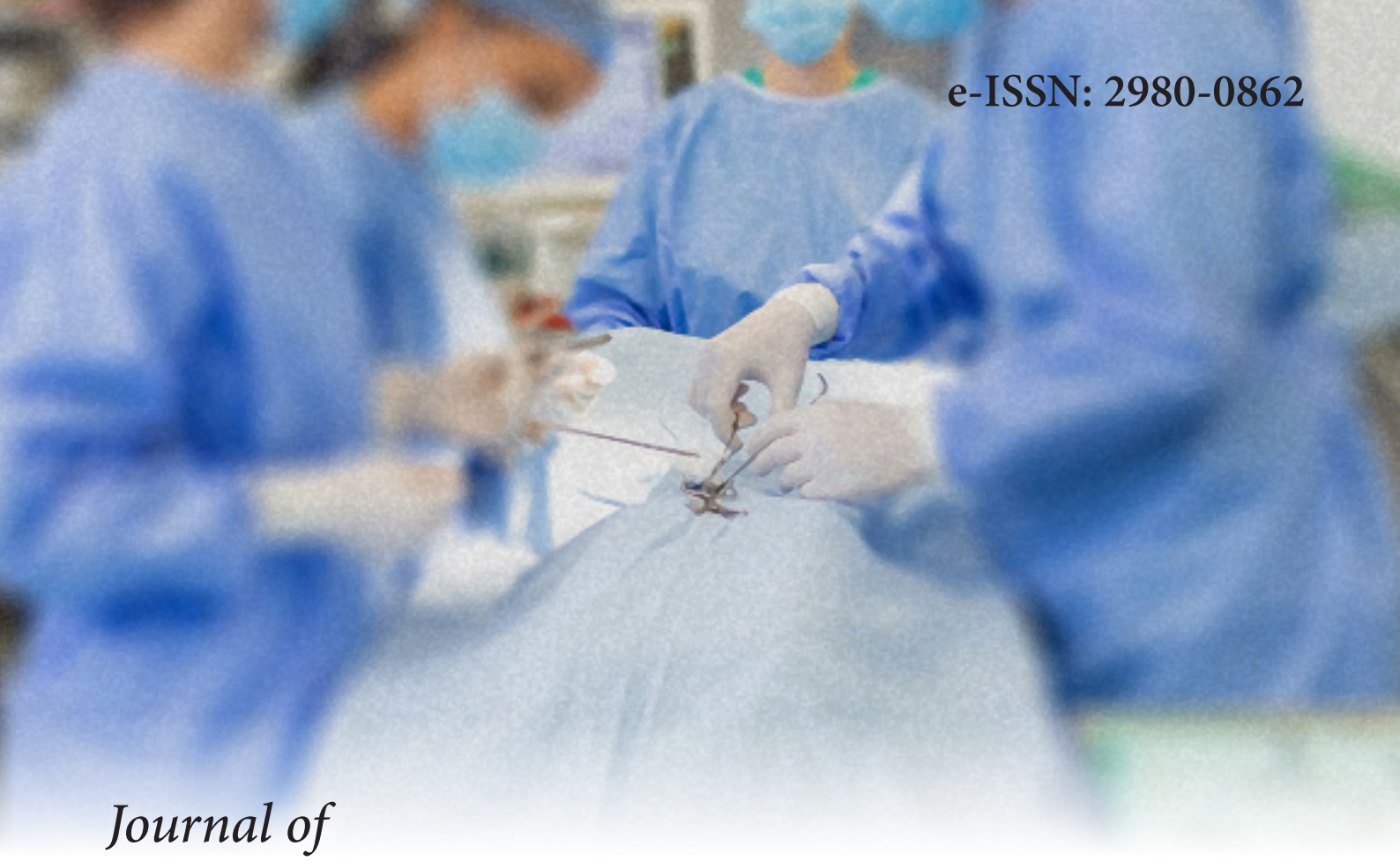

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LETTER TO THE EDITOR

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Original Article

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Evaluation of the relationship between sedation methods and postoperative delirium in geriatric patients operated with spinal anesthesia

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ABSTRACT

Aims: With the rapidly aging population, the geriatric patient population is increasing, requiring a careful approach in anesthesia management. The comorbidities commonly seen in these patients often direct anesthetists towards regional anesthesia techniques; however, the adverse effects of certain sedative agents used during regional anesthesia on cognitive functions can create uncertainty about which agent should be preferred. In this context, our study aims to evaluate the effects of dexmedetomidine and remifentanil, administered for sedation in geriatric patients undergoing spinal anesthesia, on postoperative delirium.

Methods: This prospective observational clinical study was conducted after obtaining ethical approval in patients aged 65 and older classified as American Society of Anesthesiologists (ASA) I-II-III who were planned for lower extremity surgery with spinal anesthesia. All patients underwent preoperative confusion assessment method (CAM) testing, and the cases were divided into two groups: dexmedetomidine group (group D, n=38) and remifentanil group (group R, n=38). After the completion of the surgery, sedation was discontinued, and the follow-up of the cases was maintained in the postoperative care unit until the modified Aldrete score reached 9. On the postoperative 24th hour, 72nd hour, and 30th day, the CAM test was repeated by the researcher who conducted the initial test.

Results: No significant difference was found in postoperative delirium between the two different sedation protocols in the geriatric population ($p>0.05$). A statistically significant decrease in simultaneous mean arterial pressure (MAP) values was observed in group D patients at intraoperative 90, 105, 120, and 135 minutes ($p<0.05$).

Conclusion: The effects of using dexmedetomidine and remifentanil as sedative agents in geriatric patients are similar regarding the frequency of postoperative delirium.

Keywords: Postoperative delirium, spinal anesthesia, sedation

INTRODUCTION

The rapid increase in the elderly population has led to a significant increase in the number of surgeries performed among geriatric patients.[1] In geriatric patients, age-related physiological and pharmacodynamic changes lead to increased sensitivity to anesthesia, which may affect mortality and morbidity depending on the choice and dosage of anesthesia.[2-4] The frequent comorbidities in these patients lead anesthesiologists to prefer regional anesthesia methods, particularly spinal anesthesia.[2] For patients receiving regional anesthesia, sedation plays a crucial role in maintaining patient comfort during both the intraoperative and postoperative periods.[2] There is still uncertainty regarding the choice of sedative agent.[2,5-7]

Dexmedetomidine, frequently preferred in geriatric patients, stands out due to its potential to provide analgesia and anxiolysis without the risk of respiratory depression. Additionally, α2-agonists positively impact cardiovascular stability and attenuate the physiological response to surgical stress.[5] Dexmedetomidine is known to offer better control over sedation depth in geriatric patients compared to benzodiazepines and is linked to fewer complications.[6] On the other hand, its short duration of action and rapid metabolism make remifentanil another suitable agent for sedation in geriatric patients.[7] Depending on the sedative agent to be used, one of the most common complications, especially in geriatric patients, is postoperative cognitive dysfunction (PCD).[1,2] The effects of dexmedetomidine and remifentanil in terms of PCD in geriatric patients remain unclear in the literature.[2,5-7]

The most prevalent form of PCD is delirium.[2,8] Delirium is characterized by acute daily fluctuations and impairments in attention and memory.[8] Moreover, delirium has been identified as a risk factor for dementia in aging individuals.[9] Postoperative delirium (POD) is a condition that impairs recovery, prolongs hospital stays, escalates healthcare costs, and contributes to increased morbidity and mortality, particularly in elderly patients.[8] The confusion assessment

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method (CAM), widely utilized for diagnosis, demonstrates high sensitivity and specificity.[10]

In light of this information, the primary outcome of the study was defined as the effect of two commonly used sedative agents, dexmedetomidine and remifentanil, on cognitive functions in geriatric patients undergoing surgery under spinal anesthesia. The secondary outcomes were defined as the effects of these agents on mean arterial pressure and heart rate.

METHODS

Ethics

This is a prospective observational clinical study conducted in accordance with the principles of the Declaration of Helsinki, following the approval of the Ankara Bilkent City Hospital Ethics Committee (Date: 27.04.2022, Decision No: E2-22-1760) and after obtaining informed consent from the patients. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Subject Selection, Inclusion and Exclusion Criteria

The study included patients aged 65 and older who underwent elective lower extremity surgery under spinal anesthesia and were classified as ASA I-III according to the American Society of Anesthesiologists (ASA) classification.

Exclusion criteria included obesity (body-mass index >35 kg/m^2), history of dementia, contraindications to spinal anesthesia, emergency surgeries, history of substance abuse, psychiatric disorders, severe cardiac disease, central nervous system diseases, renal and/or hepatic dysfunction, bleeding diathesis, need for premedication, preoperative CAM test positivity, glasgow coma score below 14, and patients unable to cooperate postoperatively (e.g., mental retardation, communication barriers).

Intervention and Randomization

As part of the study, all patients underwent fasting following a standard protocol. The demographic characteristics of the patients were recorded preoperatively in the ward. Intraoperatively, surgical duration, heart rate, and mean arterial pressure (MAP) were recorded.

Patients were randomized into two groups using a computerized randomization program (www.randomization.com). In the dexmedetomidine group (group D), an initial bolus of dexmedetomidine was administered at 0.5 mcg/kg over 10 minutes, followed by a continuous infusion at 0.2 mcg/kg/hour. In the remifentanil group (group R), an initial bolus of remifentanil was administered at 0.1 mcg/kg/hour over 5 minutes, followed by a continuous infusion at 0.05 mcg/kg/hour. Infusion doses were adjusted to maintain the BIS value between 65 and 85 and the Richmond agitation-sedation scale (RASS) between -1 and -3.[4,5] A respiratory rate ≤8, SpO_2 <95, heart rate <40, and systolic blood pressure <80 mmHg were defined as endpoints. When these thresholds were reached, the sedation dose was reduced regardless of the BIS value. The maximum dose did not exceed 1.4 µg/kg/h in the dexmedetomidine group (group D, n=38) and 10 µg/kg/h in the remifentanil group (group R, n=38).

