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ახალგაზრდა მკვლევარები

Vol. 4 Issue 2, 2026

https://doi.org/10.52340/jr.2026.04.02.12

Spinal Endoscopy for Decompression Combined with Lateral Lumbar Interbody Fusion

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Abstract

Lateral procedures are becoming more popular in the treatment of lumbar degenerative disease because of the decreased soft tissue disruption, morbidity and recovery times as compared to open surgery. Lateral lumbar interbody fusion (LLIF) and oblique lumbar interbody fusion (OLIF) are effective indirect decompression techniques, but with severe stenosis and approach-specific limitations, there may be continued neural compression that necessitates adjunctive endoscopic decompression. The purpose of this narrative review was to provide an overview about the clinical rationale, current applications, limitations, and future directions of the combination of endoscopic neural decompression and LLIF/OLIF. A systematic review was conducted in PubMed/MEDLINE, Embase, Scopus, Web of Science, Cochrane Library and Google Scholar databases from the year 2016 to 2026. The literature was reviewed to perform a comprehensive analysis of the efficacy and complications of combined LLIF and combined OLIF in adult clinical use, indications, and available evidence. There are studies available

indicating that adjunctive endoscopic decompression of any residual compression – either central or foraminal – can be helpful that may not be sufficiently corrected by indirect decompression alone. These reported advantages are reduction in pain, improvement in functional outcomes, improvement in radiological parameters and preservation of paraspinal musculature. But there are some methodological flaws that limit the current evidence; for example, few studies have been conducted on small populations, with varying methods, and designs that are retrospective, and there is no randomized controlled study that compares combined procedures with usual surgical alternatives. Patient selection is important, especially for patients with serious stenosis who may not benefit from indirect decompression. In summary, combined endoscopic decompression via LLIF/OLIF is a promising MIS approach in the carefully selected patient with LDH. Continued prospective multicenter studies with consistent outcomes, longer follow-up, cost-effectiveness analyses and evaluation of learning curves should be performed to define long-term safety, durability and best indications.

Keywords: spinal endoscopy, lumbar degenerative diseases, lateral lumbar interbody fusion, robot-assisted, minimally invasive.

Background

Many traditional and conventional techniques have been introduced for lumbar degenerative diseases [1]. Currently latest minimally invasive techniques are preferred mostly in practice because they offer lower morbidity rates compared with traditional techniques and lead to visibly improved patient symptoms. Traditional open surgeries are still in practice but have their own challenges like high morbidity rates and longer recovery times (VM1.1). Many studies have been conducted to study on different approaches of lumbar interbody fusions such as posterior, anterior and oblique approaches. While these techniques are being efficacious, combined with an endoscopic approach have further advantages and benefits, having a positive outcome [2]. Endoscopy surgeries have found their place of importance in today's clinical practice as it has advanced in both technology and surgical indications mainly in spinal decompression surgeries, lumbar fusion and other degenerative diseases [2].

The primary reason for its significance is the opportunity to perform the surgery at the same time minimizing the damage to surrounding nerves and tissues. Robotic-assisted endoscopic lumbar decompression fusions have shown to be a highly successful technique with satisfactory patient outcomes, particularly in cases of lumbar decompression with interbody fusion and screw placement (VM2.1) [2]. When compared with other conventional approaches, robot-assisted surgeries stand out for their positive operative and post-operative outcomes which include reduced blood loss, operating time, radiation exposure and other surgical complications making it a safe choice for the patients. However, these techniques require high technical proficiency which involves intense clinical competency and have high longitudinal retention 9VM3.1) [3,4]. This paper is a review on various techniques and approaches focusing mainly on interbody fusions along with a combined endoscopic approach for lumbar degenerative diseases. It aims to discuss clinical significance, how it is applicable clinically, its limitations of current evidence, future directions, so that clinicians can understand the evolving theories on spinal surgeries [3,4].

Methodology

Literature Search

A systematic literature search was conducted to identify studies that included an evaluation of the endoscopic neural decompression with lateral lumbar interbody fusion (LLIF) and/or oblique lumbar interbody fusion (OLIF). The electronic databases searched were PubMed/MEDLINE, Embase, the Cochrane Library, Scopus, Web of Science, and Google scholar. The search spanned publications from January 2016 to June 2026. Reference lists of relevant articles were also hand-screened to find additional eligible studies. A search strategy was used that included Medical Subject Headings (MeSH) and free-text words related to endoscopic spinal surgery and lateral lumbar interbody fusion techniques. Boolean operators (AND/OR) were employed to ensure the search is sensitive enough and relevant to the user. The basic search strategy was:

("endoscopy" OR "endoscopic" OR "spinal endoscopy" OR "full-endoscopic" OR "biportal endoscopic" OR "uniportal endoscopic" OR "percutaneous endoscopic" OR "microendoscopic" OR "endoscope-assisted") AND ("lateral lumbar interbody fusion" OR "LLIF" OR "oblique lumbar interbody fusion" OR "OLIF" OR "extreme lateral interbody fusion" OR "XLIF" OR "direct lateral interbody fusion" OR "DLIF" OR "lateral interbody fusion" OR "LIF") AND ("decompression" OR "discectomy" OR "laminectomy" OR "laminotomy" OR "foraminotomy" OR "spinal stenosis" OR "disc herniation").

