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# Lumbar disc herniation: Prevention and treatment of recurrence: WFNS spine committee recommendations

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ABSTRACT

*Objective:* This review aims to formulate the most current evidence-based recommendations on the epidemiology, prevention, and treatment of recurrent lumbar disc herniation (LDH).

*Methods:* We performed a systematic literature search in PubMed, Medline, and Google Scholar databases from 2012 to 2022 using the keywords "lumbar disc recurrence." Screening criteria resulted in 57 papers, which were summarized and presented at two international consensus meetings of the World Federation of Neurosurgical Societies (WFNS) Spine Committee. The 57 papers covered the following topics: (1) Definition and incidence of recurrence after lumbar disc surgery; (2) Prediction of recurrence before primary surgery; (3) Prevention of recurrence by surgical measures; (4) Prevention of recurrence by postoperative measures; (5) Treatment options for recurrent disc herniation; (6) The outcomes of recurrent disc herniation surgery. We utilized the Delphi method and voted on eight final consensus statements.

*Results and conclusion:* Recurrence after disc herniation surgery may be considered a surgical complication, its incidence is approximately 5% and is different from overall re-operation incidence. There are multiple risk factors predicting LDH recurrence, including smoking, younger age, male gender, obesity, diabetes, disc degeneration, and presence of lumbosacral transitional vertebrae. The level of lumbar discectomy surgery and the amount of disc material removed do not correlate with recurrence rate. Minimally invasive discectomies may have higher recurrence rates, especially during the surgeon's learning period. However, the experience of the surgeon is not related to recurrence. High-quality studies are needed to determine if activity restriction, weight loss, smoking cessation, and muscle-strengthening exercises after primary surgery can help prevent recurrence of LDH.

The best treatment option for recurrent disc herniation is still being discussed. While complications of minimally invasive techniques may be lower than open discectomy, outcomes are similar. Fusion should only be considered when spinal instability and/or spinal deformity are present. Clinical outcomes and patient satisfaction after recurrent disc herniation surgery are inferior to those after initial discectomy.

## 1. Introduction

Recurrence after initial discectomy for lumbar disc herniation (LDH) occurs frequently and sometimes may even be considered inevitable. A better understanding of the risk factors for disc recurrence may allow us to develop preventative measures to reduce the incidence of recurrent LDH.

The goal of this review is to produce up-to-date, evidence-based recommendations from two international consensus meetings of the World Federation of Neurosurgical Societies (WFNS) Spine Committee on the risk factors for LDH recurrence, surgical and postoperative techniques to avoid recurrence after primary surgery, and the best management of LDH recurrence. Our recommendations are developed for practicing spine surgeons worldwide, with a particular emphasis on those in low and middle-income countries.

## 2. Methods

We performed a systematic literature search in PubMed, Medline,

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**Abbreviations**

| | |
|---|---|
| WFNS | World Federation of Neurosurgical Societies |
| MRI | Magnetic resonance imaging |
| CT | Computed tomography |
| PRISMA | Preferred Reporting Items for Systematic Reviews and Meta-Analyses |
| LDH | Lumbar disc herniation |
| DHI | Disc height index |
| ROM | Range of motion |

and Google Scholar databases from 2012 to 2022 using the keywords "lumbar disc recurrence." Pubmed had 1667 initial results, while Medline had 688 and Google scholar had 16,800 initial results. We applied standardized inclusion/exclusion criteria to narrow our search to 57 final papers. Inclusion criteria included papers in the English language with full text available, prospective, or retrospective clinical trials, meta-analyses, randomized controlled trials, and systematic reviews. Non-human studies and case reports with <50 patients were excluded. Fig. 1 shows our search methodology. Papers covered the following topics: (1) Definition and incidence of recurrence after lumbar disc surgery; (2) Prediction of recurrence before primary surgery; (3) Prevention of recurrence by surgical measures; (4) Prevention of recurrence by postoperative measures; (5) Treatment options for recurrent disc herniation; (6) The outcomes of recurrent disc herniation surgery.

We collected and organized these papers to answer the following questions.

1. What is the definition and incidence of LDH recurrence after lumbar disc surgery?
2. Can we predict recurrence before the initial surgery?
3. Can recurrence be prevented by surgical measures such as minimally invasive discectomy or open discectomy, aggressive discectomy, and/or ligament repair techniques?
4. Can recurrence be prevented by postoperative measures such as activity restriction, smoking cessation, weight loss, special exercises, and/or muscle strengthening?
5. What is the best treatment for recurrent disc herniation: open discectomy, microdiscectomy, endoscopic discectomy, or fusion?
6. Are recurrent disc herniation outcomes the same as primary disc surgery?

Table 1 contains a summary of the reviewed papers, divided into "Incidence of recurrence" (3 papers), "Prediction of recurrence" (15 papers), "Value of annular closure devices" (3 papers), "Comparison of surgical techniques" (23 papers), "Value of fusion surgery" (8 papers), and "Outcomes of recurrent disc surgery" (8 papers).

Search results were presented and discussed at two international consensus meetings, the first in Karachi, Pakistan, in May 2022, and the second in Istanbul, Turkey, in September 2022. Ten members of the World Federation of Neurosurgical Societies (WFNS) Spine Committee who are world experts in spine care discussed and voted anonymously on the statements.

We used the Delphi method to generate a consensus: participants graded each statement using a Likert-type scale from 1 to 5 (1 = strongly agree, 2 = agree, 3 = somewhat agree, 4 = disagree, 5 = strongly disagree). Results are presented as a percentage of respondents who scored each item as 1, 2, or 3 (agreement) or as 4 or 5 (disagreement). Positive or negative consensus was achieved when the sum for agreement or disagreement, respectively, was ≥66% (see Table 2).

## 3. Results and discussion

### 3.1. Definition and incidence of recurrence after lumbar disc surgery

The definition of a recurrent lumbar disc herniation is a new disc herniation at the index level and on the same side as the initial surgery. Although some papers accept contralateral disc herniation at the same level as recurrence, such a definition causes confusion. A retrospective study[1] of 5626 Japanese patients undergoing initial disc excision between 1988 and 2007 reported 205 LDH recurrences. Of these, only 101 cases (1.8%) were real LDH recurrences, in that they were at the same level and on the same side as the primary herniation.

