European Spine Journal
https://doi.org/10.1007/s00586-025-09667-2

RESEARCH

Practice preference of revision surgery for recurrent lumbar disc herniation: an international survey of AO spine members

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Received: 17 July 2025 / Revised: 24 October 2025 / Accepted: 2 December 2025

Abstract

Objective To explore global practice patterns and surgeon preferences in the surgical management of recurrent lumbar disc herniation (rLDH), and to identify factors influencing the choice of technique.

Methods A survey was distributed to the AOSpine members globally to ascertain rLDH surgical management preferences. Preference of surgeons for management options such as sequestrectomy, partial discectomy (PD), radical discectomy (RD) and fusion was ascertained for early (<3 months) and late (>3 months) rLDH scenarios following initial recovery for 6 months.

Results 714 surgeons responded to the survey. In early rLDH, PD was predominantly preferred (48.0%, $n=343$) followed by RD (18.3%, $n=131$), fusion (17.9%, $n=128$) and sequestrectomy (14.4%, $n=103$). In late rLDH, 40.2%($n=287$) of the surgeons preferred interbody fusion followed by sequestrectomy (31.7%, $n=226$) and RD (21.6%, $n=154$). Surgeons predominantly preferred to utilize the same approach as that of index surgery. Fusion was considered when there was a concomitant or incipient degenerative disease. Fusion in the early rLDH is significantly influenced by region, training, and volume of cases handled by the surgeons.

Conclusion Partial discectomy and interbody fusion are the predominant management of choice in both the early and late rLDH. The choice of fusion predominantly depends on the state of the index and adjacent segment, instability and degeneration respectively. Fusion in the early rLDH is significantly influenced by region, surgical training, and volume of cases handled by the surgeons.

Keywords Practice preference · Recurrent lumbar disc herniation · Lumbar disc herniation · Revision surgery · Failed back syndrome

Introduction

Recurrent lumbar disc herniation (rLDH) is defined as the presence of disc material in the same intervertebral level where a patient has undergone prior surgery for lumbar disc herniation (LDH) and had a pain-free interval of 6 months following surgery [1]. While surgery for LDH often leads to satisfactory recovery, about 20% of patients suffer from unsatisfactory outcomes [2]. The overall risk of requiring a reoperation ranges from 5–12.5.5% [3–8].

A common explanation for the occurrence of rLDH is the inadequate sealing of the annular defect thereby subjecting it to cyclical pressure changes resulting to re-herniation. Risk factors for rLDH include mechanical factors such as weak annular tissue, heavy weight lifting, and repetitive loading activities as well as individual factors like age, smoking, obesity, diabetes and the location and size of the disc herniation [9–17]. It is essential to differentiate rLDH from other causes of recurrent pain post-LDH surgery such as infection or postoperative epidural scarring to avoid unwanted surgeries [18].

The surgical techniques employed in the management of rLDH include sequestrectomy, which involves the removal of only the herniated disc fragment impinging the neural structures; partial discectomy, which involves removal of the herniated fragment, annulotomy and curettage of the

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Published online: 12 December 2025

disc space with removal of the loose fragments; radical discectomy, that involves removal of the herniated fragment, annulotomy, removal of as much disc material as possible with endplate curettage; and fusion procedure, that involves sufficient endplate preparation to achieve fusion with or without the placement of an interbody material.

There is no consensus on the ideal surgical technique to be employed in the management of rLDH. Further, there remains ambiguity in the surgical approach to be utilized for these techniques [7, 19]. rLDH is a recognized contributor to failed back syndrome (FBS), characterized by persistent or recurrent pain following spinal surgery. While this survey focused on rLDH, its overlap with FBS underscores the importance of accurate diagnosis and tailored surgical intervention. Using worldwide survey responses from AO Spine surgeons, this study aims to explore the preferences of surgeons regarding the surgical treatment of rLDH. By understanding these preferences and the underlying reasons, the study seeks to highlight trends, and knowledge gaps, and pinpoint potential areas for further research to optimize patient outcomes for this spinal condition.