Other free text terms were "SED-OLIF," "ELLIF," "BESS," "OLEDIF," "OLIF-PETD," "OLIF-TELD," "endoscopic ipsilateral-contralateral decompression," and "hybrid minimally invasive spine surgery. The overall search approach was maintained for each platform, with adaptation of the database-specific controlled vocabulary and search syntax.

Eligibility criteria

We have included only clinical studies that have assessed the efficacy of endoscopic decompression of a nerve with LLIF or OLIF in adults. Clinical outcome, radiographic findings, peri-operative parameters, surgical techniques or postoperative complications were the studies that were deemed to be eligible. Comparative cohort studies, prospective and retrospective observational studies, and technical reports were used to create a thorough picture of the existing evidence. Conference abstracts, editorials, letters, duplicate publications and non-English articles were not considered and studies using only LLIF / OLIF or only endoscopic decompression were excluded. Existing narrative and systematic reviews were used to provide contextual background and support interpretation of the available evidence and were not primary clinical evidence for the synthesis.

Evidence synthesis

The included studies provide information which was reviewed and synthesized narratively. The information gathered was related to the study characteristics, patient demographics, surgical indications, surgical techniques, peri-operative outcomes, radiographic findings, functional outcomes and reported complications. The Visual Analogue Scale (VAS) for back and leg pain, the Oswestry Disability Index (ODI), the Japanese Orthopedic Association (JOA) score and, if available, the Modified MacNab criteria were commonly used clinical outcome measures. The radiographic results were intervertebral disc height, foraminal height, spinal canal dimensions, segmental lordosis, cage subsidence, fusion status and changes in adjacent segments. Data were not combined quantitatively but collated into key thematic areas: patient selection, surgical technique, clinical effectiveness, radiographic outcomes, perioperative safety, complications and present evidence limitations. Comparisons with clinical studies and investigations involving more patients received more weight than technical reports or early case series, which were seen as purely descriptive evidence of changing surgical methods. The results were summarized using existing review articles in order to provide context and areas of consensus, conflict and future research. Due to the variety of study designs, outcome measures, surgical techniques and follow-up period, a quantitative meta-analysis was not conducted.

Discussion

Patient selection and clinical indication

Surgery should not dictate corridor choice; it should be based on the pathology. These foraminal and lateral recess disease are well addressed with Trans-Kambin endoscopic fusion, but it is very poor at central stenosis, simply because the corridor doesn't go there [5]. Biportal fusion is more reliable for central and bilateral disease. There is a third option, which is somewhere between these two, called endoscopic oblique fusion; it decompresses indirectly, by ligamentotaxis – but this appears to be effective only in limited central cases [6,7]. This may be why several groups performed oblique fusion combined with either endoscopic discectomy or biportal decompression, because these procedures are usually performed alone, they tend to undertreat central and foraminal disease. A good example is patients who have failed the intraoperative EMG safety thresholds during oblique fusion. The rerouting to added foraminal decompression eliminated dysaesthesia in this group of higher risk patients, a reminder that neurophysiology, not imaging, dictates the safety of the technique in a given patient. There is also a role for body habitus: both retroperitoneal injuries were in patients with a very thin body type and suggest a habitus-specific risk for the transpsoas corridor [8,9]. Surgical history is important, too. Percutaneous endoscopic discectomy and oblique fusion have been suggested in particular for patients that have had surgery in the posterior part of the spine and where scarring may make conventional revision more difficult. The truth is that the location of the stenosis, bilateral or not, the patient's tolerance to neurophysiologic testing, body habits and surgical history are more important than any particular endoscopic platform [8,9].