Anesthesia Management

Patients were transferred to the operating room for routine preoperative preparation and standard monitoring, including electrocardiography (ECG), peripheral oxygen saturation (SpO_2), noninvasive blood pressure (NIBP), and bispectral index (BIS®, A 2000™ Bispectral Index®, Aspect Medical Systems). Intravenous access was established, and hydration was maintained with an infusion of isotonic sodium chloride solution at 10 ml/kg per hour. Spinal anesthesia was performed in all patients by administering 2-2.2 ml of 0.5% hyperbaric bupivacaine into the subarachnoid space using a 25-gauge spinal needle at the L3-L4 or L4-L5 intervertebral space while in the sitting position. Patients were positioned supine with a 30-degree head elevation. Sensory block was evaluated using a pinprick test with a hypodermic needle, while motor block was assessed using the modified Bromage scale. Sedation was initiated in patients with a sensory block at T10 or above. All patients received oxygen at 3 L/min via a face mask throughout the procedure. A decrease of 20% or more in mean arterial pressure from baseline was defined as hypotension, and in such cases, a 250 ml fluid infusion and 5 mg of ephedrine were administered. All patients were provided with active warming measures to prevent hypothermia throughout the procedure.

Measurements and Outcome Parameters

Demographic characteristics and intraoperative data of the patients were recorded. Blood pressure, respiratory rate, sedation scores, and BIS values were assessed preoperatively, after spinal anesthesia, and at 15-minute intervals throughout the procedure.

After completion of surgery, patients were monitored in the postoperative care unit until the modified Aldrete score reached 9, following discontinuation of sedation. Cognitive function was assessed using CAM on the first preoperative day and at 0, 24, 72 hours, and 30 days postoperatively.[9,10] Patients were evaluated in their wards at 24 and 72 hours postoperatively, while all study participants were assessed via telephone on the 30th day.

Statistical Analysis

Power analysis was conducted using the G*power 3.1.9.7 (Franz Faul, Universität Kiel, Germany) statistical software. The analysis yielded a power of 92% with group D (n=38, -1.44±0.57) and group R (n=38, -0.96±0.66), with α=0.05 and an effect size (d) of 0.78.

RESULTS

A total of 86 patients were evaluated in this study, and 82 patients who met the inclusion criteria were randomly assigned into two groups (n=41 per group). In the dexmedetomidine group (group D), two patients were excluded due to the need for general anesthesia following a change in the surgical procedure, and one patient was lost to follow-up postoperatively. Similarly, in the remifentanil group (group R), one patient was excluded due to the need for general anesthesia following a change in the surgical procedure, and two patients were lost to follow-up postoperatively. Consequently, the study was completed with a total of 76 patients: 38 in group D and 38 in group R (**Figure**).

No significant differences were observed between the groups regarding age, gender, height, weight, BMI, ASA score, education level, surgical duration (minutes), and hospital stay (days) (p>0.05) (**Table 1**).

In the comparison of primary and secondary outcomes between the two groups, no statistically significant difference

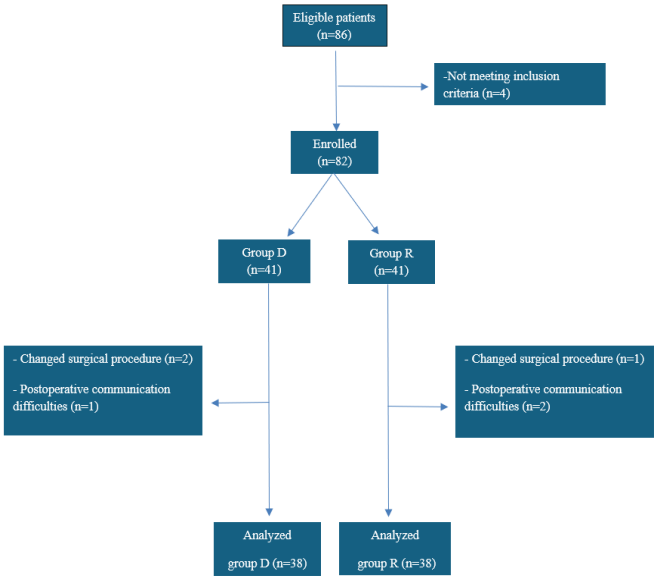

Figure. Consort flow chart

Table 1. Comparison of demographic data, hospital stay, and surgical duration between groups

	Group D (n=38)	Group R (n=38)	p
Sex			
Female	31 (81.6%)	29 (76.3%)	0.778
Male	7 (18.4%)	9 (23.7%)	
Age (years)	69.9±4.4	71.8±5.5	0.110
Height (cm)	158.7±6.8	159.1±6.9	0.789
Wieght (kg)	82.5±12.8	78.7±9.6	0.145
BMI (kg/m²)	32.9±5.6	31.2±4.5	0.156
Educational level			
Illiterate	7 (18.4%)	5 (13.2%)	0.444
Primary school	19 (50.0%)	22 (57.9%)	
Middle school	6 (15.8%)	5 (13.2%)	
High school	5 (13.2%)	2 (5.3%)	
College or higher	1 (2.6%)	4 (10.5%)	
ASA			
I	-	-	0.0676
II	28 (73.7%)	35 (92.2%)	
III	10 (26.3%)	3 (7.8%)	
Hospital stay (days)	5.92±3.66	5.39±2.58	0.471
Surgical duration (min)	103.0±30.9	94.5±29.7	0.223

Data are presented as mean±SD, number (%) or (n), BMI: Body-mass index, ASA: American Society of Anesthesiologists, SD: Standard deviation

was observed in simultaneous CAM scores, which represent the primary outcome (p>0.05) (Table 2).

Regarding the secondary outcomes, no significant differences were found between the groups in simultaneous heart rate (HR) measurements at any time point during the intraoperative period (p>0.05) (Table 2). Similarly, no statistically significant differences were observed in simultaneous MAP values at 15, 30, 45, 60, 75, 150, and 165 minutes intraoperatively (p>0.05). However, significant differences in MAP were found at 90, 105, 120, and 135 minutes (p<0.05), with lower MAP values consistently observed in group D during these time points (p<0.05) (Table 3).

Table 2. Comparison of CAM scores between groups

CAM	Group D (n=38)	Group R (n=38)	p
Postop 0. hour	0.00±0.00	0.00±0.00	1.000[a]
No delirium	38 (100.0%)	38 (100.0%)	1.000[b]
Postop 24 hours	0.05±0.23	0.00±0.00	0.160[a]
No delirium	36 (94.7%)	38 (100.0%)	0.493[b]
Delirium present	2 (5.3%)	--	
Postop 72 hours	0.03±0.16	0.00±0.00	0.324[a]
No delirium	37 (97.4%)	38 (100.0%)	1.000[b]
Delirium present	1 (2.6%)	--	
Postop 30 days	0.00±0.00	0.03±0.16	0.324[a]
No delirium	38 (100.0%)	37 (97.4%)	1.000[b]
Delirium present	--	1 (2.6%)	

CAM: Confusion assessment method, a: Independent samples T test (mean±SD), b: Chi-square test n (%), SD: Standard deviation

Table 3. Comparison of heart rate and MAP between groups

	Time (n/n)	Group D (n=38)	Group R (n=38)	p
MAP (mmHg)	15th min (38/38)	109.6±10.1	106.4±15.8	0.302
	30th min (38/38)	94.0±14.9	91.9±11.3	0.479
	45th min (38/38)	87.1±13.0	86.0±13.2	0.721
	60th min (38/38)	82.9±14.0	84.7±13.9	0.567
	75th min (37/35)	80.2±12.1	84.5±16.4	0.207
	90th min (34/29)	78.8±13.2	88.2±15.9	0.013
	105th min (30/18)	79.4±14.6	93.3±15.2	0.003
	120th min (19/14)	77.3±11.2	96.1±15.9	0.000
	135th min (10/8)	75.4±9.0	94.1±16.4	0.015
	150th min (4/3)	81.8±12.4	92.0±17.8	0.406
	165th min (3/2)	75.0±6.2	99.0±31.1	0.469
	180th min (3/0)	73.0±10.8	--	--
	195th min (1/0)	82.0±0.0	--	--
HR (bpm)	15th min (38/38)	81.6±15.4	79.5±13.4	0.532
	30th min (38/38)	72.9±15.5	75.1±13.0	0.513
	45th min (38/38)	63.7±13.2	68.9±14.0	0.103
	60th min (38/38)	62.6±11.4	68.0±12.7	0.055
	75th min (37/35)	62.7±11.5	67.1±10.0	0.085
	90th min (34/29)	62.4±10.9	67.0±10.7	0.103
	105th min (30/18)	63.1±10.9	65.6±9.4	0.422
	120th min (19/14)	63.3±9.8	66.3±10.1	0.403
	135th min (10/8)	67.4±9.9	65.0±11.0	0.632
	150th min (4/3)	74.0±9.4	63.0±14.8	0.278
	165th min (3/2)	69.7±10.0	72.0±19.8	0.867
	180th min (3/0)	71.0±12.3	--	--
	195th min (1/0)	59.0±0.0	--	--

Data are presented as mean±SD, number (%) or (n), MAP: Mean arterial pressure, HR: Heart rate

DISCUSSION

This study investigates the effects of sedation strategies on postoperative delirium in geriatric patients undergoing elective surgery under spinal anesthesia. The findings indicate no significant difference in the incidence of postoperative delirium between the dexmedetomidine and remifentanil groups. Delirium was observed in 5.2% of patients in the

dexmedetomidine group and 2.6% in the remifentanil group. Furthermore, MAP values were lower in the dexmedetomidine group at 90, 105, 120, and 135 minutes.