Studies in literature report varying recurrence rates for LDH, from 0.5% up to 21%..[1–7] Same-side and same-level disk recurrences may vary from 3.8 to 7.4%.[1] A systematic review published in 2016 and including 30 studies reports a same-level, same-side LDH recurrene rate

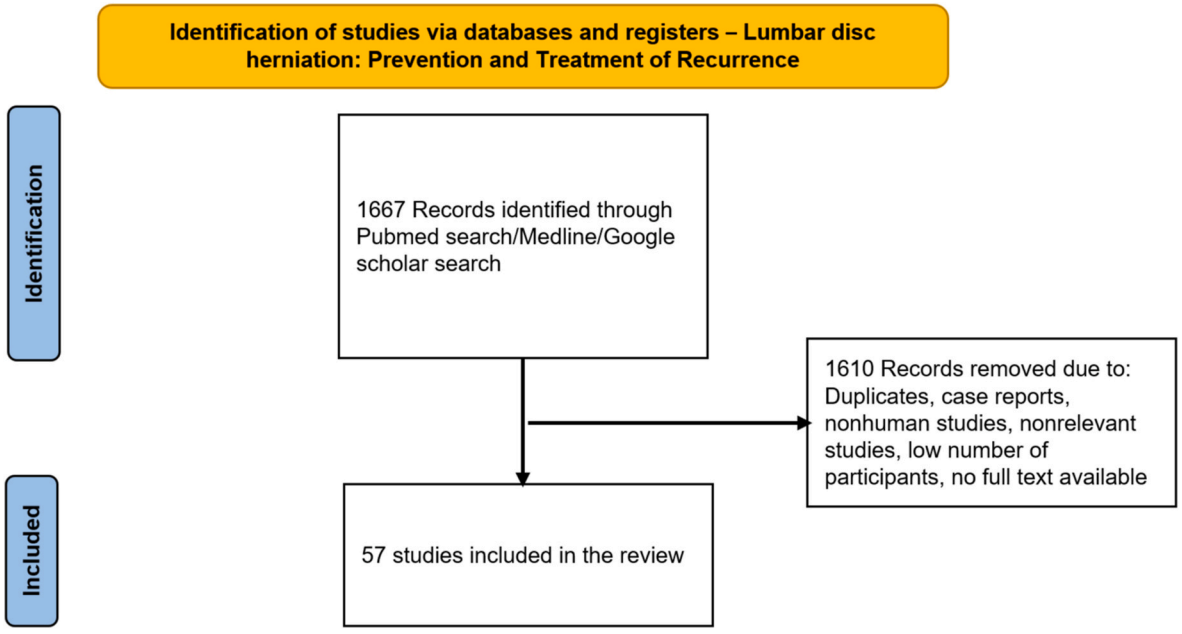


**Fig. 1.** Prisma Chart of the review process.

**Table 1**
List of analysed papers.

| No | Study | Type of Study | Evidence Level | Objective | Number of patients | Conclusions |
|---|---|---|---|---|---|---|
| Incidence of recurrence papersrowhead | | | | | | |
| 1 | Aizawa et al[1] 2012 | Retrospective | 3 | Epidemiology in Japan | 5626/192 reoperation | Reoperation rate of real recurrent herniations gradually increased from 0.5% at 1 year after primary surgery to 2.8% at 15.7 years. |
| 2 | Yoshihara et al[8] 2016 | Systematic review | 2 | Epidemiology trends and outcomes of revision surgery for real rLDH | 30 studies | The incidence of revision surgery, specifically for real-rLDH, lies between 1.4% and 11.4%. The complication rate is reported between 0% and 34.6%, with dural tear being the most common complication. |
| 3 | Fritzel et al[62] 2015 | Retrospective | 3 | Swedish Spine Registry Swespine | 13,562 patients/ 257 reoperation | First year recurrence 2%. Patients undergoing repeated surgery were less satisfied |
| **Prediction of recurrence papers**rowhead | | | | | | |
| 4 | Azimi et al[4] 2015 | Retrospective | 3 | Prediction of recurrence | 402/35 reoperation | Artificial Neural Network can be used to predict the diagnostic statues of recurrent disc herniation |
| 5 | Jia et al[16] 2021 | Retrospective | 3 | To develop and validate a nomogram useful in predicting rLDH. | 352 patients/32 recurrence | The course of disease, Pfirrmann grade, Modic change, migration grade are risk factors for recurrence. |
| 6 | Hao et al[15] 2020 | Retrospective | 3 | Relationship between Modic changes and rLDH | 102 patients | Recurrent lumbar disc herniation occurs when Modic changes or herniated cartilage are present. |
| 7 | Huang et al[12] 2016 | Metaanalysis | 2 | Risk factors for rLDH | 17 studies | smoking, disc protrusion, and diabetes are predictors for rLDH. |
| 8 | Kim et al[17] 2015 | Retrospective | 3 | Risk factors for recurrence of L5–S1 level. | 39 recurrences at L5-S1 | Moderate disk degeneration, a large sROM, a small L5 vertebral transverse process, and a low iliac crest height index are biomechanical risk factors of rLDH in L5–S1. Being male and having a large annular defect are also risk factors. |
| 9 | Shin et al[22] 2018 | Retrospective | 3 | To investigate risk factors for rLDH after discectomy including lumbosacral transitional vertebrae | 119 patients/21 (17.6%) recurrence | Lumbosacral transitional vertebrae and a hypermobile disc in flexion-extension radiography are risk factors for rLDH. |
| 10 | Siccoli et al[9] 2021 | Retrospective | 2 | To investigate risk factors for rLDH especially the effect of age on recurrence in a prospective registry | 3013 patients/ 166 (5.5%) reoperation | Younger patients do not have a higher reoperation probability. However, older patients tend to experience recurrent LDH significantly earlier after the index surgery. |
| 11 | Yao et al[26] 2016 | Retrospective | 3 | To search the risk factors of recurrence after MED | 111 patients | Age (≥50 years old), obesity (body mass index ≥25), the treatment period, modic change, nonmigrated herniation, and central herniation are potential risk factors for recurrence. |
| 12 | Yin et al[14] 2018 | Meta-Analysis | 2 | To search the epidemiological prevalence of recurrent herniation in patients following PELD and to analyze the potentially related risk factors. | 63 studies | PELD is associated with 3.6% recurrence rate. It usually occurred within 6 months postoperatively. Older age (≥50 years), obesity (BMI ≥25), upper lumbar disc and central disc herniation are risk factors for recurrence after PELD. Different surgical approaches (PETD or PEID), lateral discs, migrated discs and foraminoplasty did not affect the incidence. |
| 13 | Li et al[21] 2020 | Retrospective | 3 | To evaluate the association between facet joint parameters (facet orientation and facet tropism) and rLDH | 246 patients | With the decrease of facet orientation, the risk of rLDH increases continuously. Facet joint parameters may play a more important role in the pathogenesis of rLDH |
| 14 | Yaman et al[19] 2017 | Retrospective | 3 | To determine the risk factors for rLDH. | 126 patients | Risk factors for recurrence are higher disc height, higher body mass index, Modic changes. |
| 15 | Li et al[13] 2018 | Retrospective | 3 | To investigate the clinical features and the risk factors for rLDH in China. | 321 patients | Gender, age, current smoking, BMI, occupational lifting, trauma, surgical procedures, herniation type, disc height index, facet orientation, facet tropism, and sROM are risk factors for rLDH. |
| 16 | Yu et al[18] 2020 | Retrospective | 3 | To investigate the risk factors with the recurrence of L5–S1 disc herniation after PETD. | 484 patients | The recurrence of L5–S1 disc herniation following PETD was associated with increased age and BMI, more severe disc degeneration, increased sagittal range of motion, increased lumbar lordosis, and sacral slope. |