Methods

Survey design

A survey was designed and disseminated through the AO Spine Knowledge Forum to understand the preferences of surgeons regarding the surgical management of rLDH. The survey was distributed to over 6,000 AO Spine members internationally and was conducted electronically in September 2024. Surgeon demographic information was collected including geographic clusters as per the AO Spine categorization (Asia Pacific, North America, Latin America, Europe and Southern Africa, and Middle East and Northern Africa), years of practice, speciality, case volume, and practice setting. Surgeons were enquired about their management preference for patients presenting with rLDH in the early postoperative period (<3 months) and late postoperative period (>3 months) following the 6 months pain free period, along with the surgical technique utilized for the same. They were also enquired when they preferred fusion in cases of rLDH. The classification of early (<3 months) and late (>3 months) rLDH following a 6-month pain-free interval was based on clinical observations suggesting differing pathophysiological mechanisms and treatment responses. While arbitrary, this threshold aligns with prior studies that distinguish early mechanical failure from progressive degenerative changes. We acknowledge the need for further validation of this temporal cutoff. The complete survey questionnaire is presented in Supplementary File 1.

We used percentages to represent the categorical data and used binary logistic regression to analyse the influence of the demographic variables towards the decision to fuse in various scenarios of rLDH. A p-value less than 0.05 was considered significant. Statistical analysis was performed using SPSS version 25 (IBM Corp., Armonk, USA).

Results

Survey demographics

A total of 714 surgeons responded to the survey on the management of rLDH. Respondents formed an international cohort, with the largest group from Europe and Southern Africa (34.7%), followed by Asia Pacific (24.7%), Latin America (18.7%), Middle East and Northern Africa (12.7%), and North America (8.9%). Most respondents were orthopaedic surgeons (61%) and academic/university hospital affiliated (38%). On the other hand, 29.8% of surgeons were affiliated with private practice, and 29.1% were in public/military hospitals. Finally, surgeon experiences among the respondents varied widely, and they were equally distributed across five groups ranging from <5 years of experience to >20 years of experience. Over 63.3% of the respondents underwent spine surgery fellowship following post-graduation. The complete demographics of the respondents are given in Table 1.

Early rLDH management

In cases where there is an early rLDH within 3 months of the initial recovery, 48.0% ($n=343$) of the surgeons preferred partial discectomy defined by removal of the herniated fragment, annulotomy and curettage of the disc space with removal of the loose fragments followed by radical discectomy 18.3% ($n=131$), defined by removal of the herniated fragment, annulotomy, removal of as much disc material as possible with endplate curettage. Fusion was opted by 17.9% ($n=128$) of the respondents while 14.4% ($n=103$) surgeons considered sequestrectomy as the only procedure of choice for early rLDH as shown in Fig. 1. When enquired about the approach utilized for the treatment decision made, 46.5% ($n=332$) considered utilizing the same approach as that for the index surgery while 27.2% ($n=194$) considered switching to a more open approach i.e. from tubular to open revision decompression for the rLDH scenarios.

Late rLDH management

In cases presenting late with rLDH more than 3 months of the initial recovery, 40.2% ($n=287$) of the surgeons preferred

Table 1 Demographics of survey respondents

Characteristics of Participants	*Overall* ($n=714$)
Specialty	
Orthopedics	435 (60.9%)
Neurosurgery	271 (37.9%)
Others	8 (1.2%)
Practice Focus	
Degenerative	681 (95.3%)
Trauma/Spinal cord injury	498 (69.7%)
Tumor	361 (50.5%)
Deformity	354 (49.5%)
Infection	17 (2.3%)
Others	20 (2.8%)
Hospital Setting	
University affiliated hospital	272 (38.2%)
Private	213 (29.8%)
Government Hospital	208 (29.1%)
Others	21 (2.9%)
Years in Practice	
< 5 years	93 (20.6%)
5–10 years	98 (21.6%)
11–15	83 (18.4%)
16–20	61 (13.5%)
> 20 years	117 (25.9%)
Number of LDH cases attended in a month	
< 10	69 (9.6%)
10–20	257 (35.9%)
20–30	140 (19.7%)
30–40	92 (12.9%)
40–50	43 (6.1%)
> 50	113 (15.8%)
Number of LDH surgeries performed in a year	
1–20	205 (28.7%)
21–50	273 (38.3%)
51–100	133 (18.6%)
> 100	103 (14.4%)