Postoperative delirium is associated with both patient-related and surgery-related risk factors. Advanced age is recognized as the most significant risk factor for postoperative delirium.[11] With aging, organ function declines, and alterations occur in the metabolism and excretion of anesthetic agents.[11] Male sex has also been identified as a predisposing factor for postoperative delirium, a view supported by numerous studies.[11,12] Major and emergency surgical procedures have been associated with a higher incidence of delirium compared to minor and elective surgeries, and the risk of delirium increases with prolonged surgical duration.[13] An extended hospital stay has also been identified as a risk factor for delirium.[13] A meta-analysis by Yang et al.,[13] including 10,053 patients, identified factors associated with delirium following orthopedic surgeries in geriatric patients, with hospital stay duration being one of them. In our study, no significant differences were observed regarding predisposing risk factors for postoperative delirium.

The incidence of postoperative delirium following orthopedic surgery ranges from 5% to 61%; this variation is influenced by predisposing risk factors and the choice of sedative agents.[2,5-7] In our study, the incidence of postoperative delirium was 3.9%, which is below the reported average in the literature. These findings suggest that both sedative agents evaluated may be safe regarding postoperative delirium.

In a randomized controlled trial by Shin et al.,[2] intraoperative dexmedetomidine and propofol sedation were compared in patients over 65 years undergoing lower extremity surgery under spinal anesthesia. The incidence of postoperative delirium was lower in patients receiving dexmedetomidine sedation. A retrospective study by Park et al.,[14] including 1045 patients, yielded similar results, demonstrating that dexmedetomidine sedation led to a lower incidence of postoperative delirium compared to propofol in elderly patients. Maldonado et al.[15] compared sedation with propofol, dexmedetomidine, and midazolam, reporting a delirium incidence of 50% in the propofol and midazolam groups, whereas it was only 3% in the dexmedetomidine group. Poorzamany et al.[16] concluded that dexmedetomidine was more reliable than remifentanil for sedation in cataract surgery. However, this study included patients aged 40 to 70. Moreover, the number of studies comparing postoperative delirium incidence between dexmedetomidine and remifentanil in geriatric patients remains limited in the literature. In our study, postoperative delirium occurred in 5.2% of geriatric patients in the dexmedetomidine group and 2.6% in the remifentanil group. These findings suggest that both agents may effectively reduce the incidence of postoperative delirium in geriatric patients.

Although hypotension is commonly observed during sedation in spinal anesthesia, sufficient studies on its impact on postoperative delirium are lacking, and findings in the literature appear contradictory. In a retrospective study, Maheshwari et al.[17] linked intraoperative and postoperative hypotension to delirium, suggesting that preventing hypotension may play a crucial role in reducing its incidence. Conversely, Wang et al.[18] reported that both excessively high and low mean arterial pressure increase the risk of postoperative delirium. However, Hirsch et al.[19] reported that neither moderate nor profound hypotension was associated with delirium in their study. Similarly, in the large-scale ISPOCD1 study, Moller et al.[20] found no association between hypotension and postoperative delirium. In our study, intraoperative MAP was significantly lower in group D patients at 90, 105, 120, and 135 minutes; however, no significant difference was observed throughout the remainder of the operation. Despite lower blood pressure, hypotension was prevented in both groups, with intervention applied if mean arterial pressure decreased by 20% or more from baseline. In this context, beyond utilizing studies linking hypotension to delirium, we prioritized maintaining stable hemodynamic management while considering the frailty of our patient population.

In a study by Jo et al.[21] comparing dexmedetomidine and midazolam sedation under BIS monitoring, the bradycardic effect of dexmedetomidine was highlighted. Similarly, Yıldırım et al.[22] compared remifentanil and dexmedetomidine for sedation in spinal anesthesia among patients aged 20 to 60. Bradycardia was not observed in either group. While remifentanil provided more stable hemodynamics, caution is required regarding its respiratory depressant effect. In our study, there was no significant difference in heart rate between the two groups. No cases of respiratory depression were observed in the remifentanil sedation group. Thus, both sedation agents appear to be safe regarding bradycardia and respiratory complications at the doses used in our study. Do et al.[23] highlighted the association between low social support and postoperative delirium.

Limitations

This study has several limitations. One important factor that may be overlooked in the evaluation of delirium in geriatric patients is social support. Although a relative accompanies the patient during surgery, geriatric patients living alone may experience significant stress due to concerns about future isolation and reduced functionality without a caregiver. Another limitation was the inability to assess postoperative mobilization duration. Early mobilization is known to reduce the risk of delirium; however, in our study, postoperative mobilization could not be tracked due to insufficient patient documentation in orthopedic units.

CONCLUSION

Our study demonstrates that dexmedetomidine and remifentanil administration in geriatric patients under spinal anesthesia result in similar postoperative delirium incidence rates. These findings suggest that both sedation methods can be safely and effectively utilized.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Ankara Bilkent City Hospital Ethics Committee (Date: 27.04.2022, Decision No: E2-22-1760).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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Epidemiological and clinical characteristics of pediatric globe injuries

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ABSTRACT

Aims: The aim of this study was to perform a retrospective analysis of the outcomes of childhood globe injuries diagnosed and treated at our hospital.

Methods: A retrospective review of the medical records of patients under 18 years of age, diagnosed and treated for globe injuries, was conducted at our clinic. Globe injuries were categorized into open globe injuries (OGI) and closed globe injuries (CGI). Visual acuity scores were converted into LogMAR units for standardization.

Results: A total of 29 pediatric cases were included in the study. Of these, 23 were male (79.3%) and 6 were female (20.7%). The mean age was 10.2±4.1 years. Following trauma, OGI occurred in 17 cases (58.6%), while CGI occurred in 12 cases (41.4%). The initial mean best-corrected visual acuity (BCVA) was 0.96±1.05 logMAR, and the mean BCVA at the last follow-up visit was 0.18±0.52 logMAR for all cases (p=0.001). Contusion (91.7%) was the predominant injury type in CGI cases, while penetrating injury (58.8%) was the most common type of OGI. Pencil tips, wood, glass, and plastic objects were the leading causes of globe injuries. Hyphema, traumatic cataract, and iris prolapse were the most frequent associated findings.

Conclusion: Although many globe injuries in children can be prevented, they still have the potential to lead to significant physical and psychological consequences. The findings of our study may contribute to a deeper understanding of the patterns of eye injuries in children.

Keywords: Cataract, intraocular foreign body, globe injuries, trauma

INTRODUCTION

The childhood period is a phase of rapid physical, emotional, and cognitive development, and it is also a dynamic time filled with exploration and learning. During this period, various accidents and traumas are frequently encountered.[1] The active and curious nature of children makes them more vulnerable to eye injuries compared to adults.[1,2] Eye injuries represent one of the significant health issues encountered during this period and require special attention due to their potential effects on visual function.[1,2] These injuries typically occur as a result of sports activities, play, or household accidents and can range from superficial abrasions to severe penetrating trauma.[1,3,4,5] Common findings associated with these injuries include corneal damage, cataracts, hyphema, intraocular hemorrhages, retinal tears, and detachments.[3,6] Early diagnosis and appropriate treatment play a critical role in preserving visual function and preventing permanent damage.

Eye injuries are one of the leading causes of unilateral blindness in childhood. Vision loss occurring during this period can lead to psychosocial issues in addition to functional impairment.[1,4,6,7] Furthermore, due to the long-life expectancy, vision loss imposes a socio-economic burden on both the individual and society.[6,8,9]

It is of great importance for healthcare professionals, policymakers, and parents to be knowledgeable about the causes, types, diagnostic methods, and treatment approaches for pediatric eye injuries. Therefore, this study will focus on the causes, frequency, treatment methods, and visual outcomes of pediatric eye injuries.

METHODS

This study, carried out from 2020 to 2025 at the Department of Ophthalmology, Faculty of Medicine, Tokat Gaziosmanpaşa University, adhered to the principles outlined in the Helsinki Declaration. The study was carried out with the permission of the Tokat Gaziosmanpaşa University Non-interventional Researches Ethics Committee (Date: 05.03.2025, Decision No: 25-MOBAEK-089).

A retrospective analysis of the medical records of patients under 18 years of age, diagnosed and treated for ocular trauma, was conducted at our clinic. Data were extracted from the patient files, which included details such as age, gender, trauma cause, best corrected visual acuity (BCVA), findings from both anterior and posterior segment examinations, presence of intraocular foreign bodies, intraocular pressure

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measurements, ultrasonic posterior segment examination findings, treatments administered, surgical interventions, and follow-up duration. The visual acuity scores were converted into LogMAR units for standardization.

Patients under 18 years of age with globe injuries were included in the study. However, patients with insufficient follow-up duration and incomplete file records were excluded. Globe injuries were categorized based on the system established by the Ocular Trauma Classification Group.[5]

Descriptive statistics were employed to analyze the data, with results expressed as mean±standard deviation and percentages. Paired sample comparisons were performed using the Wilcoxon test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

In this study, a total of 29 pediatric cases were included. Among these cases, 23 were male (79.3%) and 6 were female (20.7%). The mean age was found to be 10.2±4.1 years. Following trauma, OGI occurred in 17 cases (58.6%), while CGI occurred in 12 cases (41.4%). The initial mean BCVA was 0.96±1.05 logMAR, and the mean BCVA at the last follow-up visit was 0.18±0.52 logMAR in the total cases (p=0.001). The initial BCVA was 1.48±0.99 logMAR in OGI, while it was 0.32±0.74 logMAR in CGI (p=0.002). The BCVA at the last follow-up visit was 0.32±0.66 logMAR in OGI, while it was 0 logMAR in CGI (p=0.41). All cases in the CGI group had 20/20 BCVA at the last follow-up visit. The BCVA significantly improved in patients with CGI and OGI. The mean follow-up was 10±9.8 months.

Contusion constituted nearly all of the CGI cases. Penetrating injury was found to be the most common type of OGI, followed by rupture and intraocular foreign body. Perforating injury was not observed in this study. Zone 1 was the most affected zone in OGI. Table 1 shows the demographic characteristics and features of the injuries.