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**Table 1** (*continued*)

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| 17 | Chang et al[23] 2016 | Retrospective | 3 | To investigate the risk of recurrence of LDH in patients with scoliosis who underwent microdiscectomy. | 58 patients/6 (10.3%) reoperations | The recurrence rate is significantly higher among the scoliosis group than the nonscoliosis group (33.3% vs 2.3%). |
| 18 | Ellenbogen et al[33] 2014 | Retrospective | 3 | Surgeon grade and/or disc space lavage has an impact in reducing the re-operation rate | 971 patients/52 recurrence | Surgeon grade and intervertebral disc lavage have not been found conclusively to be factors in the rate of recurrence. There is a possible trend towards intervertebral disc lavage reducing the rate of recurrence |
| **Value of annular closure devices**rowhead | | | | | | |
| 19 | Choy et al[38] 2018 | Metaanalysis | 2 | Outcomes and complications of annular closure device for disc herniation. | 4 trials | Use of Barricaid and Anulex devices are beneficial for short term outcomes to reduce symptomatic disc reherniation |
| 20 | van den Brink et al[36] 2019 | Randomized multicenter trial | 1 | Is implantation of a bone-anchored annular closure device following lumbar discectomy reducing the risk of recurrent herniation. | 554 patients | Among patients with large annular defects following limited lumbar discectomy, additional implantation with a bone anchored device lowered the risk of symptomatic reherniation and reoperation over 1 year follow-up. Serious adverse events occurred less frequently in the ACD group |
| 21 | Ledic et al[37] 2015 | Prospective single-arm studies | 2 | To assess the benefits of disk reherniation reduction and disk height maintenance in limited discectomy combined with the implantation of the annular closure device. | 75 patients | Limited lumbar diskectomy combined with the use of an annular closure device provided very low rates of disk reherniation and exhibited excellent disk height maintenance |
| **Comparison of surgical techniques for recurrent disc herniation**rowhead | | | | | | |
| 22 | Chang et al[24] 2014 | Metaanalysis | 2 | Comparison of minimally invasive discectomy with standard discectomy | 16 trials/2139 patients | 7 studies reported a higher recurrence with minimally invasive discectomy. |
| 23 | Göker and Aydın,[65] 2020 | Retrospective | 3 | Is full endoscopic interlaminar discectomy efficient for recurrent disc herniation | 60 patients | Full endoscopic technique can be used safely for recurrent disc herniations |
| 24 | Hubbe et al[66] 2016 | Retrospective | 3 | Efficacy of minimally invasive tubular microdiscectomy for the treatment of rLDH. | 30 patients | clinical outcome of minimally invasive tubular microdiscectomy is comparable to the reported success rates of other minimally invasive techniques. |
| 25 | Joswig et al[67] 2015 | Retrospective | 3 | Complications, recurrence Rates, and outcomes of interlaminar full-endoscopic diskectomy | 76 patients/19 (28%) recurrence | The rate of conversions (10%), complications (5%), and recurrent lumbar disk herniations (28%) did not negatively affect the long-term outcomes. |
| 26 | Kim et al[68] 2014 | Retrospective | 4 | Surgical outcomes of percutaneous endoscopic discectomy for rLDH. | 26 patients | Good results, no risk factors |
| 27 | Lee et al[46] 2018 | Retrospective | 3 | Comparison of transforaminal percutaneous endoscopic lumbar diskectomy (PELD) with open lumbar microdiscectomy (OLM) for rLDH. | 83 patients | Both have favorable clinical outcomes. PELD results in fewer complications compared with OLM |
| 28 | Onyia and Menon[43] 2017 | Systematic review | 2 | To find out available operative options, and which intervention gives better outcomes | 10 studies | Minimally invasive techniques for revision of recurrent disc herniation do not really appear to be superior to the conventional open surgical approaches. Fusion should not be undertaken in all recurrences but should only be considered as an option for revision when spinal instability, spinal deformity or associated radiculopathy is present. |
| 29 | Selva-Sevilla et al[59] 2019 | Retrospective | 3 | Cost-utility analysis, comparing conservative treatment, discectomy, and discectomy with fusion for patients with rLDH. | 50 patients | Conservative treatment is more cost-effective than discectomy alone, or discectomy and fusion. |
| 30 | Staartjes et al[35] 2017 | Retrospective | 3 | Incidence of recurrence after tubular microdiscectomy for LDH and analysis of learning curve progression | 1241 patients/56 (4.5%) reoperation | A decrease in surgical time and recurrent herniations were observed over time of experience. |
| 31 | Nomura et al[42] 2014 | Retrospective | 3 | Microendoscopically assisted transosseous discectomy for rLDH | 57 patients | Transosseous discectomy is a safe and effective surgical approach for rLDH. The outcomes and complications are similar to MED. |
| 32 | Cheng et al[25] 2013 | Retrospective | 3 | To compare the causes and characteristics of reoperations after different primary operations for LDH. | 207 patients | Real *c* is the most common cause of reoperations, and more reoperations for real rLDH and shorter intervals were found after minimally invasive endoscopic discectomy than after open disc surgery. |
| 33 | Kang et al[47] 2020 | Retrospective | 3 | To compare the outcomes of open microscopic discectomy and biportal endoscopic discectomy. | 36 patients | Biportal endoscopic discectomy had similar outcomes to open discectomy at 1 year after surgery. However, faster pain relief, earlier functional recovery, and better patient satisfaction were observed |