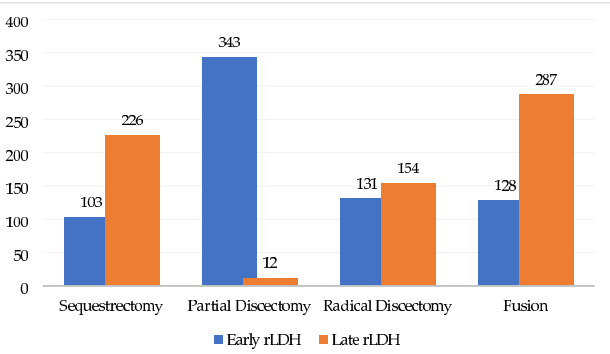

Fig. 1 Surgical choice of management of recurrent lumbar disc herniation (rLDH) in early (< 3 months) and late (> 3 months) presentation following initial recovery

interbody fusion as the primary management choice followed by sequestrectomy 31.7% ($n=226$), and radical discectomy 21.6% ($n=154$) as shown in Fig. 1. When enquired about the approach utilized for the treatment decision made, 34.2% ($n=244$) considered utilizing the same approach as that for the index surgery while 22.3% ($n=159$) considered switching to a more open approach. However, most of the respondents 40.8% ($n=291$) opted towards the approach necessary for the fusion procedure.

Fusion choice

Fusion was considered as a treatment choice in rLDH by 39.4% ($n=281$) of the respondents when there is a concomitant or incipient pathology (i.e. instability, advanced disc degeneration). However, 32.9% ($n=235$) considered fusion during the second instance of rLDH while 18.6% ($n=133$) considered it during the first episode of rLDH.

Regression analysis

When analyzing the factors contributing to the decision to fuse at the first recurrence irrespective of time, it is noted that fellowship-trained surgeons from all over the globe except Europe and Southern Africa significantly tend to fuse irrespective of their experience, practice setting or caseloads as shown in Table 2.

We categorized the scenario into early and late recurrences of LDH and analyzed the responses of the surgeons. We noted that surgeons from Europe & Southern Africa were the only group that did not have significant odds of choosing fusion at the first incidence of rLDH in the early postoperative period ($p=0.11$) while all other regions had significant odds towards fusion ($p<0.001$). We also noted the odds of fusion significantly increase when the surgeon has a neurosurgery training background ($p=0.004$). We also noted surgeons handling a higher volume of spine cases reported to fuse during the early instances of rLDH ($p<0.001$) as shown in Table 3. We also analyzed the factors contributing to the decision to fuse in the late rLDH and found surgeons from all over the globe of all case volumes tend to fuse when presented late with rLDH without any influence of the experience, practice setting or area of practice as shown in Table 3.

Discussion

Not all disc herniations noted at the index surgical level need to be responsible for the recurrent pain among patients who underwent LDH surgery. Grane et al. [20] noted rLDH in the index level among 16% of the patients who remained asymptomatic on follow-up. Hence, a thorough investigation is necessary before labelling a patient to suffer from rLDH and surgical management is indicated only in patients

Table 2 Regression analysis of the decision to fuse at the first instance of rLDH

Demographic Factors	β	S.E.	*p*	OR	95% C.I.	
					Lower	Upper
Asia Pacific	2.236	0.752	**0.003**	9.353	2.142	40.839
Europe & Southern Africa	0.853	0.767	0.266	2.346	0.522	10.544
Latin America	2.022	0.771	**0.009**	7.551	1.666	34.218
Middle East & Northern Africa	2.051	0.780	**0.009**	7.773	1.686	35.839
North America	2.512	0.775	**0.000**	8.751	2.512	43.215
Degenerative focus	−0.764	0.577	0.186	0.466	0.150	1.444
Orthopaedic specialty	−0.456	0.234	**0.050**	0.634	0.401	1.003
University hospital	0.224	0.260	0.389	1.252	0.752	2.084
Public hospital	0.307	0.265	0.247	1.359	0.808	2.286
Private practice	0.220	0.185	0.493	1.118	0.845	2.836
Rural	0.207	0.276	0.453	1.230	0.716	2.113
Suburban	−0.100	0.524	0.849	0.905	0.324	2.529
Urban	0.112	0.432	0.717	0.845	0.221	2.114
Spine Fellowship	0.519	0.221	**0.019**	1.681	1.091	2.590
< 10 cases	0.285	0.554	0.608	1.329	0.449	3.939
11–25 cases	0.292	0.469	0.533	1.340	0.534	3.357
26–50 cases	0.461	0.343	0.178	1.586	0.810	3.104
51–100 cases	0.384	0.264	0.146	1.468	0.875	2.464
> 100 cases	0.305	0.296	0.588	1.125	0.784	3.154
< 10 LDH cases	−0.431	0.504	0.393	0.650	0.242	1.747
10–20 LDH cases	0.243	0.340	0.474	1.276	0.655	2.483
20–30 LDH cases	0.183	0.365	0.616	1.201	0.587	2.456
30–40 LDH cases	0.000	0.383	1.000	1.000	0.472	2.117
40–50 LDH cases	0.500	0.443	0.260	1.648	0.691	3.929
> 50 LDH cases	−0.325	0.441	0.564	0.854	0.125	1.214
1–20 LDH surgery	−0.549	0.401	0.171	0.578	0.263	1.268
20–50 LDH surgery	−0.542	0.354	0.126	0.582	0.291	1.164
50–100 LDH surgery	−0.436	0.367	0.235	0.647	0.315	1.328
> 100 LDH surgery	−0.112	0.324	0.471	0.541	0.214	1.121

