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Editor
Nancy E. Epstein, MD
Professor of Clinical Neurosurgery, School of Medicine, State U. of NY at Stony Brook

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Original Article

Awake lumbar spine surgery performed under spinal versus conventional anesthesia

Mohamed M. Mohi Eldin[1], Ahmed Salah-Eldin Hassan Abdelaaty[2], Omar Youssef[3], Alaa A. Abdulkawy[4], Mohamed Eltoukhy[5]

[1]Department of Neurosurgery, Kasr Alainy Faculty of Medicine, [2]Department of Neurosurgery, Faculty of Medicine, [3]Neurosurgical Department, Cairo University, [4]Department of Neurosurgery, Al-Sahel Teaching Hospital, General Organization of Teaching Hospitals and Institutes, [5]Department of Neurosurgery, Cairo University, Cairo, Egypt.

E-mail: Mohamed M. Mohi Eldin - mmohi63@yahoo.com; Ahmed Salah-Eldin Hassan Abdelaaty - salawiha1@hotmail.com; Omar Youssef - omaryoussef@gmx.com; *Alaa A. Abdulkawy - alaa.neurosurgery92@gmail.com; Mohamed Eltoukhy - mohamed.eltoukhy@kasralainy.edu.eg

***Corresponding author:**
Alaa A. Abdulkawy, Department of Neurosurgery, Al-Sahel Teaching Hospital, General Organization of Teaching Hospitals and Institutes, Cairo, Egypt.

alaa.neurosurgery92@gmail.com

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ABSTRACT

Background: Lumbar spine surgery for discectomy or laminectomy is mostly performed under general anesthesia (GA). Here, we explored whether, in a series of 84 patients, better peri-operative outcomes and lower complication rates could be achieved for those undergoing diskectomy/laminectomy under spinal anesthesia (SA) versus GA.

Methods: From 2022 to 2023, 84 patients were randomly assigned to undergo lumbar discectomy/laminectomy for stenosis under SA: 42 patients versus GAGA: 42 patients. For these two populations, we analyzed and compared multiple variables, including duration of anesthesia, estimated blood loss (EBL), and outcomes (i.e., including pre/post-operative Visual Analogue Scale, Oswestry disability index, and short-form 36 questionnaires).

Results: Major advantages of SA versus GA included a reduced mean EBL, shorter mean operative time, reduced mean hospital length of stay, and fewer post-operative side effects. Notably, baseline heart rate or mean arterial blood pressure showed no significant differences between SA and GA groups.

Conclusion: Based on this small preliminary sample of patients undergoing lumbar disc/stenosis surgery, it appeared that SA reduced the mean EBL, offered shorter mean operative times, mean hospital lengths of stay, and fewer post-operative side effects versus GA.

Keywords: Awake surgery, Complications, Lumbar discectomy, Operative time, Spinal anesthesia

INTRODUCTION

Multiple studies have previously compared the risks versus benefits of performing lumbar diskectomy/stenosis surgery under spinal anesthesia (SA) versus general anesthesia (GA) [Table 1].[2,6,7,9] Here, in a prospective randomized sample of 42 patients undergoing lumbar diskectomy/laminectomy for stenosis under SA versus 42 performed under GA, we asked which anesthetic regimen would reduce mean estimated blood loss (EBL), shorten mean operative times, decreases hospital lengths of stay, and result in fewer post-operative side effects.

MATERIALS AND METHODS

Prospectively, 84 patients undergoing discectomy/laminectomy for stenosis were randomly assigned to SA: 42 patients versus GA: 42 patients groups during 2022–2023. We utilized multiple

Table 1: Summary table for references.