Table 1. Demographic characteristics and features of injuries in children with ocular trauma

Variables	n	%
Gender		
Female	6	20.7
Male	23	79.3
Age (mean±SD)	10.2±4.1	
Closed globe injuries		
Contusion	11	91.7
Lamellar laceration	1	8.3
Open globe injuries		
Rupture	4	23.5
Penetrating injury	10	58.8
Perforating injury	0	0
Intraocular foreign body	3	17.6
Zone of open globe injuries		
Zone 1	15	88.2
Zone 2	1	5.9
Zone 3	1	5.9

SD: Standard deviation

When the etiological causes of globe injuries were evaluated, it was observed that pencil tips, wood, glass and plastic objects were the most common causes. Table 2 indicates the causes of globe injuries.

Table 2. The etiological causes of globe injuries

Cause	n	%
Sharp objects		
Pencil tip	4	13.8
Glass	2	6.9
Fork	1	3.4
Wire	1	3.4
Nail	1	3.4
Utility knife	1	3.4
Thorn	1	3.4
Bar	1	3.4
Blunt trauma		
Wood	3	10.3
Plastic object	2	6.9
Firecracker explosion	2	6.9
Confetti explosion	1	3.4
Stone	1	3.4
Traffic accident	1	3.4
Toy	1	3.4
Metal bar	1	3.4
Ball	1	3.4
Pencil case	1	3.4
Fall	1	3.4
Key	1	3.4
Other/unknown	1	3.4

It was determined that hyphema, traumatic cataract, and iris prolapse were the most frequent associated findings with globe injuries. Commotio retina, conjunctival and eyelid lacerations, and pupillary sphincter rupture were observed only in CGI. Iris prolapse; intraocular foreign body, vitreous hemorrhage, vitreous loss, and iris defect were seen only in OGI. Table 3 displays the anterior and posterior segment findings associated with globe injuries.

Table 3. Anterior and posterior segment findings associated with globe injuries

Findings n (%)	OGI n (%)	CGI n (%)
Traumatic cataract	9 (31)	1 (3.4)
Hyphema	4 (13.8)	8 (27.6)
Iris prolapse	8 (27.6)	-
Intraocular foreign body	3 (10.3)	-
Commotio retina	-	4 (13.8)
Conjunctiva laceration	-	1 (3.4)
Eyelid laceration	-	1 (3.4)
Vitreous hemorrhage	1 (3.4)	-
pupillary sphincter rupture	-	1 (3.4)
Vitreous loss	1 (3.4)	-
Iris defect	1 (3.4)	-

OGI: Open globe injuries, CGI: closed globe injuries

A patient with CGI who had eyelid and conjunctival laceration underwent primary suturing. The other cases with CGI were treated with medication. All cases with OGI underwent surgery. Primary suturing was performed on all patients. Intraocular foreign bodies were removed from the eyes of three cases. Lens clearance with phacoemulsification and intraocular lens implantation was performed in three cases during the first surgery. Pupilloplasty was carried out for one patient in a second procedure. Intraocular pressure was controlled with anti-glaucomatous medication in four hyphema cases with CGI. In three other hyphema cases with CGI, anterior chamber lavage was added to the anti-glaucomatous medication to achieve intraocular pressure control.

DISCUSSION

According to various studies, the global incidence of severe vision loss or blindness due to ocular trauma in children is considerable.[10-12] Despite the fact that many eye injuries can be prevented through simple precautions, a significant number of children still experience visual impairment, which can impact their psychosocial development.[1,4] To effectively design prevention strategies, it is essential to have a comprehensive understanding of the characteristics of children who sustain ocular injuries. We believe that the results of this study may contribute to the understanding of the characteristics of globe injuries in children in our region.

Pediatric globe injuries present with diverse epidemiological and clinical features. In our study, we observed that these injuries were more prevalent in male children (79.3%) compared to females (20.7%), with a mean age of 10.2±4.1 years. This pediatric population of globe injuries was similar to others.[2,7,8] Pirhan et al.[2] reported that 82% of their pediatric ocular trauma population were boys. Niyaz[8] found a 73.3% predominance of boys in her study on childhood ocular trauma. These results are similar to those in adults when comparing gender distribution.[11,12] When we evaluated the age distribution in our population, the results were consistent with those reported in the literature.[14-7] Çetin et al.[7] reported the mean age as 9.9±4.5 years, while Küsbeci et al.[14] found it to be 9.2±4.7 years. Akça Bayar et al.[6] reported a slightly lower mean age of 8.5±3.4 years.

The initial mean BCVA was 0.96±1.05 logMAR, which significantly improved to 0.18±0.52 logMAR at the last follow-up visit in all cases. When we divided the cases into OGI and CGI for comparison, the cases with CGI had better initial and final BCVA. All cases with CGI had 20/20 or better final visual acuity. On the other hand, some cases with OGI experienced permanent vision loss. In general, OGI results in poor visual acuity, while CGI results in better final visual acuity in children.[11,12]

Contusion was predominantly observed in patients with CGI in our study. Akça Bayar et al.[6] also reported a predominance of contusions in their comparative study of CGI and OGI. Contusion is generally associated with CGI in the literature.[6,13] We primarily observed penetrating injuries in OGI in this study, which is commonly reported as the most frequent injury type in the literature.[13,17] Additionally, we observed zone 1 injuries most frequently in this retrospective study, consistent with other studies in the literature.[2,9,14,17,18]

The etiological causes of pediatric globe injuries are generally associated with sharp objects.[6,9,10,18] Metal objects such as scissors, knives, forks, glass, and pens/pencils are reported as the most common sharp objects, while wood, toys, balls, and stones are frequently cited as causes of blunt trauma in the literature.[2,6,9,10,13,18] In this study, we observed pencil tips, wood, glass, and plastic objects as common causes of injury. Canleblebici et al.[19] reported a case series of penetrating injuries caused by pencils in a study conducted in Turkiye.

When examining concomitant intraocular injuries, hyphema, traumatic cataract, iris prolapse, and commotio retina are commonly reported in the literature.[13-18] In our study, traumatic cataract and iris prolapse were frequently associated with OGI, while hyphema and commotio retina were more common in CGI. These findings are similar to those reported in other studies.[13-18]

CONCLUSION

Although many eye injuries in children can be prevented, they still have the potential to lead to significant physical and psychological consequences. The findings of our study may contribute to a deeper understanding of the patterns of eye injuries in children. It is essential to raise public awareness and provide education about the causes of eye injuries, as well as preventive strategies, to help reduce the incidence of traumatic eye injuries in children.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Tokat Gaziosmanpaşa University Non-interventional Researches Ethics Committee (Date: 05.03.2025, Decision No: 25-MOBAEK-089).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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The effects of analgesia methods on postoperative diaphragm muscle contraction in patients undergoing laparotomy

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ABSTRACT

Aims: This prospective observational study aimed to evaluate the effects of different postoperative analgesia methods on diaphragm thickening fractions in patients undergoing major elective abdominal surgery.

Methods: Sixty-six adult patients scheduled for elective major abdominal surgery due to gastrointestinal tumors were enrolled and divided into three groups according to analgesia methods; intravenous (IV) analgesia, abdominal wall block (B), and a combination of block plus intravenous analgesia (BIV). Diaphragm thickness and diaphragm thickening fractions were measured preoperatively and postoperatively using ultrasound during rest and forced inspiration. The primary parameter was the prevention of diaphragm dysfunction by BIV compared to other methods. The secondary outcome was the change in diaphragm thickening fractions at rest and during maximal inspiration compared to preoperative values.

Results: No patients demonstrated clinical diaphragm dysfunction based on contraction indices. However, postoperative diaphragm thickening fractions decreased significantly in the IV group at rest and in the B group during maximal inspiration ($p<0.05$), whereas no significant reduction was observed in the BIV group. BIV provided significantly better postoperative pain control (lower VAS scores) and was associated with preserved diaphragm thickening fractions, supporting a potential protective effect on diaphragmatic function.

Conclusion: Major abdominal surgery leads to a measurable decline in diaphragmatic contractility in patients receiving single-modality analgesia (B or IV), whereas combined BIV analgesia preserves postoperative diaphragm function while improving pain control. These findings suggest that multimodal analgesia may help protect respiratory muscle performance in the early postoperative period.

Keywords: Analgesia, diaphragm, postoperative pain

INTRODUCTION

In the postoperative period following major abdominal surgery, respiratory function often declines, largely due to surgery-induced pain, which impairs diaphragmatic activity. Diaphragmatic dysfunction may lead to inadequate ventilation, atelectasis, and secretion retention.[1] Ultrasound-based measurements of diaphragm thickness and thickening fractions provide an objective and reproducible method to evaluate postoperative diaphragmatic performance. However, few studies have directly compared the impact of different analgesia methods on these parameters.

The impact of analgesia methods on diaphragm function remains a subject of debate. In particular, there is a limited number of studies that objectively assess the effects of different analgesia techniques on diaphragm thickness and contractile capacity. Ultrasound-based measurements of diaphragm thickness and diaphragm thickening fractions provide a reliable and objective means of evaluating these functional changes.[2,3]

This study aims to evaluate the effects of different postoperative analgesia methods on diaphragm muscle thickness and functional indices. Preoperative measurements were conducted to confirm that patients initially had normal diaphragm function; however, the primary focus was placed on postoperative measurements. The main parameter assessed in the study was whether there was a postoperative reduction in the diaphragm thickening fractions measured during maximal inspiration. In addition, the study investigated whether reductions occurred in the diaphragm thickening fractions at rest breath and during maximal inspiration compared to preoperative values.

Within this context, changes in diaphragm parameters were compared among three different analgesia groups (intravenous analgesia only, abdominal plane block only, and a combination of plane block and intravenous analgesia) in order to determine which method exerts the least respiratory impact.