CI – Confidence Interval; LDH – lumbar disc herniation; rLDH – recurrent LDH; OR – odds ratio; SE – standard error; β – beta coefficient

with identifiable neural compression with corresponding symptoms [21]. Although risk factors responsible for rLDH have been investigated in detail, variations in the management of rLDH remain largely unexplored [9–17]. The key findings of the current study are as follows:

1. Partial discectomy is the preferred management of choice in early rLDH.
2. Fusion is the predominant management of choice in late rLDH.
3. The choice of fusion predominantly depends on the concomitant or incipient disc degeneration.
4. Fusion in the early rLDH is significantly influenced by region, training, and volume of cases handled by the surgeons.

O'Connell described the technique of radical discectomy where aggressive removal of the herniated disc material along with curettage of the end plates was performed [22]. The technique has been criticized for causing nucleus and endplate injury resulting in accelerated degeneration at the index level resulting in the recurrence of symptoms. On the other hand, partial discectomy described by Williams & Spengler involved only the removal of protruded disc material with little invasion of the disc space [23, 24]. It has also been criticized for being associated with a higher incidence of rLDH. MJ McGirt et al. [25] and Luca et al. [8] in their systematic review analyzed the incidence of recurrent symptoms between the two techniques and found the incidence of recurrent pain to be similar between the two in the short term. However, at more than 2 years of follow-up, the incidence of back pain was 2.5 times less with partial discectomy compared to radical discectomy despite having higher rLDH incidence [25]. This explains the choice of conservative discectomy techniques such as sequestrectomy and partial discectomy being predominantly used in both early and late rLDH scenarios compared to radical discectomy as shown in Fig. 1.

Fusion is predominantly considered the surgical technique of choice in late rLDH scenarios. However, 32.9%

Table 3 Regression analysis of the decision to fuse at early and late rLDH scenarios