First Author	Reference Number	Journal	Year of Publication	Country	Study design	Patient Population	Aim of the study	Results	Conclusions
Agarwal *et al.*	[1]	World Neurosurgery	2016	USA	Retrospective Study	542 patients (SA: 364 and GA: 178)	Cost: SA vs. GA in L. Disk/Lam	SA: 41.1% lower direct operating cost, 36.6% lower indirect cost, and 39.6% lower total cost vs. GA	Cost: SA<GA in L. Disk/Lam
Attari *et al.*	[2]	Journal of Research in Medical Sciences	2011	Iran	Prospective Randomized Controlled Trial	72 patients (SA: 35 and GA: 37)	Perioperative outcomes in L. Disk/Lam: SA vs. GA	EBL: SA<GA AR: SA<GA	SA was superior to GA
Baenziger *et al.*	[3]	Journal of Neurosurgical Anesthesiology	2020	Switzerland	Prospective Randomized Controlled Trial	100 patients (SA: 50 and GA: 50)	Clinical outcomes in L. Disk/Lam: SA vs. GA	Anesthesia time: SA<GA Transition time: SA<GA VAS for pain: SA<GA	SA was associated with shorter anesthesia and transition times and lower VAS for pain.
Dripps and Vandam	[4]	The Journal of the American Medical Association	1954	USA	Prospective Randomized Controlled Trial	8460 patients (SA: 8460)	Neurological complications of SA.	There were minor neurological sequelae related to SA.	SA is safe and not associated with major neurological complications.
Hebl *et al.*	[5]	Anesthesia and Analgesia	2010	USA	Retrospective Study	937 patients (SA: 937)	Neurologic complications and block efficacy after SA in patients with L. pathology	Ten patients experienced new deficits or worsening of existing symptoms.	Patients with pre-existing spinal canal pathology have a higher incidence of neurologic complications after SA.
Jellish *et al.*	[6]	Anesthesia and Analgesia	1996	USA	Prospective Randomized Controlled Trial	122 patients (SA: 61 and GA: 61)	Perioperative outcomes: SA vs. GA L. Disk/Lam	Surg. Dur.: SA<GA anes. Dur.: SA<GA Nausea: SA<GA EBL: SA<GA	SA to be superior to GA
Kahveci *et al.*	[7]	Neurologia i Neurochirurgia Polska	2014	Turkey	Prospective Randomized Controlled Trial	80 patients (SA: 40 and GA: 40)	Perioperative outcomes and cost effectiveness In L. Disk/Lam: SA vs. GA	HR and MABP: SA<GA Anes. Dur.: SA<GA AR: SA<GA Costs: SA<GA EBL: SA<GA	SA is clinically as effective as GA but more cost effective.

(Contd...)

Table 1: *(Continued).*

First Author	Reference Number	Journal	Year of Publication	Country	Study design	Patient Population	Aim of the study	Results	Conclusions
McLain *et al.*	[8]	Spine	2004	USA	Retrospective Study	400 patients (SA: 200 and GA: 200)	Perioperative complications In L. Disk/Lam: SA vs. GA	Complications: SA<GA LOS SA<GA. Surg. and Anes. Dur.: SA<GA HR and MABP: SA<GA. AR: SA<GA Nausea, urinary retention: SA<GA.	SA is associated with decreased nausea, reduced AR, and reduced complication rate.
Sadrolsadat *et al.*	[9]	Surgical Neurology	2009	Iran	Prospective randomized controlled trial	100 patients (SA: 50 and GA: 50)	Perioperative Parameters in L. Disk/Lam: SA vs. GA	EBL: SA>GA No major intraoperative complication in SA or GA Hypertension: SA<GA N and V: SA>GA.	SA has no advantages over GA.

Lam: Laminectomy, Disc: Diskectomy, LOS: Length of stay, Anes: Anesthesia≤Less, Dur: Duration, Surg: Surgery, EBL: Estimated blood loss, AR: Analgesic requirements, L: Lumbar, N and V: Nausea and Vomiting, GA: General anesthesia, SA: Spinal anesthesia, VAS: Visual Analog scale

inclusion and exclusion criteria [Table 2 and Figure 1]. Surgeons were aware of the type of anesthesia, but the surgeon evaluating the data 3 months later was blinded to the study design.

Anesthetic techniques

Pre-operative pre-medication included midazolam 0.02 mg/kg IV, and the following vital signs were monitored: Heart rate, mean arterial blood pressure, and oxygen saturation (SpO_2). Patients underwent different permutations/combinations of lumbar diskectomy/laminectomy for stenosis [Table 3 and Figures 2-7].