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This study compared the effects of intravenous (IV) analgesia, abdominal plane block (B), and combined analgesia (BIV) on postoperative diaphragm function, with a focus on changes in diaphragm thickening fractions relative to baseline measurements.

METHODS

Study Design

This prospective observational clinical study was conducted over a five-month period following approval from the Prof. Dr. Cemil Taşcıoğlu City Hospital Clinical Researches Ethics Committee (Date: 09.10.2023, Decision No: 201). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. During this period, adult patients scheduled for elective major abdominal surgery due to gastrointestinal system tumors were evaluated. Inclusion criteria were: age ≥18 years, planned elective major abdominal surgery, and provision of informed consent. Exclusion criteria included a body-mass index (BMI) >35 kg/m^2, a history of neuromuscular disease, advanced-stage chronic respiratory disease, previous abdominal or thoracic surgery, inability to communicate (e.g., language barrier, mental retardation), or illiteracy.

All patients were informed about the study and gave written consent. To confirm normal preoperative diaphragm function and enable comparison with postoperative measurements, an ultrasonographic assessment was performed, and preoperative measurements were recorded.

Patient Grouping

Postoperative analgesia methods were observed and recorded for each patient. While most patients were treated with one of three primary analgesia techniques, a small number received epidural analgesia. However, since only five patients received epidural analgesia, this subgroup was excluded from the study due to the inability to perform statistically reliable analyses. Consequently, statistical evaluations were limited to patients within the three main analgesia groups. The sample size was determined based on a power analysis targeting the comparison of diaphragm thickening fractions at rest breath and maximal inspiration across the three analgesia groups (plane block, intravenous analgesia, and a combination of both). Using G*power 3.1 software, the analysis assumed an effect size of f=0.4 (moderate-to-large), a significance level (α) of 0.05, and a power of 0.80. Based on one-way ANOVA, it was estimated that a minimum of 66 patients would be required. Accordingly, cases undergoing elective surgery during the study period were prospectively recorded and grouped by the analgesia method administered. Once a group reached 22 patients, no additional patients were included in that group.

- **Group IV (n=22):** Intravenous analgesia only
- **Group B (n=22):** Abdominal plane block only
- **Group BIV (n=22):** Combination of abdominal plane block and intravenous analgesia

Analgesia Protocols

All patients underwent general anesthesia and laparotomy for the surgical procedure. Anesthesia induction was achieved with propofol (2.5 mg/kg) and rocuronium (0.6 mg/kg) as a muscle relaxant. Additionally, fentanyl (0.5 µg/kg) was administered to maintain hemodynamic stability. Maintenance of anesthesia was achieved with sevoflurane (MAC=2), and sugammadex (2 mg/kg) was administered prior to extubation to reverse the neuromuscular blockade and prevent any residual block at the conclusion of the procedure. Postoperative analgesia was provided using intravenous and/or abdominal plane block techniques. The analgesia protocols were as follows.

- Intravenous (IV) analgesia: In our routine practice, 1000 mg paracetamol and 100 mg tramadol are administered intravenously approximately 15 minutes before the end of surgery as a single-dose infusion. Bilateral ultrasound-guided transverse abdominis plane (TAP) block with 20 ml of 0.25% bupivacaine per side is performed at the end of surgery prior to extubation as a single administration. No repeat doses are given.
- Abdominal plane block: At the end of surgery, prior to extubation, a bilateral transverse abdominis plane (TAP) block is administered under ultrasound guidance, following strict aseptic techniques. For the TAP block, 20 ml of 0.25% bupivacaine is injected on each side between the transversus abdominis and internal oblique muscles. This block is performed as a single administration, without repetition.

In our routine practice, patients are evaluated for pain at the first postoperative hour. Additional intravenous analgesics are administered to those requiring supplemental pain control. However, diaphragm measurements were obtained prior to any assessment of additional analgesic needs, ensuring that our results were not influenced by postoperative analgesic interventions.

Diaphragm Assessment

There are two main acoustic windows to visualize the diaphragm:[3]

- The zone of apposition between the 8th and 10th intercostal spaces on the mid- or anterior axillary line, 0.5-2 cm below the costophrenic sinus, where a high-frequency linear probe (≥10 MHz) is essential.
- The subcostal region, between the midclavicular and anterior axillary lines, using the liver or spleen as an acoustic window; here, a cardiac or abdominal probe (2-5 MHz) can be used.

The first method was adopted in our study. Diaphragm thickness was evaluated in the supine position, at the xiphoid level (between the 8th and 10th intercostal spaces), just below the anterior axillary line using a high-frequency linear ultrasound probe.[2] A skin-safe marker was used to mark the probe's position on the patient's body to ensure consistent placement during follow-up measurements, as diaphragm thickness may vary depending on the measurement site. This practice helps maintain measurement reproducibility.[4]

In B-mode imaging (**Figure 1**) at a depth of 1.5-3 cm, two parallel echogenic lines were easily identified: the more superficial one corresponding to the parietal pleura and the deeper one to the peritoneum. The diaphragm appears as the less echogenic structure between these two lines.[3] Subsequently, M-mode (**Figure 2**) was used to record the measurements. The distance between the parietal pleura and peritoneum was measured along a perpendicular line during inspiration, expiration, and

forced inspiration. Three parameters were measured during each assessment: diaphragm thickness during inspiration (mm), expiration (mm), and maximal inspiration (mm).

Diaphragm measurements were first obtained preoperatively as baseline values. Postoperative assessments were performed in the post-anesthesia care unit (PACU) one hour after extubation, once patients had adequate emergence from anesthesia and muscle strength. Diaphragm thickness was recorded at end-expiration and peak inspiration during quiet and maximal breathing for both time points, and values were documented for comparison.

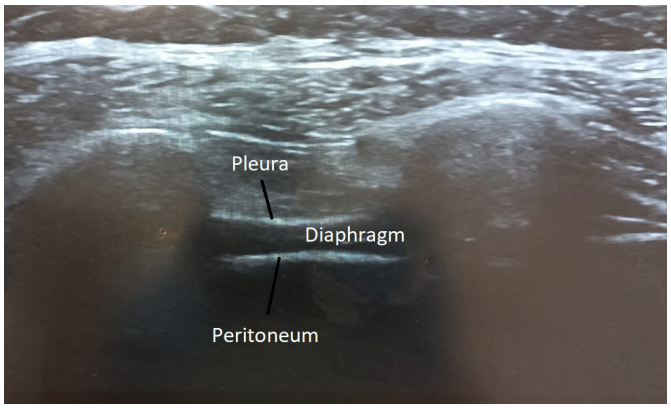

Figure 1. Diaphragmatic view in B-mode ultrasound

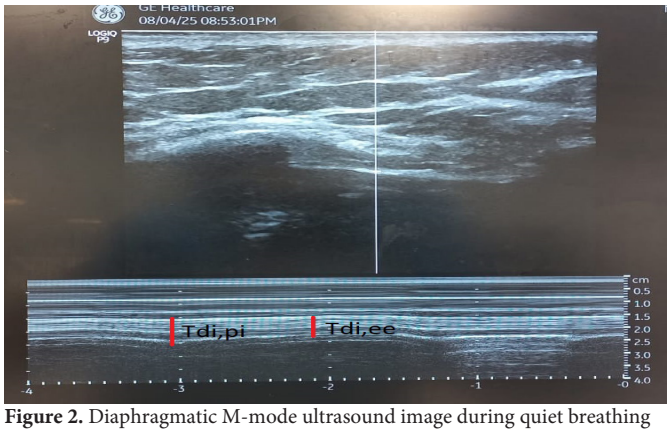

Figure 2. Diaphragmatic M-mode ultrasound image during quiet breathing

In addition, diaphragm thickening fractions were calculated using the following formulas:[2]

Thickening fraction in rest breath:

$$TF_{di}(\%) = \frac{(T_{di,pi} - T_{di,ee})}{T_{di,ee}} X\ 100$$

TFdi (%): diaphragm thickening fraction,
Tdi, pi: diaphragm thickness at peak inspiration,
Tdi, ee: diaphragm thickness at end expiration.

Thickening fraction in maximal inspiration:

$$TF_{di,max}(\%) = \frac{(T_{di,pi} - T_{di,ee})}{T_{di,ee}} X\ 100$$

TFdi, max (%): Maximal diaphragm thickening fraction,
Tdi, pi: diaphragm thickness at peak inspiration,
Tdi, ee: diaphragm thickness at end expiration.

Preoperative measurements were used as control values to confirm that patients had normal diaphragm function. The primary evaluation focused on postoperative measurements, particularly the potential reduction in the maximal diaphragm thickening fractions. Comparisons were also made with preoperative values. Previous studies have identified a diaphragm thickening fraction (TFdi) in the range of approximately 30% to 260% as normal.[2,5] A maximum TFdi value below 20% is considered diagnostic of severe diaphragm dysfunction.[2,6,7]

In this study, we measured the patients' diaphragmatic thickness at rest and during maximal inspiration in the preoperative and postoperative periods, calculated their diaphragm thickening fractions, and evaluated them for diaphragmatic dysfunction. We also investigated the relationship of the results with the analgesia method.

Statistical Analysis

Descriptive statistics for continuous variables were reported as mean±standard deviation, median, minimum, and maximum values. Categorical variables were presented as counts and percentages. The Shapiro-Wilk test was used to assess the normality of continuous variables.

For comparison of continuous variables across anesthesia groups, one-way ANOVA was used for normally distributed data, and the Kruskal-Wallis test for non-normally distributed data. The Kruskal-Wallis multiple comparison test was applied to identify which groups accounted for any significant differences.

The Wilcoxon test was used to compare preoperative and postoperative diaphragm thickening fractions. For nominal variables in contingency tables, the Chi-square test or Fisher's exact test was used as appropriate.

All statistical analyses were performed using IBM SPSS version 20 (Chicago, IL, USA), with a p-value of <0.05 considered statistically significant.