Demographic Factors	Decision to Fuse at early rLDH				Decision to Fuse at late rLDH			
	β	S.E.	*p*	OR	β	S.E.	*P*	OR
Asia Pacific	1.996	0.756	**0.008**	7.363	1.882	0.444	**0.000**	6.564
Europe & Southern Africa	1.202	0.763	0.115	3.328	0.975	0.445	**0.028**	2.652
Latin America	1.738	0.776	**0.025**	5.683	1.621	0.463	**0.000**	5.060
Middle East & Northern Africa	2.019	0.781	**0.010**	7.530	1.855	0.479	**0.000**	6.389
North America	1.586	0.623	**0.006**	7.241	1.424	0.354	**0.000**	4.321
Degenerative focus	−1.069	0.647	0.099	0.343	−0.573	0.411	0.163	0.564
Orthopaedic specialty	−0.699	0.243	**0.004**	0.497	−0.941	0.190	**0.000**	0.390
University hospital	0.007	0.260	0.978	1.007	0.055	0.209	0.792	1.057
Public hospital	0.030	0.267	0.910	1.031	−0.110	0.217	0.611	0.896
Private practice	0.042	0.245	0.993	1.121	0.062	0.325	0.715	0.954
Rural	0.166	0.279	0.551	1.181	0.110	0.228	0.630	1.116
Suburban	−0.446	0.609	0.465	0.641	−0.511	0.451	0.257	0.600
Urban	0.211	0.451	0.595	1.025	0.351	0.214	0.425	1.084
Spine Fellowship	−0.078	0.226	0.730	0.925	0.350	0.181	0.053	1.418
< 10 cases	1.134	0.543	**0.037**	3.109	1.001	0.473	**0.034**	2.722
11–25 cases	0.336	0.493	0.496	1.399	1.169	0.397	**0.003**	3.220
26–50 cases	1.091	0.335	**0.001**	2.976	0.904	0.285	**0.002**	2.470
51–100 cases	0.488	0.271	**0.072**	1.628	0.478	0.211	**0.024**	1.612
> 100 cases	0.894	0.324	**0.015**	1.925	0.754	0.325	**0.003**	2.615
< 10 LDH cases	−1.269	0.570	0.260	0.281	0.096	0.381	0.801	1.101
10–20 LDH cases	−0.064	0.327	0.844	0.938	0.211	0.281	0.451	1.235
20–30 LDH cases	−0.375	0.363	0.301	0.687	0.098	0.300	0.744	1.103
30–40 LDH cases	−0.260	0.376	0.490	0.771	0.278	0.312	0.374	1.320
40–50 LDH cases	0.106	0.440	0.809	1.112	0.408	0.388	0.293	1.503
> 50 LDH cases	0.325	0.351	0.229	0.985	0.365	0.322	0.888	1.010
1–20 LDH surgery	−0.405	0.404	0.316	0.667	−0.362	0.335	0.280	0.696
20–50 LDH surgery	−0.565	0.360	0.117	0.568	−0.498	0.296	0.093	0.608
50–100 LDH surgery	−0.299	0.366	0.414	0.741	−0.259	0.303	0.392	0.772
> 100 LDH surgery	−0.322	0.312	0.469	0.842	−0.255	0.295	0.390	0.751

LDH – lumbar disc herniation; rLDH – recurrent LDH; OR – odds ratio; SE – standard error; β – beta coefficient

considered fusion only during the second instance of rLDH while 18.6% considered it during the first episode of rLDH. This could be explained by the fact that fusion being considered as an ultimate endpoint to prevent further rLDH has serious implications on the degenerative cascade in the adjacent segments. Hence, due consideration is warranted before opting for it as the surgical choice in the first incidence of rLDH. However, fusion is warranted when concomitant or incipient degenerative disease with instability, and advanced disc degeneration is noted at the index level. The late presenting rLDH are considered mostly due to the advancing disease process rather than insufficient decompression during the index surgery thereby warranting fusion over decompression to avoid subsequent surgeries in the future. Chen et al. [26] in their survey among spine surgeons in Australia and New Zealand noted 10% fusion rates at first rLDH and the rate increased to 82% for the second rLDH for the same reasons discussed above. Interestingly, the authors also reported that surgeons in private practice had greater odds of choosing fusion for the first rLDH which may be due to patients' concerns about cost effectiveness, financial incentive, and perceived lower risk of reoperation. Apart from these subjective factors, objective parameters that would influence surgeons to perform fusion in cases of rLDH include advanced disc disease with endplate damage, instability, or deformity which are further influenced by educational background, mentor influence, surgeon preferences, patient needs, and available surgical resources [27].

Although late rLDH warrants fusion in scenarios of advanced degeneration, the choice of fusion in early rLDH is found to be dependent on the surgeon factors such as region, surgical training and volume of cases handled. Surgeons from the European background were more conservative in their approach towards early rLDH and deferred fusion significantly compared to surgeons from other regions of the world which needs further exploration of the regional differences noted in the study. Further, neurosurgeons significantly preferred fusion in early rLDH compared to orthopaedic spine surgeons and surgeons handling large volumes of cases significantly preferred fusion even in

early rLDH scenarios. Despite handling high case volumes, the decision to fuse must be considered only in cases where it is warranted for the reasons discussed earlier and it might not be considered in every instance of rLDH to avoid further recurrences. The survey did not distinguish between the first and subsequent recurrences and the results may not representative of differences in preferences between them.