Clinical data

Eighty-four patients enrolled in the study had an average of 42.3 years of age: 47 were males and 37 were females [Table 4]. Notably, multiple clinical and outcome data were analyzed (i.e., most importantly, the mean EBL, mean operative times, mean hospital lengths of stay, and incidence of post-operative side effects) for patients managed with SA versus GA. At 3 and 6 months postoperatively, outcomes were evaluated utilizing the (Visual Analog Scale [VAS] score/Oswestry Disability Index [ODI] questionnaire/short form-36 [SF-36] questionnaire (i.e., the latter two using the Arabic Version)). Notably, all patients had 3-month post-operative magnetic resonance imaging.

Statistical analysis

Statistical analyses utilized the Statistical Package for the Social Sciences (SPSS) version 25.0 (SPSS. Chicago, the USA), the Kolmogorov–Smirnov test (i.e., to determine variable distribution), the independent sample *t*-test, and the Chi-square test. Heterogeneous variables were analyzed using non-parametric statistical methods (i.e., using the Mann–Whitney U-test).

RESULTS

Multiple demographic characteristics were similar for both groups [Tables 4 and 5]. Both groups also showed statistically significant clinical improvement after surgery [Table 6]. Further, there were no significant differences in pre-operative, 3 months, and 6-month post-operative VAS scores, ODI, and SF-36 between the SA versus GA group patients (i.e., except at 3-month post-operative VAS scores were lower in the SA versus GA group) [Table 7].

Benefits of SA versus GA

Multiple other variables showed significant improvement/benefits for utilizing SA versus GA for performing lumbar