RESULTS

The demographic characteristics and operative data of the patients included in the study are presented in Table 1. A total of 66 patients were enrolled. The mean age was 67.11±10.52 years, with a minimum age of 40 and a maximum age of 87 years. The mean BMI was 25.45±5.11.

Table 1. Demographic characteristics and surgical parameters of the patients

Variable	Mean±SD	Median (min-max)
Type of surgery		
Low anterior resection (rectal CA)	20	30.3%
Gastric CA staging	1	1.5%
Total gastrectomy	9	13.6%
Subtotal gastrectomy	10	15.2%
Rectal resection+liver resection	**1**	**1.5%**
Colectomy	25	37.9%
Type of analgesia		
Block only (B)	22	33.3%
Intravenous only (IV)	22	33.3%
Combination (BIV)	22	33.3%

SD: Standard deviation, Min: Minimum, Max: Maximum, BMI: Body-mass index, PEEP: Positive end expirauar pressure, PPEAK: Peak airway pressure, VAS: Visual Analogue Scale, ASA: American Society of Anesthesiologists, CA: Cancer, B: Block, IV: Intravenous, BIV: Block intravenous

The average duration of surgery was 202.88±58.31 minutes. The mean tidal volume was 482.35±46.45 ml, the mean PEEP was 5.12±0.56 cmH_2O, and the mean peak airway pressure (PPEAK) was 18.26±3.26 cmH_2O.

The median postoperative VAS score was 4, and the median Aldrete score was 10. The mean length of hospital stay was 6.70±7.26 days.

Of the patients, 62.1% were male; 48.5% had an ASA score of 3; and 37.9% underwent colectomy.

Table 2 shows that the groups were demographically similar, with no statistically significant differences among them ($p>0.05$). However, a significant difference was observed in ASA scores ($p<0.05$), attributable to a higher proportion of ASA 3 patients in the BIV group.

Postoperative VAS scores differed significantly among the groups ($p<0.001$), with the BIV group demonstrating significantly lower scores than the other groups ($p<0.001$; Figure 3).

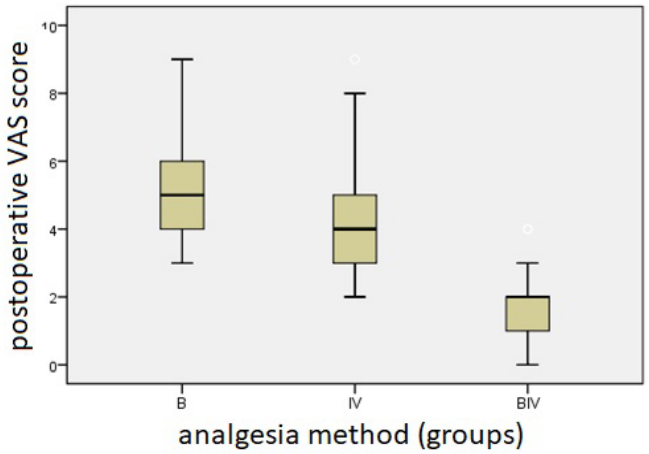

Figure 3. Postoperative VAS scores by analgesia group

VAS: Visual Analogue Scale

The length of hospital stay also differed significantly among the groups ($p<0.01$), being longer in the BIV group compared to both the B and IV groups.

Table 3 presents the diaphragm thickening fractions and maximal inspiration diaphragm thickening fractions measured in the preoperative and postoperative periods.

Table 3. Preoperative and postoperative comparison of diaphragm thickening fractions

Parameter		Mean±SD (n=66)	Median (min-max)
Preoperative	TFdi	34.09±23.55	30.78 (2.78-147.62)
	TFdi,max	104.61±52.12	101.78 (20.59-242.86)
Postoperative	TFdi	27.68±14.54	26.49 (5.26-69.23)
	TFdi,max	89.53±54.36	80.19 (19.05-276.47)

SD: Standard deviation, Min: Minimum, Max: Maximum, TFdi: Diaphragm thickening fractions, TFdi,max: Maximal diaphragm thickening fraction

In both preoperative and postoperative assessments, patients demonstrated normal diaphragm thickness and thickening fraction indices, and no diaphragmatic dysfunction was observed. However, postoperative measurements showed a decrease in diaphragm thickening fractions compared with baseline values.

Table 4 provides the statistical comparison of preoperative and postoperative diaphragm indices. Diaphragm thickening fractions were significantly lower in the postoperative period compared to preoperative values ($p<0.01$). Similarly, maximal diaphragm thickening fractions decreased significantly postoperatively ($p<0.05$).

Table 4. Comparison of pre- and postoperative diaphragm thickening fractions

	Preoperative (n=66)	Postoperative (n=66)	
Index	Mean±SD Median (min-max)	Mean±SD Median (min-max)	p-value
TFdi	34.09±23.55 30.78 (2.78-147.62)	27.68±14.58 26.49 (5.26-69.23)	0.007[d]
TFdi,max	104.61±52.12 101.78 (20.59-242.86)	89.53±54.36 80.19 (19.05-276.47)	0.038[d]

SD: Standard deviation, Min: Minimum, Max: Maximum, TFdi: Diaphragm thickening fractions, TFdi,max: Maximal diaphragm thickening fraction, d: Wilcoxon test

Table 5 compares the preoperative and postoperative diaphragm measurements across the analgesia groups. Patients receiving IV analgesia demonstrated a significant postoperative reduction in diaphragm thickening fraction ($p<0.05$), and the B group showed a significant decrease in maximal diaphragm thickening fraction ($p<0.05$). In contrast, no significant reduction was detected in either resting or maximal thickening fractions in the BIV group ($p>0.05$),

Table 2. Comparison of demographic characteristics among the groups

Parameter	B group (n=22) Mean±SD (median)	IV group (n=22) Mean±SD (median)	BIV group (n=22) Mean±SD (median)	p-value
Age (years)	65.50±11.17 (69)	69.23±8.45 (71)	66.59±11.79 (66)	0.490[a]
BMI (kg/m²)	23.95±4.41 (23)	25.55±3.84 (25)	26.86±6.51 (26)	0.414[b]
Postoperative VAS	5.36±1.81 (5)	4.50±2.11 (4)	1.82±1.00 (2)	<0.001[b]
Aldrete recovery score	9.64±0.58 (10)	8.68±0.78 (8)	9.64±0.72 (10)	<0.001[b]
Hospital stay (days)	4.64±1.78 (4)	7.95±12.09 (5)	7.50±2.72 (7)	0.001[b]
	n (%)	n (%)	n (%)	
Female (%)	8 (36.4)	10 (45.5)	7 (31.8)	0.634[c]
Male (%)	14 (63.6)	12 (54.5)	15 (68.2)	
ASA 1 (%)	7 (31.8)	3 (13.6)	0	0.017[c]
ASA 2 (%)	6 (27.3)	11 (50.0)	7 (31.8)	
ASA 3 (%)	9 (40.9)	8 (36.4)	15 (68.2)	

[a]: One-way ANOVA, [b]: Kruskal-Wallis test, [c]: Chi-square test / Fisher's exact test, B: Block, IV: Intravenous, BIV: Block intravenous, SD: Standard deviation, BMI: Body-mass index, VAS: Visual Analogue Scale, ASA: American Society of Anesthesiologists

indicating relative preservation of diaphragmatic function (Figure 4, 5).

Tablo 5. Comparison of preoperative and postoperative diaphragm thickening fractions in groups

		Preop	Postop	
	Group	Mean±SD Median (min-max)	Mean±SD Median (min-max)	p-value
Diaphragm thickening fractions	B	41.30±34.51 32.45 (2.78-147.62)	31.59±17.86 25.65 (8.57-69.23)	0.093[d]
	IV	31.91±17.11 32.45 (10.64-76.92)	24.07±11.77 25.65 (5.26-44.0)	0.024[d]
	BIV	29.07±12.10 28.0 (11.76-55.56)	27.40±12.94 27.27 (6.06-63.64)	0.538[a]
Maximal diaphragm thickening fractions	B	133.26±59.36 127.27 (25.0-242.86)	113.75±62.80 95.0 (43.75-276.47)	0.046[d]
	IV	98.01±40.88 89.56 (34.62-176.82)	73.55±41.99 63.33 (19.05-168.0)	0.115[d]
	BIV	82.57±42.39 78.63 (20.59-215.38)	81.30±49.87 77.27 (20.0-245.45)	0.833[d]

SD: Standard deviation, Min: Minimum, Max: Maximum, B: Block, IV: Intravenous, BIV: Block intravenous, d: Wilcoxon test

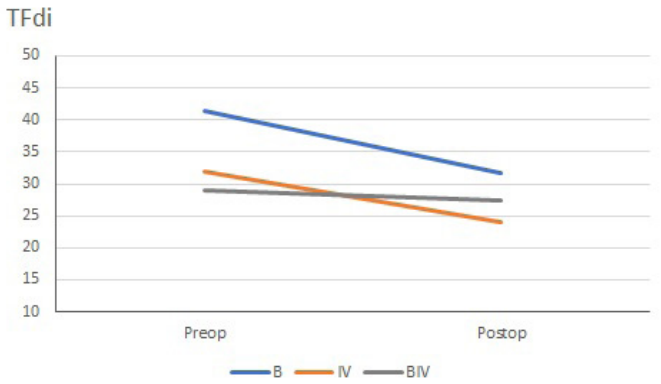

Figure 4. Changes in diaphragm thickening fraction from preoperative to postoperative periods

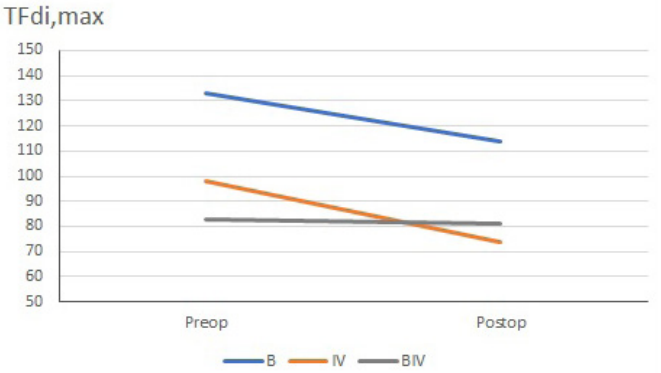

Figure 5. Changes in maximal diaphragm thickening fraction from preoperative to postoperative periods

DISCUSSION

This study demonstrates that major abdominal laparotomy is associated with a measurable decline in diaphragmatic contractility, which is attenuated by combined (BIV) analgesia. These findings are clinically relevant because postoperative diaphragmatic dysfunction predisposes patients to respiratory complications, and our results indicate that analgesic technique influences the extent of this impairment.