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**Table 1** (*continued*)

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| | | | | | | when applying biportal endoscopic discectomy. |
| 34 | Li et al[48] 2016 | Systematic review | 2 | To identify the effectiveness of percutaneous endoscopic lumbar discectomy in the treatment of rLDH. | 8 studies/579 patients | PELD is an effective procedure for the treatment of rLDH in terms of reducing complication and shorting hospital course, comparing with open discectomy. |
| 35 | Park et al[69] 2019 | Retrospective | 3 | To identify factors causing early recurrence after transforaminal endoscopic discectomy. | 1900 patients/ 209 recurrences (11.0%) | In patients undergoing TELD procedures, smaller-sized herniated discs are linked to early recurrences. |
| 36 | Qin et al[44] 2018 | Meta-analysis | 2 | To compare the clinical efficacy between percutaneous endoscopic lumbar discectomy vs posterior open lumbar microdiscectomy | 9 studies/1585 patients | No significant difference existed in outcomes between the 2 surgical procedures. They were similar in terms of operation time, complication rate, and incidence of recurrence and reoperation. But PELD showed shorter hospital stay and time of return to work. |
| 37 | Ran et al[28] 2015 | Metaanalysis | 2 | To compare the reherniation rate and clinical outcomes between discectomy and sequestrectomy | 12 studies | By contrast to discectomy, sequestrectomy was associated with significantly less operative time, lower visual analogue scale for low back pain, less post-operative analgesic usage and better patients' satisfaction. Recurrent herniation rate, reoperation rate, intraoperative blood loss, hospitalization duration and VAS for sciatica were without significant difference. |
| 38 | Reito et al[70] 2020 | Retrospective | 4 | To investigate the 30-day recurrence rate after emergency lumbar discectomy | 130 patients/6 recurrence | An emergency discectomy is associated with a higher rate than expected of both recurrent LDHs and 30-day readmissions. |
| 39 | Shamji et al[30] 2014 | Retrospective | 3 | To compare sequestrectomy or conventional discectomy | 172 patients | No clinical advantage was found to performing a limited sequestrectomy instead of conventional microdiscectomy for the treatment of radiculopathy owing to lumbar disk herniation. The incidence of rLDH requiring revision surgery was lower in patients treated by more aggressive disc removal. |
| 40 | Shi et al[45] 2019 | Meta-analysis | 2 | To compare the outcomes of percutaneous endoscopic lumbar discectomy (PELD) and microendoscopic discectomy (MED) for rLDH. | 18 studies/2161 patients | For the treatment of LDH, both of PELD and MED can reach excellent results. Duration of operation, ODI, VAS-leg pain, VAS-unspecified, excellent & good rate, total complication rate, dural tear rate, and residue or recurrence rate are similar. MED showed certain advantages of less fluoroscopic times and lower reoperation rate. |
| 41 | Soliman et al[29] 2014 | Retrospective | 3 | The long-term results (7 years) of limited discectomy, or fragmentectomy, for lumbar disk herniation using a minimally invasive technique. | 152 patients | Removal of the fragment only is an effective way to treat lumbar disk herniation. |
| 42 | Yüce et al[71] 2019 | Retrospective | 3 | To evaluate the efficacy of lumbar microdiscectomy technique with preserving of ligamentum flavum (LF) for recurrent lumbar disc surgery. | 149 patients | Preserving of ligamentum flavum decreases complication, operation time, surgical hemorrhage and provides good surgical outcomes in recurrent lumbar disc surgery. |
| 43 | Mroz et al[58] 2014 | Survey | 4 | To assess the surgical treatment patterns among neurologic and orthopedic spine surgeons in USA for the treatment of rLDH. | 445 surgeons | Significant differences exist among US spine surgeons in the surgical treatment of rLDH. |
| **Value of fusion surgery for recurrent disc herniation**rowhead | | | | | | |
| 44 | Dower et al[54] 2015 | Systematic review | 2 | Role of fusion surgery | 37 studies/1483 patients | No evidence to recommend the routine addition of fusion. Minimally invasive discectomy has lower complication rates than conventional discectomy. |
| 45 | Lequin et al[55] 2014 | Retrospective | 3 | To report the results of stand-alone trabecular metal cages in rLDH. | 26 patients | Although only 46% of patients reported a good recovery with significant reductions in back and leg pain, 85% of patients reported at least some benefit from the operation |
| 46 | Ye et al[57] 2019 | United States Nationwide Inpatient Sample | 2 | To search the outcomes of interbody fusion surgery for rLDH | 2625 patients | Patients who received LLIF and PLIF/TLIF approaches had significantly lower risk of digestive system complications compared to those receiving ALIF. However, LIF approaches do not correlate significantly with the risk of postoperative bleeding or nervous system complications. |
| 47 | Yao et al[72] 2017 | Retrospective | 3 | To compare minimally invasive transforaminal lumbar interbody fusion | 74 patients | None of the three surgical approaches exhibited clear advantages in long-term |

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**Table 1** (*continued*)