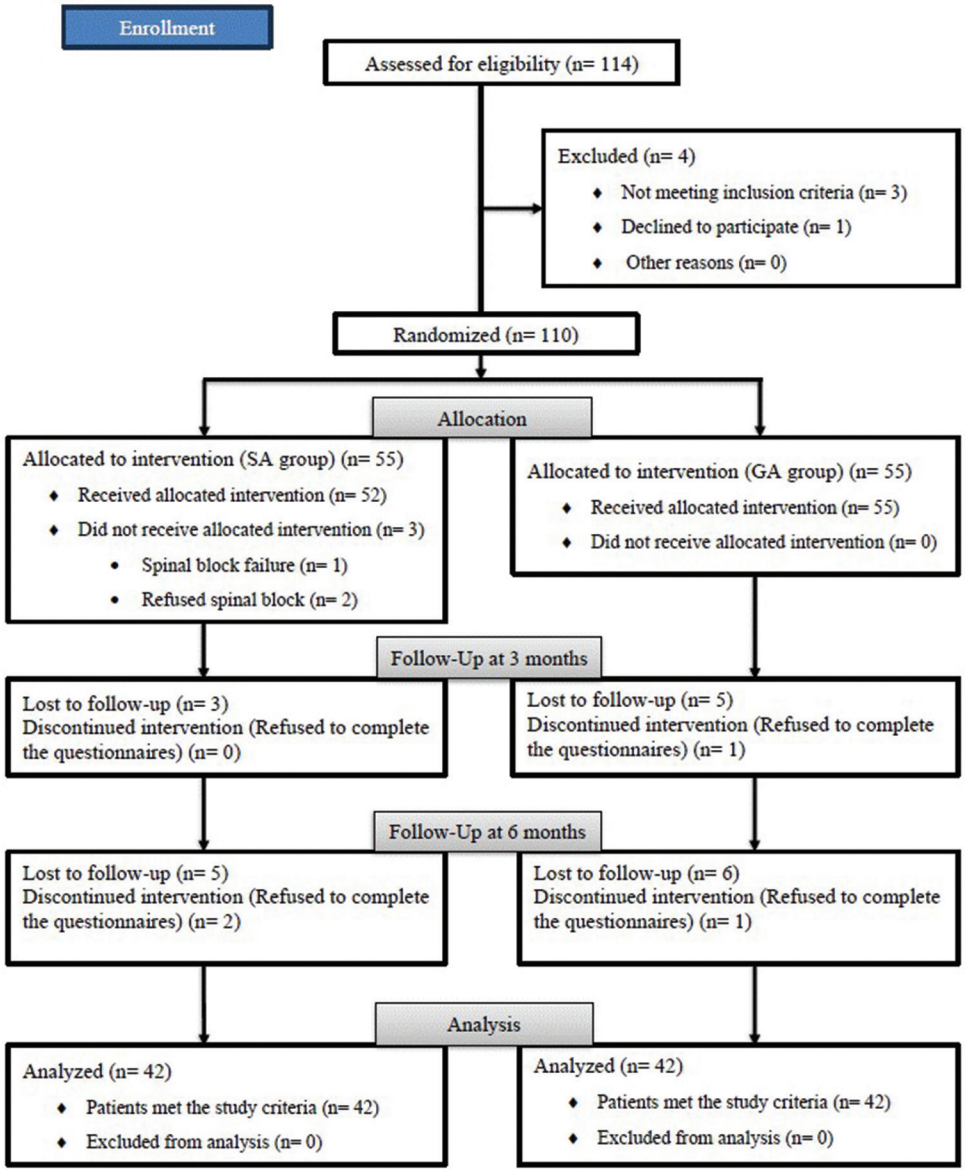

Figure 1: Flowchart of enrollment, randomization, and follow-up of patients.

Table 2: Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Patients diagnosed with one or two levels of lumbar disc prolapse or lumbar canal stenosis.	Patients with more than 2 levels of spinal stenosis or having signs of spinal instability
Failure of adequate conservative measures	Patients with coagulopathies or localized infection
Age between 20 and 70 years	Patients with ASA physical status score higher than II
ASA physical status score I or II	Patients with any contraindication for SA, either relative or absolute[8]
	Cases of recurrent lumbar disc prolapse or lumbar canal stenosis

ASA: American society of anesthesiologists, SA: spinal anesthesia

diskectomy/laminectomy for stenosis, including better immediate post-operative peripheral SpO_2, reduced mean EBL, shorter surgical duration, less time in the post-anesthesia care unit, reduced post-operative pain, reduced

Figure 2: During initiation of spinal anesthesia after insertion of the spinal needle.

Figure 3: The OR setting during performing microscopic discectomy under spinal anesthesia. OR: Operating Room.

Figure 4: The skin incision after microscopic discectomy.

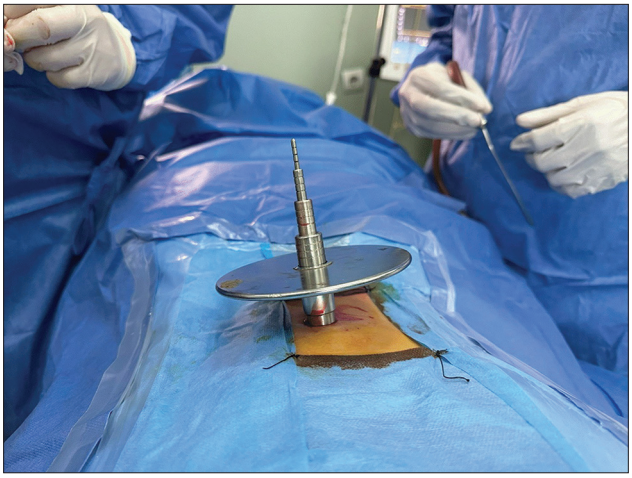

Figure 5: After insertion of the tubular dilator system in a case of endoscopic discectomy.

Figure 6: The OR setting during performing endoscopic discectomy under spinal anesthesia.

Table 3: Procedure vs. anesthesia.

	Anesthesia		Total	*P*-value
	GA	SA		
Procedure				
Discectomy	8	8	16	0.902
Endoscopic discectomy	9	9	18	
Laminectomy	5	9	14	
Laminectomy and discectomy	5	4	9	
Microscopic discectomy	9	7	16	
Microsurgical unilateral exposure with bilateral decompression	6	5	11	
Total	42	42	84	

GA: General anesthesia, SA: Spinal anesthesia

post-operative analgesia, less post-operative nausea/vomiting, and urinary retention, shorter lengths of stay, and overall costs [Tables 8-10]

Table 4: Patient Characteristics, diagnosis, and levels.