Diaphragmatic thickness and thickening fractions measured by ultrasound are affected by individual factors such as age, body mass index, and gender.[8] Although no significant demographic differences were found between the groups in this study, we evaluated diaphragm thickening fractions, which are more standardized and have clearly defined threshold values in the literature, to minimize variability.

The BIV group had a longer hospital stay than the other groups, which we attributed to the higher prevalence of comorbidities, as reflected by the greater proportion of ASA 3 patients.

Conversely, postoperative VAS scores were significantly lower in the BIV group (Table 2), as expected. The combination of a regional block (targeting somatic pain) and intravenous analgesia (addressing visceral pain) provides more comprehensive analgesia, resulting in superior pain control.

We hypothesized that groups with lower postoperative pain would demonstrate better preservation of diaphragmatic function. Our analysis partially confirmed this: the IV group exhibited a significant reduction in resting diaphragm thickening fraction, and the B group showed a significant reduction in maximal diaphragm thickening fraction, whereas the BIV group demonstrated no significant postoperative decline in either parameter.

This relative preservation of diaphragmatic function in the BIV group highlights the potential functional benefit of multimodal analgesia.

The absence of neuromuscular monitoring with train-of-four (TOF) is a limitation of this study. Although neuromuscular monitoring with TOF could have provided additional objective confirmation, postoperative measurements were obtained one hour after extubation, and sugammadex (2 mg/kg) was administered to reverse rocuronium-induced blockade. Moreover, TOF is not routinely used in postoperative recovery in clinical practice;[9,10] instead, objective criteria such as the Aldrete score are preferred. In our study, a median Aldrete score of 10 supported the assumption of adequate recovery of muscle strength during measurements.

Our findings are consistent with previous studies reporting that abdominal surgery leads to early postoperative diaphragmatic dysfunction,[1] and they suggest that multimodal analgesia can attenuate this decline by providing superior pain control.

It is well known that postoperative pain restricts respiratory mechanics.[11] In our study, the BIV group had significantly lower VAS scores, confirming that combined analgesic approaches offer more effective pain control. Unlike the IV and B groups, this improved pain control was associated with preserved diaphragmatic thickening fractions, highlighting the potential functional benefit of multimodal analgesia. Previous studies have similarly shown that upper abdominal surgery can lead to marked diaphragmatic dysfunction lasting up to a week, which cannot be entirely prevented by analgesia.[1] Our results suggest that sufficient multimodal analgesia may not only reduce VAS scores but also support diaphragmatic contractility in the immediate postoperative period.

Although epidural analgesia has been shown to improve postoperative respiration and reduce pulmonary complications,[12] no patients in our study groups received epidural analgesia. The observed protective effect of combined BIV analgesia may be considered functionally analogous to

the benefits described with epidural techniques in previous studies.

A key strength of this study is the quantitative, non-invasive, and reproducible assessment of diaphragmatic function using ultrasonography. While many studies have assessed diaphragm dysfunction, relatively few have compared the effects of different analgesia methods on diaphragm thickening fractions.[12-14]

Limitations

Nevertheless, the study has certain limitations. Most notably, we could not control for other potential factors affecting diaphragm function (e.g., postoperative fatigue, residual anesthetic effects, subjective nature of pain, or subgroup variations in surgical type). Moreover, the absence of neuromuscular monitoring techniques such as TOF limits the objectivity of diaphragmatic function assessment. Even though the ultrasound measurements were performed by an experienced practitioner, operator dependency remains a potential source of bias affecting measurement reliability.

CONCLUSION

Our findings indicate that major abdominal laparotomy leads to a measurable decline in diaphragmatic function in patients receiving single-modality analgesia (IV or B), as demonstrated by postoperative reductions in diaphragm thickening fractions. In contrast, combined BIV analgesia preserved diaphragmatic function and was associated with lower postoperative VAS scores, suggesting a protective effect on respiratory muscle performance. These results support the integration of multimodal analgesia into perioperative management as a comprehensive strategy to maintain early postoperative respiratory function in patients undergoing major abdominal surgery.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Prof. Dr. Cemil Taşcıoğlu City Hospital Clinical Researches Ethics Committee (Date: 09.10.2023, Decision No: 201).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Journal of Comprehensive Surgery

Case Report

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Splenic hamartoma: a case report

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ABSTRACT

Splenic hamartomas are benign vascular tumors initially described by Rokitansky in 1861. They are mostly asymptomatic and encountered incidentally. Large hamartomas may be palpable and can result in splenomegaly or rupture. A 55-year-old female presents to our medical facility for routine screening. Medical history reveals no prior operation or morbidity. Routine abdominal ultrasound revealed a 6x5 cm hypoechoic splenic mass containing cystic changes. A computed tomography was performed to establish a differential diagnosis, which revealed a mass in the anterior part of the spleen with a similar density to normal parenchyma and containing patchy hypodense areas. Based on these findings, an ultrasound guided tru-cut biopsy was performed to confirm the diagnosis. Histopathological evaluation confirmed the diagnosis of splenic hamartoma. In conclusion, splenic hamartomas should be considered in the differential diagnosis of well-circumscribed, hypervascular, solid and hypoechoic or isodense lesions when encountered on abdominal ultrasonography or computed tomography.

Keywords: Ultrasonography, computed tomography, hamartoma, spleen

INTRODUCTION

Splenic hamartomas are benign vascular tumors initially described by Rokitansky in 1861. They are mostly asymptomatic and encountered incidentally. Large hamartomas may be palpable and can result in splenomegaly or rupture. Splenic hamartomas are histopathologically composed of disorganized red pulp cells. In this case, we present the findings of a splenic mass that was incidentally identified on ultrasound imaging.

CASE

A 55-year-old female presents to our medical facility for routine screening. Medical history reveals no prior operation or morbidity. Routine abdominal ultrasound revealed a 6x5 cm hypoechoic splenic mass containing cystic changes (Figure 1). A computed tomography was performed to establish a differential diagnosis, which revealed a mass in the anterior part of the spleen with a similar density to normal parenchyma and containing patchy hypodense areas (Figure 2, 3). Based on these findings, an ultrasound guided tru-cut biopsy was performed to confirm the diagnosis (Figure 4). Histopathological evaluation confirmed the diagnosis of splenic hamartoma.

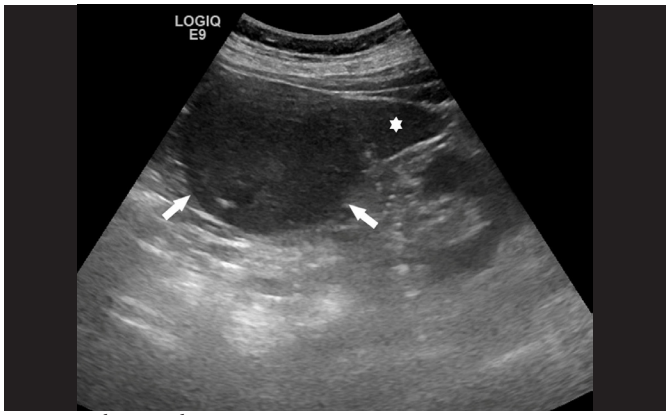

Figure 1. Ultrasound

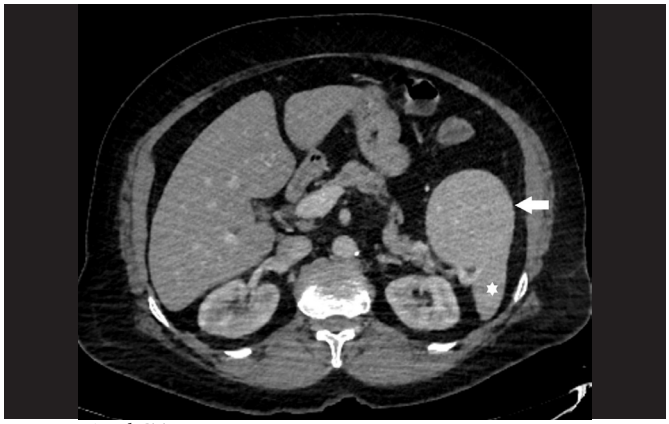

Figure 2. Axial CT

CT: Computed tomography

DISCUSSION

Splenic hamartomas are rare vascular lesions that are generally discovered incidentally during imaging.[1] They are typically seen in older patients with a similar male-female incidence.[2] In clinical series involving splenectomy, they are observed at a rate of 3/200,000. These lesions are frequently round, well-circumscribed, non-encapsulated and multiple or solitary.