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| | | | | (MIS-TLIF), microendoscopic discectomy (MED), and PELD in rLDH. | | pain or functional scores. MED and PELD were associated with lower costs and better perioperative effects than MIS-TLIF. However, compared with MIS-TLIF, the higher recurrence rates of MED and PELD should not be ignored. |
| 48 | O'Donnell et al[60] 2016 | Retrospective | 3 | To search outcomes after reoperation discectomy with or without fusion surgery for rLDH in the workers' compensation population. | 10,592 patients received work compensation/ 102 recurrence | Workers' compensation patients receiving revision discectomy with fusion had lower return to work rates, higher costs, and a longer duration of postoperative opioid use than those receiving revision discectomy alone. |
| 49 | Niesche et al[73] 2014 | Retrospective | 3 | To search if minimally invasive TLIF is a reliable surgical treatment option in rLDH. | 33 patients | Percutaneous minimally invasive TLIF is a tissue protecting and safe alternative procedure for lumbar fusion in patients with rLDH. |
| 50 | Li et al[74] 2015 | Retrospective | 3 | To report the outcomes of transforaminal lumbar interbody fusion (TLIF) for recurrent lumbar disc herniation (rLDH) | 73 patients | TLIF can be considered an effective, reliable, and safe alternative procedure for the treatment of rLDH. |
| 51 | Sönmez et al[52] 2013 | Retrospective | 3 | To compare the results of unilateral vs bilateral percutaneous pedicle screw instrumentation with MIS TLIF | 20 patients | Unilateral fixation with TLIF is useful for rLDH. |
| 52 | Mamuti et al[56] 2016 | Retrospective | 3 | To evaluate efficacy of mini-open retroperitoneal anterior lumbar discectomy and ALIF for rLDH following posterior instrumentation. | 35 patients | Mini-open retroperitoneal anterior lumbar interbody fusion is an effective treatment for patients with rLDH following primary posterior instrumentation. |
| **Outcomes of recurrent disc surgery**rowhead | | | | | | |
| 53 | Buchmann et al[61] 2016 | Retrospective | 3 | Outcomes of recurrence surgery | 64 reoperation | Recurrent lumbar disc herniation surgery has less-promising outcomes. |
| 54 | Nolte et al[63] 2019 | Retrospective | 3 | Comparison of outcomes of revision surgeries and primary surgeries for LDH. | 110 patients/ 38 recurrence | Patients undergoing revision microdiskectomy are likely to experience worse postoperative symptoms and disability |
| 55 | Kovačević et al[27] 2017 | Retrospective | 3 | Differences in clinical outcomes and recurrence rates of standard discectomy vs microdiscectomy | 167 patients/ 12 reoperation | Microdiscectomy has significantly lower recurrence rates than standard discectomy (SD 6.3% *vs*. MD 3.2%). |
| 56 | Ahsan et al[2] 2012 | Retrospective | 3 | To search the outcomes of discectomy for primary or recurrent LDH | 416 patients/ 28 reoperation | Discectomy achieved satisfactory results for both primary and recurrent LDHs. |
| 57 | Patel et al[64] 2013 | Retrospective | 3 | To compare the outcome of revision lumbar discectomy with that of primary discectomy | 546 patients/ 36 reoperation | Revision discectomy can give results that are as good as those seen after primary surgery |

between 1.4 and 11.4%.[8]

The overall re-operation rate, however, is different from recurrence rate, and varies from 5.2 to 19% in the literature, increasing with more years of follow-up. One year after surgery, the reoperation rate is 0.5%, while it increases to 2.8% at 15 years after surgery.[1,8]

### 3.2. Risk factors associated with LDH recurrence

One study suggests that male patients and younger patients are at higher risk of LDH recurrence.[1] However, in a prospective study of 3013 patients, the authors found no effect of patient age on LDH recurrence.[9] They found an overall 5.5% re-operation rate for disc recurrence, with earlier re-operations in older adults.[9]

Other factors such as obesity and smoking have also been suspected to be associated with LDH recurrence.

Although some studies report that high body mass index (BMI) increases the risk of recurrence,[10] other studies suggest that BMI is not associated with LDH recurrence.[11]

In a meta-analysis of 17 studies, the only risk factors that were significantly associated with recurrent LDH were smoking, disc protrusion (as opposed to disc extrusion or sequestration), and diabetes.[12] There was no association with gender, BMI, occupational work, level, or side of herniation.[12] A retrospective analysis of 321 Chinese patients found that gender, age, current smoking, BMI, occupational lifting, trauma, surgical procedures, herniation type, disc height index, facet orientation, facet tropism, and sagittal range of motion (sROM) were all risk factors for increased LDH recurrence.[13]

In a meta-analysis of 63 studies, Yin et al reported that LDH recurrence after percutaneous endoscopic lumbar discectomy (PELD) was 3.6% and usually within 6 months of initial surgery.[14] Older age (≥50 years), obesity (BMI ≥25), upper lumbar disc, and central disc herniation are risk factors for recurrence after PELD. Different surgical approaches, lateral discs, migrated discs and foraminoplasty did not affect the incidence of LDH recurrence.[14]

### 3.3. Disc degeneration

A retrospective study of 102 patients with 2-year follow-up revealed that recurrent disc herniation was more common in patients with Modic end-plate changes.[15] More LDH recurrences were also seen when the herniated disc component was hyaline cartilage, as compared to nucleus pulposus.[15] Another study of 352 lumbar disc herniation patients confirmed that Modic end-plate changes, as well as Pfirrmann disc degeneration grading, disease course, and migration grade were associated with LDH recurrence risk.[16]

A retrospective study of 467 patients with L5-S1 disc herniations reported that moderate disc degeneration and disc height are risk factors for recurrent lumbar disc herniation.[17] Male gender, large annular defect, large sROM, small L5 vertebral transverse process, and low iliac crest height index are also associated with higher rates of LDH recurrence. Additional studies support that age, BMI, more severe disc degeneration, increased sagittal range of motion, higher lumbar lordosis, and sacral slope are associated with increased LDH recurrence after endoscopic discectomy.[18,19] Increased disc height index, ROM, and facet joint parameters/orientation are also associated with LDH recurrence.[20,21]