Variable	SA Group	GA Group	*P*-value
Age (years)	41.24±11.421	43.36±12.413	0.418
Gender (M/F) (%)	25 (59.5)/17 (40.5)	22 (52.4)/20 (47.6)	0.510
Comorbidities (%)			
No Comorbidities	37 (88.1)	30 (71.4)	0.218
HTN	3 (7.1)	5 (11.9)	
DM	1 (2.4)	4 (9.5)	
DM and HTN	0 (0)	1 (2.4)	
HCV	0 (0)	2 (4.8)	
RA	1 (2.4)	0 (0)	
BMI	25.12±1.330	25.35±1.776	0.520
ASA (I/II) (%)	40 (95.2)/2 (4.8)	39 (92.9)/3 (7.1)	0.645
Diagnosis (LDP/LCS) (%)	25 (59.5)/17 (40.5)	25 (59.5)/17 (40.5)	1.00
Level (%)			
L3–4	0 (0)	2 (4.8)	0.098
L3–4, L4–5	1 (2.4)	3 (7.1)	
L4–5	32 (76.2)	20 (47.6)	
L4–5, L5–S1	2 (4.8)	3 (7.1)	
L5–S1	7 (16.6)	12 (28.6)	
Multilevel	0 (0)	2 (4.8)	

GA: General anesthesia, SA: Spinal anesthesia, HTN: Hypertension, DM: Diabetes mellitus, HCV: Hepatitis C virus, BMI: Body mass index, ASA: American Society of Anesthesiologists, RA: Rheumatoid arthritis, LDP: Lumbar disc prolapse, LCS: Lumbar canal stenosis.

Table 5: HR and MABP vs. anesthesia.

	Anesthesia	Mean	Std. Deviation	*P*-value
Baseline				
HR	SA	74.88	2.568	0.193
	GA	75.79	3.653	
MABP	SA	74.64	2.564	0.423
	GA	75.02	1.675	
After the initiation of anesthesia				
HR	SA	71.40	4.407	0.002
	GA	74.02	2.754	
MABP	SA	68.57	2.777	<0.001
	GA	76.36	2.658	
After the initiation of surgery				
HR	SA	71.43	3.877	<0.001
	GA	81.43	4.860	
MABP	SA	68.43	3.262	<0.001
	GA	75.95	2.409	
After completion of surgery				
HR	SA	72.26	3.116	<0.001
	GA	83.57	5.442	
MABP	SA	69.95	2.802	<0.001
	GA	75.95	2.537	
After admission to the PACU				
HR	SA	73.67	3.167	<0.001
	GA	85.12	5.919	
MABP	SA	75.55	2.948	<0.001
	GA	78.67	3.660	
Before shifting to the general ward				
HR	SA	73.71	2.616	<0.001
	GA	85.62	4.282	
MABP	SA	75.07	2.735	<0.001
	GA	78.90	3.862	

HR: Heart rate, MABP: Mean arterial blood pressure, GA: General anesthesia, SA: Spinal anesthesia, PACU: Post-anesthesia care unit

Table 6: Pre-operative versus post-operative VAS and ODI.

	SA			GA		
	Mean	**SD**	***P*-value**	**Mean**	**SD**	***P*-value**
VAS						
Pre-operative	8.12	0.861		7.83	0.853	
Post-operative						
After 3 months	2.88	1.33	<0.001	3.29	1.22	<0.001
After 6 months	1.81	1.087	<0.001	2.1	0.878	<0.001
ODI						
Pre-operative	51.6	13		50.02	11.62	
Post-operative						
After 3 months	16.4	10.63	<0.001	16.74	9.25	<0.001
After 6 months	11.07	4.79	<0.001	11.8	4.64	<0.001

GA: General anesthesia, SA: Spinal anesthesia, VAS: Visual Analog Scale, ODI: Oswestry disability index, SD: Standard deviation

Table 7: Pre-operative versus post-operative VAS and ODI in the SA group versus GA group.

	Anesthesia	**Mean**	**SD**	***P*-value**
Pre-operative				
VAS	SA	8.12	0.861	0.089
	GA	7.83	0.853	
ODI	SA	51.5976	13.00901	0.478
	GA	50.0238	11.62102	
3-month post-operative				
VAS	SA	2.8810	1.32890	0.046
	GA	3.2857	1.21546	
ODI	SA	16.3952	10.63180	0.258
	GA	16.7405	9.24509	
6-month post-operative				
VAS	SA	1.81	1.087	0.077
	GA	2.10	0.878	
ODI	SA	11.0690	4.79056	0.346
	GA	11.8024	4.64036	

GA: General anesthesia, SA: Spinal anesthesia, PACU: Post-anesthesia care unit, VAS: Visual Analog Scale, ODI: Oswestry disability index, SD: Standard deviation

Table 8: Blood loss, anesthetic time, procedure time, and PACU time.