With regards to the approach selected for the rLDH scenarios, surgeons predominantly opted to use the same approach used for the index surgery irrespective of the presentation of rLDH. This is explained by the current increase in the usage of minimally invasive techniques such as tubular and endoscopic approaches for the index LDH surgery thereby limiting the surgical difficulty in handling the revision scenario [28]. However, usage of a conventional approach with minimal soft tissue dissection such as microdiscectomy would mandate an approach modification to more open techniques in revision scenarios to avoid expected complications with revision surgery [29]. Despite the choice of approach, conventional open discectomy has also been shown to demonstrate satisfactory results comparable to primary discectomy in rLDH scenarios [6]. Hence, the choice of approach for rLDH surgery is purely based on the convenience and expertise of the surgeon with a given approach.

Mroz et al. [30] conducted a survey of 445 spinal surgeons from the USA to examine the differences in rLDH treatment decision during first and second rLDH following microdiscectomy. They found that the number of cases that the surgeon performed yearly influenced their treatment decision. Surgeons who performed more than 200 cases were more likely to choose fusion in second rLDH significantly more compared to patients who performed less than 100 cases per year. The result of this study is in line with the results of our study with respect to fusion during the second rLDH. While our study did not assess clinical outcomes, prior literature suggests that fusion may reduce recurrence risk but carries higher morbidity and potential adjacent segment degeneration [31, 32]. Comparative outcome studies are needed to evaluate the long-term efficacy of fusion versus non-instrumented techniques in rLDH.

This study has several limitations. First, it is descriptive and cannot provide any insight into causality. Second, since the survey was voluntary, a degree of response bias may also be expected. Importantly, the response rate was low among AO Spine surgeons, which may introduce sampling bias and limit the generalizability of our findings. Furthermore, the survey was only distributed to members of AO Spine, which may not be entirely representative of all spine surgeons including neurosurgeons. This survey did not differentiate between first and subsequent recurrences of rLDH. Although second or third recurrences are less common, they may warrant distinct surgical strategies. Future studies should explore treatment preferences and outcomes in these scenarios. The strengths of this study lie in the AO Spine membership group, which represents a truly global spine surgeon community, a large sample size, and a detailed exploration of surgical decision-making in rLDH scenarios. This study is also novel in recruiting a large number of orthopaedic and neurosurgeons, aiming to explore practice patterns related to spine surgery in the rLDH scenarios. The distinction between early and late rLDH based on a 3-month threshold post-recovery may appear arbitrary. However, it was intended to reflect potential differences in etiology and surgical decision-making. Future studies should investigate more nuanced temporal classifications and their clinical relevance. While this study is descriptive, it provides valuable insights into global practice patterns and surgeon decision-making in rLDH scenarios. These findings serve as a foundation for hypothesis generation and underscore the need for prospective studies comparing outcomes of different surgical strategies across diverse patient populations with early and late rLDH. Key outcomes should include pain relief, functional recovery, recurrence rates, and cost-effectiveness. Additionally, studies exploring the impact of surgeon training, regional practices, and patient-specific factors on surgical outcomes would further refine treatment algorithms.

Conclusion

Partial discectomy and interbody fusion are the predominant management of choice in early and late rLDH respectively. The choice of fusion predominantly depends on the status of the index and adjacent segment for instability and degeneration respectively. Fusion in the early rLDH is significantly influenced by region, surgical training, and volume of cases handled by the surgeons.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00586-025-09667-2.

Acknowledgements This study was organized and funded by AO Spine through the AO Spine Knowledge Forum Degenerative, a focused group of international spine degeneration experts. AO Spine is a clinical division of the AO Foundation, which is an independent medically-guided not-for-profit organization. Study support was provided directly through the AO Spine Research Department.

Author contributions SM and SĆ contributed to conceptualisation, methodology, data curation, formal analysis, investigation, project administration, visualisation, writing—original draft preparation, and writing—review & editing. WH, LA, CC, and SI contributed to the study design, data collection, and execution. GV, HJM, TSY, JCW, AJ, and ZB contributed to the supervision, critical revision of the manuscript, and provided expert input during drafting and final approval.

All authors reviewed and approved the final version of the manuscript.

Data availability Data generated during the study will be made available upon reasonable request to the authors.

Declarations

Competing interests The authors declare no competing interests.

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