**Table 2**
Statements voted after "Lumbar disc herniation: Prevention and Treatment of Recurrence" statements.

| Statement | Likert type scale | No of respondents |
|---|---|---|
| 1-Recurrent lumbar disc herniation is a new disc herniation at the same index level and side. Recurrence incidence is around 5% (0.5% and 21%). Reoperations after disc surgery may be from contralateral disc herniation or another level of herniation. Reoperation incidence is between 5.2 and 19% | 1. Strongly agree<br>2. Agree<br>3. Somewhat agree<br>4. Disagree<br>5. Strongly disagree | 5 (55.6%)<br>3 (33.3%)<br>1 (11.1%) |
| 2-Smoking, younger age, male gender, obesity, diabetes, the persistence of weightlifting after the first surgery, Modic changes, Pfirrmann grade, migration grade, large segmental ROM, presence of lumbosacral transitional vertebrae may be factors to predict recurrence of disc herniation. | 1. Strongly agree<br>2. Agree<br>3. Somewhat agree<br>4. Disagree<br>5. Strongly disagree | 7 (77.8%)<br>2 (22.2%) |
| 3-Minimally invasive discectomies (endoscopic etc.) may have higher recurrence rates. The level of lumbar microdiscectomy surgery and the amount of disc material removed has no correlation with the rate of recurrence. There is a trend toward intervertebral disc lavage reducing the rate of recurrence. | 1. Strongly agree<br>2. Agree<br>3. Somewhat agree<br>4. Disagree<br>5. Strongly disagree | 5 (55.6%)<br>3 (33.3%)<br>1 (11.1%) |
| 4-There is no linear relationship between the experience of the surgeon and the rate of reoperation. However, more recurrent herniations can be observed during the learning period for endoscopic and tube-guided surgeries. | 1. Strongly agree<br>2. Agree<br>3. Somewhat agree<br>4. Disagree<br>5. Strongly disagree | 4 (44.4%)<br>2 (22.2%)<br>3 (33.3%) |
| 5-Among patients with large annular defects following lumbar discectomy, additional implantation of annular repair devices may lower the risk of recurrence in 1 and-2-year follow-up. However, the long-term results are not well known. | 1. Strongly agree<br>2. Agree<br>3. Somewhat agree<br>4. Disagree<br>5. Strongly disagree | 2 (22.2%)<br>6 (66.7%)<br>1 (11.1%) |
| 6-There is no evidence to conclude that recurrence can be prevented by activity restriction, weight loss, smoking cessation, and muscle-strengthening exercises. | 1. Strongly agree<br>2. Agree<br>3. Somewhat agree<br>4. Disagree<br>5. Strongly disagree | 6 (66.7%)<br>2 (22.2%)<br>1 (11.1%) |
| 7-There is no good evidence to decide the best treatment option for recurrent disc herniation. Although back pain responds more to discectomy and fusion, the routine addition of fusion surgery for recurrent lumbar disc herniation is not recommended. Fusion should only be considered an option when spinal instability, spinal deformity, or associated radiculopathy is present. Although complications are less with microdiscectomy than with open discectomy, the outcomes are similar. Therefore, when we compare the costs of treatment options, conservative treatment is more cost-effective, followed by discectomy and then discectomy and fusion. | 1. Strongly agree<br>2. Agree<br>3. Somewhat agree<br>4. Disagree<br>5. Strongly disagree | 7 (77.8%)<br>2 (22.2%) |
| 8-Clinical outcomes after surgical therapy of recurrent disc herniations are inferior to initial surgery. Patient satisfaction after primary discectomy has been found to be 79%, and after recurrent discectomy, 58%. | 1. Strongly agree<br>2. Agree<br>3. Somewhat agree<br>4. Disagree<br>5. Strongly disagree | 7 (77.8%)<br>2 (22.2%) |

### 3.4. Lumbosacral transitional vertebrae and scoliosis

A retrospective study of 119 patients undergoing L4-5 discectomy with a minimum follow-up of 2 years reported a 17.6% recurrence rate, at an average time of 17.6 ± 21.1 months.[22] 52.4% of patients with recurrence had lumbosacral transitional vertebrae, whereas only 7.1% of patients without recurrence had transitional anatomy, suggesting that lumbosacral transitional anatomy is associated with increased rate of LDH recurrence. Patients with scoliosis also appear to be at higher risk of LDH recurrence, with a retrospective review of 58 patients showing 33.3% LDH recurrence rate in scoliosis patients, as compared to a 2.5% recurrence rate in the non-scoliosis group.[23]

### 3.5. Surgical techniques to prevent LDH recurrence

There is continued debate regarding whether surgical techniques, including minimally invasive versus open discectomy approaches, aggressive diskectomy versus sequestrectomy, and/or annular repair techniques affect the rate of LDH recurrence.

### 3.6. Surgical approach

A meta-analysis of 16 trials and 2139 patients reported that minimally invasive diskectomies (including endoscopic approaches) have higher recurrence rates than open surgery.[24] Another study by Cheng et al involving 207 patients has also shown more reoperations for LDH recurrences and at shorter intervals after minimally invasive endoscopic discectomy as compared to open discectomy.[25] Yao et al have reported similar results with microendoscopic discectomy (MED).[26] However, a study by Kovačević et al.[27] found significantly lower recurrence rates with microdiscectomy (3.2%) than open discectomy (6.3%).

In a meta-analysis of 12 studies, sequestrectomy was associated with significantly less operative time, lower visual analogue scale for low back pain, less post-operative analgesic usage, and better patient satisfaction, as compared to aggressive discectomy.[28] Recurrent herniation rate, reoperation rate, intraoperative blood loss, length of hospital stays, and leg pain visual analogue scale (VAS) were similar between the two groups.[28] While positive results were also reported by Soliman et al for sequestrectomy,[29] another retrospective study found no clinical advantage of limited sequestrectomy as compared to conventional microdiscectomy.[30] The incidence of LDH recurrence in this study was higher in patients treated with sequestrectomy, as compared to more aggressive disc removal.[30] Another study showed that the amount of disc material removed does not correlate with LDH recurrence rate.[31] Level of lumbar discectomy surgery also does not appear to affect recurrence rate.[32]

In a retrospective review microdiscectomy of 971 patients, Ellenbogen et al.[33] reported statistically insignificant decrease in LDH recurrence after intra-operative lavage of the disc space. Despite the lack of statistical significance, the authors recommend disc space lavage as a routine part of lumbar microdiscectomy surgery.

### 3.7. Surgeon experience

One study found that the risk of LDH reoperation was 1.2-fold higher in patients operated on by junior surgeons, as compared to consultants, although this difference was not statistically significant.[33] Another study on the learning curve progression in minimally invasive surgery found a statistically significant decrease in surgical time and recurrent LDH herniations over time for the same surgeon.[35] A different report, however, showed no linear relationship between the surgeon's experience and LDH reoperation rate.[34]

### 3.8. Annular repair devices

A handful of annular closure devices, including Barricaid (Intrinsic

Therapeutics)[36,37] and Anulex-Xclose (Anulex Technologies, Inc),[38] have been developed to obstruct annular defects and prevent LDH herniation. An industry-sponsored randomized multicenter trial reported lower risk of symptomatic re-herniation at 1 year follow-up after placement of the Barricaid device.[38] This device can only be placed if the post-annular defect is between 4 and 6 mm tall and 6–10 mm wide. A meta-analysis including four studies has shown that annular closure devices like Barricaid reduce symptomatic disc re-herniation in the short-term.[38] High-quality studies with long-term outcomes are still needed to prove the efficacy of annular closure devices, which are relatively limited in use today.