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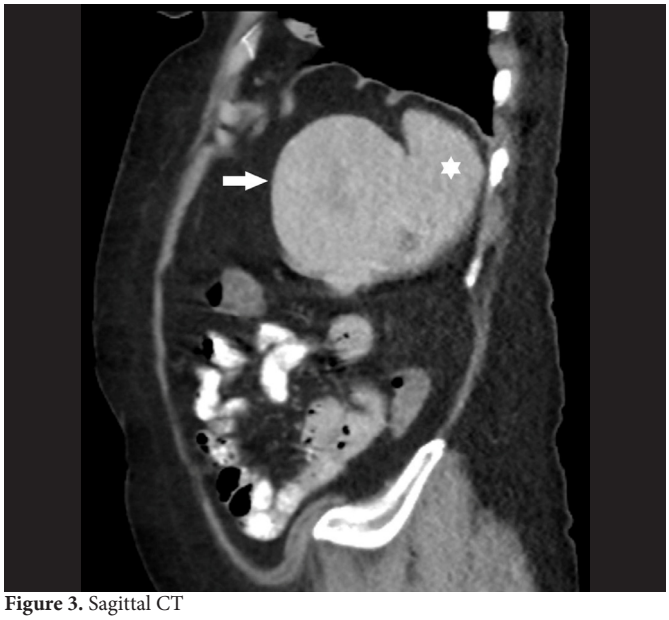

Figure 3. Sagittal CT

CT: Computed tomography

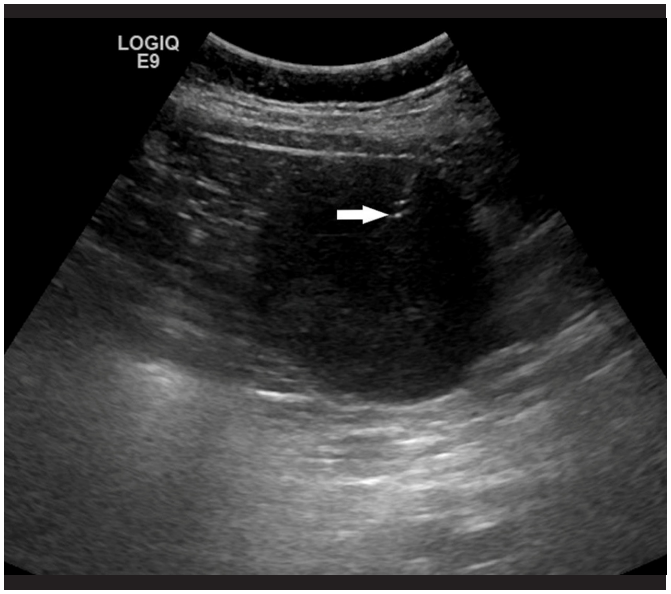

Figure 4. Bx with ultrasound

While similar in nature to spleen parenchyma, hamartomas are composed of abnormally organized splenic components such as white and red pulp. Although they are typically solitary, patients with tuberous sclerosis or Wiskott-Aldrich syndrome may present with multiple lesions. Symptoms arise due to the mass effect caused progression of lesion size.[3]

Splenic hamartomas are usually observed as hypoechoic solid masses on ultrasonography; however, they may exhibit heterogeneity due to cystic and hemorrhagic changes.[4] Doppler sonography and post-contrast examinations reveal these masses to be hypervascular. In this case, abdominal ultrasonography revealed a hypoechoic, well-circumscribed and solid hypervascular lesion in the anterior part of the spleen consistent with a hamartoma.

On CT examination, hamartomas appear as isodense or hypodense solid lesions that exhibit heterogeneous contrast enhancement when compared with the adjacent splenic parenchyma.[5] Similarly, the present case revealed a well-circumscribed isodense lesion consistent with a splenic hamartoma on CT evaluation.

Differential diagnosis usually remains wide even after imaging characterization, and splenectomy remains a crucial step for differentiation from other entities. The later includes vascular and non-vascular solid lesions of the spleen.[6] It may be difficult to differentiate a splenic hamartoma from littoral cell angioma, hemangioma, hemangioendothelioma, lymphangioma, sclerosing angiomatoid nodular transformation, and angiosarcoma. Radiologically, a similar picture may be seen with lymphoma, metastatic neoplasms, inflammatory myofibroblastic tumor, and disseminated granulomatous diseases.[5-8]

Although splenic hamartoma may be suggested by images, tissue is required for definitive diagnosis and is usually obtained via splenectomy or partial splenectomy, which can also relieve symptoms and exclude malignancies.[5,9,10] When associated with hematologic disorders, splenectomy can sometimes result in cure.[6] Extraction of the intact spleen has important diagnostic and therapeutic rules. A fragmented spleen may add difficulty to the diagnosis and result in peritoneal dissemination in case a malignancy is diagnosed. In addition, hemato-logic disturbances may continue to occur if a splenic fragment is retained within the peritoneal cavity.[7]

It is of paramount importance to mention that fine-needle aspiration, although it can provide evidence for diagnosis, carries the risk of hemorrhage and peritoneal seeding. Hence, surgery becomes mandatory.[11] In children, given the important immune function of the spleen, every effort should be made to save normal splenic tissue with partial splenectomy for single small lesions. Otherwise, total splenectomy may be preferred for multiple, large, or centrally-located lesions or when malignancy cannot be excluded.[7,9,10]

CONCLUSION

As a result, splenic hamartomas should be considered in the differential diagnosis of well-circumscribed, hypervascular, solid and hypoechoic or isodense lesions when encountered on abdominal ultrasonography or computed tomography. Although splenic hamartoma may be suggested by images, tissue is required for definitive diagnosis and is usually obtained via splenectomy or partial splenectomy, which can also relieve symptoms and exclude malignancies.

ETHICAL DECLARATIONS

Informed Consent

The patient signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Journal of Comprehensive Surgery

Letter to the Editor

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Letter to the Editor: comment on "Incidental gynecologic cancers who underwent surgery for pelvic organ prolapse"

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Keywords: Incidental gynecologic cancer, pelvic organ prolapse, prolapse surgery, gynecologic malignancy, urogynecology

Dear Editor,

We read with great interest the article by Ismayilov et al.[1] on the detection of incidental gynecologic malignancies in patients undergoing surgery for pelvic organ prolapse (POP). The study offers valuable insights into the prevalence of occult malignancies in this population and highlights the ongoing debate regarding the necessity of preoperative screening in asymptomatic individuals. While the findings contribute meaningfully to the existing literature, we wish to elaborate on several key aspects of the study that warrant further discussion.

ABSENCE OF INCIDENTAL MALIGNANCIES AND STUDY POWER CONSIDERATIONS

The study reports that no incidental malignancies were detected among the 107 patients undergoing POP surgery. This finding is somewhat unexpected, as previous meta-analyses have documented an estimated incidental malignancy rate of 1 in 77 for cervical cancer and 1 in 250 for endometrial cancer in similar cohorts.[2] The authors' results may be attributable to sampling bias or limited statistical power, given the relatively small sample size. Given the heterogeneity of incidental cancer detection rates in the literature, a larger multi-center cohort study would be necessary to determine whether the absence of malignancies in this study is reflective of a broader population trend or simply an artifact of limited sample size.

DIAGNOSTIC SENSITIVITY OF PREOPERATIVE SCREENING MODALITIES

A significant discrepancy was observed between preoperative and postoperative diagnoses of endometrial polyps (p=0.0001), suggesting that preoperative endometrial sampling may have limited sensitivity in detecting intrauterine pathology. The authors correctly acknowledge that Pipelle biopsy, while commonly used, has an inherent false-negative rate, particularly in postmenopausal patients. The sensitivity of Pipelle sampling ranges from 80-98% in cases of endometrial cancer, but it declines for detecting focal intrauterine lesions, such as endometrial polyps and hyperplasia.[3]

Given the limitations of blind endometrial sampling, hysteroscopy has been increasingly recommended for the evaluation of intrauterine pathology, particularly in patients with risk factors for endometrial disease. Several studies have demonstrated the superior sensitivity of hysteroscopy compared to blind sampling techniques.[4] The omission of hysteroscopy from the preoperative workup in the present study may have contributed to missed diagnoses. Would the authors consider integrating hysteroscopy into routine preoperative assessment for high-risk patients undergoing POP surgery?

THE INFLUENCE OF PATIENT-SPECIFIC RISK FACTORS ON MALIGNANCY DETECTION

The study population comprised 80.4% postmenopausal women, yet no cases of endometrial malignancy were detected. This raises questions about risk stratification and selection criteria. Known risk factors for endometrial malignancy include obesity, hypertension, diabetes, and nulliparity, all of which significantly increase the likelihood of occult gynecologic malignancy.[5] The study reports that 35% of patients had hypertension and 17.8% had diabetes, yet the relationship between these comorbidities and preoperative screening outcomes was not examined in detail.

A more detailed subgroup analysis assessing malignancy risk based on BMI, metabolic comorbidities, and family history of gynecologic cancers could have strengthened the study's conclusions. Would the authors consider conducting an expanded analysis to explore the potential role of individualized risk stratification in guiding preoperative screening strategies?

CLINICAL IMPLICATIONS AND FUTURE DIRECTIONS

Despite the absence of incidental cancer cases, the study reinforces the importance of routine pathological examination of hysterectomy specimens in POP surgery. The detection of

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preinvasive cervical lesions in 4.7% of patients underscores the value of histopathologic assessment, even in the absence of overt preoperative abnormalities. This aligns with previous research advocating for universal pathological examination of surgical specimens to ensure the identification of clinically relevant premalignant conditions.[2]

However, considering the limitations of preoperative screening, we propose that future research should:

- Investigate the diagnostic utility of preoperative hysteroscopy, particularly in postmenopausal patients with risk factors for endometrial pathology.
- Conduct prospective studies with larger, multi-center cohorts to validate the findings.
- Explore individualized risk stratification approaches to enhance preoperative screening protocols for high-risk patients.

CONCLUSION

The study by Ismayilov et al.[1] provides valuable preliminary data on the low prevalence of incidental malignancies in patients undergoing POP surgery. However, further large-scale studies with comprehensive risk stratification are needed to determine whether routine histopathologic evaluation remains the most effective strategy for early detection of occult malignancies. Additionally, the role of hysteroscopy in enhancing preoperative diagnostic accuracy warrants further investigation.

ETHICAL DECLARATIONS

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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