	Anesthesia	**Mean**	**SD**	***P*-value**
Blood loss (in mL)	SA	33.69	12.976	0.001
	GA	42.14	11.590	
Time of initiation of anesthesia (in minutes)	SA	5.86	1.555	<0.001
	GA	15.90	4.131	
Procedure time (in minutes)	SA	144.29	54.388	0.721
	GA	144.17	42.569	
PACU time (in minutes)	SA	5.74	2.88	<0.001
	GA	15.02	2.474	

GA: General anesthesia, SA: Spinal anesthesia, PACU: Post-anesthesia care unit, SD: Standard deviation

Table 9: Post-operative analgesia vs. anesthesia.

	Anesthesia		**Total**	***P*-value**
	GA	**SA**		
Post-operative analgesia				
Number of patients who did not need post-operative analgesia				<0.001
Count	9	38	47	
Number of patients who needed post-operative analgesia				
Count	33	4	37	

GA: General anesthesia, SA: Spinal anesthesia

Table 10: Nause, vomiting, and urine retention vs. anesthesia type.

	Anesthesia		**Total**	***P*-value**
	GA	**SA**		
Nausea				
No				<0.001
Count	21	38	59	
Yes				
Count	21	4	25	
Vomiting				
No				0.019
Count	31	39	70	
Yes				
Count	11	3	14	
Urinary retention				
No				
Count	42	42	84	
Yes				
Count	0	0	0	

GA: General anesthesia, SA: Spinal anesthesia

Figure 7: Surgical incision after performing endoscopic discectomy.

Comparable incidence of adverse events utilizing SA versus GA for diskectomy/laminectomy

Patients from both the SA and GA groups sustained comparable and relatively minimal post-operative adverse events. Four patients sustained intraoperative traumatic durotomies: 2 patients in the SA group (4.76 %) and 2 in the GA group (4.76 %). There were also 2 cases of post-operative discitis, one from each of the SA and the GA groups; both responded to conservative intravenous antibiotic therapy. An additional GA patient had a recurrent disc herniation that occurred 1 week postoperatively, requiring operative revision.

DISCUSSION

In our series, as seen in other studies, there was no statistically significant difference in outcomes for the 42 patients undergoing diskectomy/laminectomy utilizing SA versus the 42 having GA; patients in both of our groups showed statistically significant and comparable clinical post-operative improvement based on post-operative VAS, ODI, and SF-36 scores at 3 months or 6 months postoperatively.[3]

Our incidence of post-operative adverse events for both groups, including dural tears, infection, and recurrent disc herniations, was also similar to Baenziger *et al.*,[3] McLain *et al.*,[8] Hebl *et al.*,[5] and Dripps and Vandam[4] studies.

Like our findings, Jellish *et al.*[6] and McLain *et al.*[8] reported that SA was associated with less post-operative pain, less post-operative analgesic requirements, and less nausea/vomiting versus GA.

Although we documented a statistically significant reduction in intraoperative blood loss for the SA versus GA groups, other studies showed more variable results.[6,9]

Despite our documenting a reduced time for SA versus GA, other studies came to different conclusions (i.e., McLain *et al.*,[8] Attari *et al.*,[2] and Sadrolsadat *et al.*[9])

Our patients having SA (2.33 days) exhibited faster recoveries and earlier discharges from the hospital versus GA (3.07 days), findings similar to those in McLain *et al.*[8] series.

Our data and findings from other studies showed nearly equal perioperative adverse events occurring in each group.[4,9]

We, like others, have noted that SA was associated with lower overall costs versus GA for patients undergoing lumbar diskectomy/laminectomy.[1]

CONCLUSION

SA for patients undergoing lumbar diskectomy/laminectomy reduced the mean EBL and offered shorter mean operative times and mean hospital lengths of stay, along with fewer post-operative adverse events versus GA.

Ethical approval

The research/study was approved by the Institutional Review Board at Cairo University Hospitals, number MD - 114–2022, dated May 22, 2022.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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