### 3.9. Post-operative measures to prevent LDH recurrence

As discussed in the prior section, several patient factors including smoking, high BMI, and inactivity are associated with LDH recurrence. Kara et al reported that lack of regular physical exercise significantly predicted recurrent LDH.[39] However, there is insufficient data in the literature to determine whether activity restriction, smoking cessation, weight loss, and/or special exercises to strength specific muscles can help prevent LDH recurrence.

### 3.10. Treatment options for LDH recurrence

There is still discussion regarding the best treatment option for recurrent disc herniations, with the two main options being discectomy alone (either minimally invasive or open) versus discectomy with fusion.

### 3.11. Minimally invasive vs open discectomy

The presence of scar tissue increases the difficulty of repeat discectomy, which increases the risk of a dural tear or nerve injury.[40,41] To avoid exposing the scar tissue, a transosseous discectomy can be performed and has similar outcomes and complications in comparison to microendoscopic diskectomy.[42] A systematic literature review published in 2017 shows similar outcomes with minimally invasive versus conventional open techniques for recurrent disc herniations.[43] Another meta-analysis of 9 studies and 1585 patients shows similar operation time, complication rates, recurrence, and re-operation rates for percutaneous endoscopic lumbar discectomy (PELD) versus posterior open lumbar discectomy.[44] However, PELD had shorter hospital stay and faster return to work. An even larger meta-analysis from 2019 including 18 studies and 2161 patients found good results for both PELD and microendoscopic discectomy (MED), using a microscope through a tubular system.[45] However, MED had less fluoroscopy time and lower reoperation rate than PELD. Another study found fewer complications with PELD as compared to lumbar microdisectomy.[46] Biportal endoscopic discectomy also appears to be associated with faster pain relief, earlier functional recovery, and better patient satisfaction in some studies.[47] A systematic review of 8 studies and 579 patients reported[48] reported that PELD is an effective procedure for the treatment of recurrent LDH in terms of reducing complications and shortening hospital course as compared to open discectomy.

### 3.12. Discectomy versus fusion

There is considerable debate regarding whether fusion, which is a longer surgery with more complications and higher cost, is better than simple repeat discectomy for treating recurrent disc herniations. Earlier studies more than 10 years have also mentioned discectomy alone instead of fusion has been the most frequently applied technique for recurrent LDH.[49–51]

In a retrospective study comparing minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) to microendoscopic discectomy (MED) and PELD in recurrent LDH, there were no clear advantages in long-term pain or functional scores.[52] MED and PELD were associated with lower cost and faster post-operative recovery than minimally invasive transforaminal interbody fusion (MIS-TLIF), but they had higher LDH recurrence rates.[53] In a systematic review of 37 studies and 1483 patients, back pain, and Japanese Orthopedic Association (JOA) scores improved more significantly with fusion than with discectomy alone. There were no disc recurrences after fusion surgery, but overall surgical complication rates were higher with fusion.[54]

Other fusion options besides transforaminal interbody fusion (TLIF) for treating disc recurrences include posterior lumbar interbody fusion using stand-alone trabecular metal cages without fixation hardware,[55] mini-open anterior lumbar interbody fusion (ALIF) followed by posterior instrumentation,[56] or lateral lumbar interbody fusion (LLIF). A Nationwide Inpatient Sample analysis of 2625 U S patients with recurrent LDH showed higher complication rates for ALIF as compared to LLIF or TLIF/PLIF.[57]

In an electronic survey of 445 orthopedic and neurosurgeons in the US, surgeons with fewer years in practice were more likely to perform discectomy with PLIF/TLIF, as were those performing fewer surgeries per year.[58] No significant differences were identified in surgical approach by region, specialty (orthopedics versus neurosurgery), fellowship training, or practice type.

Cost-utility analysis of discectomy versus discectomy with fusion has shown that discectomy is more cost-effective.[59] Another study with worker's compensation patients showed lower return to work rates, higher cost, and longer duration of post-operative opioid use with fusion, as compared to discectomy alone.[60]

Although back pain responds more to discectomy with fusion, the routine addition of fusion surgery for recurrent lumbar disc herniation is not recommended. Fusion should only be considered when spinal instability, spinal deformity, and/or associated radiculopathy is present. Therefore, when we compare the costs of treatment options, conservative treatment is more cost-effective, followed by discectomy, and then discectomy and fusion. We propose the following treatment algorithm for treatment of recurrent LDH (Fig. 2).

Although the description of degenerative Instability is not well defined, some of the radiologic instability criteria are angulation or translation during flexion-extension films, Modic changes and facet degeneration on MR images. Spinal deformity can be defined as loss or lordosis or kyphosis of the lumbar spine on standing lateral films, significant shift of sagittal vertical axis (SVA) on whole spine lateral radiograms, or degenerative scoliosis on anteroposterior radiograms.

### 3.13. Outcomes of LDH recurrence surgery

Most studies suggest that clinical outcomes after surgical therapy of recurrent disc herniations are inferior to those after initial surgery.[61] While one small retrospective analysis of 30 patients found similarly good results after revision discectomy as compared to initial discectomy,[43] a large analysis of 13,562 patients who underwent lumbar discectomy in the Swedish National Spine Register[62] found a 79% patient satisfaction rate in initial discectomy versus 58% patient satisfaction rate in revision diskectomy. In another study, recurrent discectomy patients had worse postoperative VAS-back, VAS-leg, Oswestry Disability Index scores, and patient satisfaction.[63] Moreover, the complication rate of recurrent disc herniation surgery is reported to be between 0% and 34.6%, with dural tear being the most common complication.[64]

### 3.14. WFNS spine committee recommendations

Taking this literature in summary, and via the two rounds of voting outlined in our methods section, the WFNS Spine Committee formulated the following eight consensus statements.

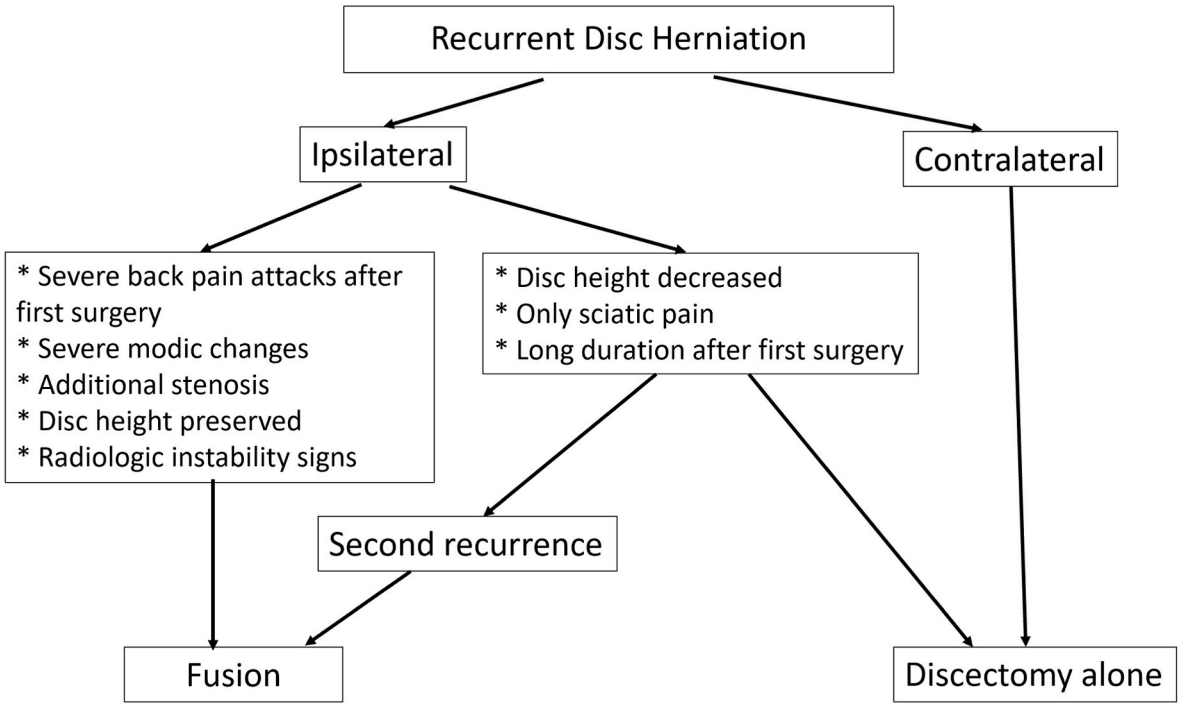


**Fig. 2.** WFNS Spine Committee Suggested Algorithm for the treatment of recurrent lumbar disc herniation.

1 -Recurrent lumbar disc herniation is a new disc herniation at the same index level and side. Recurrence incidence is around 5% (0.5% and 21%).

Reoperations after disc surgery may be from contralateral disc herniation or another level of herniation. Reoperation incidence is between 5.2 and 19%

2 -Smoking, younger age, male gender, obesity, diabetes, the persistence of weightlifting after the first surgery, Modic changes, Pfirrmann grade, migration grade, large segmental ROM, presence of lumbosacral transitional vertebrae may be factors to predict recurrence of disc herniation.

3 -Minimally invasive discectomies (endoscopic etc.) may have higher recurrence rates. The level of lumbar discectomy surgery and the amount of disc material removed has no correlation with the rate of recurrence. There is a trend toward intervertebral disc lavage reducing the rate of recurrence.

4 -There is no linear relationship between the experience of the surgeon and the rate of reoperation. However, more recurrent herniations can be observed during the learning period for endoscopic and tube-guided surgeries.

5 -Among patients with large annular defects following lumbar discectomy, additional implantation of annular repair devices may lower the risk of recurrence in 1 and-2-year follow-up. However, the long-term results are not well known.

6 -There is no evidence to conclude that recurrence can be prevented by activity restriction, weight loss, smoking cessation, and muscle-strengthening exercises.

7 -There is no good evidence to decide the best treatment option for recurrent disc herniation. Although back pain responds more to discectomy and fusion, the routine addition of fusion surgery for recurrent lumbar disc herniation is not recommended. Fusion should only be considered an option when spinal instability, spinal deformity, or associated radiculopathy is present. Although complications are less with microdiscectomy than with open discectomy, the outcomes are similar. Therefore, when we compare the costs of treatment options, conservative treatment is more cost-effective, followed by discectomy and then discectomy and fusion.

8 -Clinical outcomes after surgical therapy of recurrent disc herniations are inferior to initial surgery. Patient satisfaction after primary discectomy has been found to be 79%, and after recurrent discectomy, 58%.

## 4. Conclusion

In this manuscript, we summarize the latest evidence on the epidemiology, prevention, risk factors, and treatment of lumbar disc herniation recurrence. The incidence of recurrence after disc herniation surgery is approximately 5%. Disc recurrence is defined as a new disc herniation at the same level and same side as the initial disc herniation. Multiple risk factors predict recurrence, including smoking, younger age, male gender, obesity, diabetes, disc degeneration, and presence of lumbosacral transitional vertebrae. The level of lumbar discectomy surgery and the amount of disc material removed do not correlate with recurrence rate. Minimally invasive discectomies may have higher recurrence rates, especially during the surgeon's learning period. However, the experience of the surgeon is not related to recurrence. High-quality studies are needed to determine if activity restriction, weight loss, smoking cessation, and muscle-strengthening exercises after primary surgery can help prevent recurrence of LDH.

The best treatment option for recurrent disc herniation is still being discussed. While complications of minimally invasive techniques may be lower than open discectomy, outcomes are similar. Fusion should only be considered when spinal instability and/or spinal deformity are present. Clinical outcomes and patient satisfaction after recurrent disc herniation surgery are inferior to those after initial discectomy.

## Ethics approval and consent to participate

Not applicable.

## Availability of data and materials

The raw data supporting the conclusions of this manuscript will be made available by the authors, without undue reservation, to any qualified researcher.

## CRediT authorship contribution statement

**Mehmet Zileli:** Writing – review & editing, Data curation, Conceptualization. **Joachim Oertel:** Writing – review & editing, Data curation, Conceptualization. **Salman Sharif:** Writing – review & editing, Data curation, Conceptualization. **Corinna Zygourakis:** Writing – review & editing.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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