Pedicle screw placement accuracy

After the corridor fits the patient, its instrumentation accuracy is the next factor that influences the outcome. However, freehand fluoroscopic placement remains as the standard to which navigation and robotics are compared [9]. Electromagnetic navigation reduces registration learning curve to less than optical navigation and continues to provide real-time feedback during screw placement and cage insertion, as it doesn't require a continuous line of sight as optical navigation does [10,11]. In one study, the authors showed that O-arm navigation reduced radiation dose and operating time compared to fluoroscopy and showed that they had similar results between groups suggesting more consistent placement but not formally demonstrated against a tool such as the Gertzbein-Robbins scale. The early cases of robot-assisted surgery are similar: more accurate than fluoroscopy alone; less trauma; less radiation; and the learning curve is steep enough that it merits a warning in its own right. There's another type of comparison offered by biomechanics. While lateral screw-rod constructs still performed better than a stand-alone cage in terms of stress distribution, finite-element modelling revealed that they were less effective than bilateral pedicle screws in controlling segmental motion [10,11]. You don't necessarily know if a less invasive or easier to achieve construct is equivalent biomechanically, and the difference may manifest down the road with subsidence or additional stress at the adjacent level. It’s also worth highlighting that these accuracy measurements were taken by various navigators and various screw/cage systems in various studies, and this means that the numbers cannot be taken directly from one study to the next again noted under limitations. In general, accuracy of both navigation and robotics (which has been studied less well) tends to increase the placement consistency, and most of this data is from small, retrospective or single arm series, not controlled trials [11].

Complication rates

While accurate instrumentation is a key input to complication risk, rates vary as much as with using different corridors or different teams. The early series of transforaminal endoscopic fusion reported complication rates as high as 36% including cage migration, radicular pain, and paraesthesias.Later series show much lower rates, and the explanation is not hard to imagine those early cases exposed were the instrument refinement, added visualization, and the neurophysiologic selection that all target [12,13]. In contrast, there is another pattern of lateral lumbar fusion: transient psoas weakness, thigh sensory change, retroperitoneal injury, ileus, and cage migration requiring revision in four of 70 cases. Transient dysaesthesia is the hallmark of oblique fusion and occurs in about 1 in 4 to 1 in 5 unselected patients. That's because the trans-Kambin corridor is near the existing nerve root, which is what makes it happen, and why it didn't occur in the EMG-selected higher-risk subgroup following direct decompression where the irritating nerve root was removed. By comparison, biportal transforaminal fusion typically causes small and self-limited complications (incidental durotomy, transient nerve irritation, epidural hematoma) at rates like its minimally invasive and open counterparts [12,13]. Endoscopic decompression combined with either oblique or horizontal fusion also had no significant complications reported, and the most common adverse event was transient thigh numbness or psoas irritation. So, the complications correlate with the anatomic structure of the corridors, not endoscopy as a single entity which is significant when recommending that a patient accept some risk for one or the other. Various series were also treated with various implant systems and instrument sets, thus making comparisons of rates across studies approximate at best.

Radiation exposure

There are other intraoperative safety measures besides complications, and radiation is no exception. Most cases are treated with fluoroscopy, but repeated fluoroscopy particularly in larger patients can generate a significant dose for the surgeon as well as the patient [14]. A reduction in kilovoltage of the x-rays is useful with pulsed fluoroscopy, but yearly occupational dose limits continue to limit surgeons who perform many of these procedures. Reduces radiation exposure and operating time vs fluoroscope alone, and the initial registration cost is recouped due to decreased number of radiation exposures used later during screw placement and decompression [14]. Electromagnetic navigation also goes further: it doesn't require any re-registration when the line of sight is lost, as optical systems do. The cost benefit to be noted is straightforward: Patient set-up dose increases slightly while total surgeon dose decreases significantly after registration. That distinction is determined by whom you ask cumulative career dose is the number that counts in the eyes of a high-volume surgeon, but single case dose is what counts most in the eyes of the patient. There is very little literature focused specifically on lateral, not transforaminal, direct dosimetric comparison and this could be filled with dedicated studies [14,15].

Operative time and learning curve

Next, how much radiation navigation actually saves depends somewhat on how fast a team's learning curve is, which is the next thing to be compared. The length of the operation depends on the technique used, the number of levels to be addressed and the surgeon's experience. In one lateral lumbar fusion series, as the number of cases increased, the average time per segment decreased from 103.2 minutes in 70 cases to 82.6 minutes in the latest 20 cases, representing a clean "learning-curve effect4 [15]. In patients with severe central stenosis, transforaminal endoscopic discectomy combined with oblique fusion was not different from open transforaminal fusion, and the total time for repositioning was not different from oblique fusion alone. Biportal transforaminal fusion, however, has consistently been longer lasting than the posterior or minimally invasive comparators. The cost is more than just an incidental: two working portals require more coordination, and surgeons must have prior experience in both the endoscopic and microscopic minimally invasive surgical techniques before they become efficient. Even with the accuracy improvements when robot-assisted fusion is mastered, it's still a steep learning curve. This is where the surgeon-level variability and the technique-level variability get intertwined the same procedure, performed by surgeons at varying stages of their own learning curve, can reasonably yield very different time and complication results a confounder that pervades this entire literature, and not just within one section of it [16]. Combined, these numbers follow a well-recognized pattern of rapid early results with the volume of cases, in the 20-40 case range that is common for advanced minimally invasive spine procedures, although no precise line has been drawn to determine the amount needed for most of the procedures discussed here.

Clinical outcomes

If it doesn't show up in what patients report, then none of the above. The next comparison is. Lateral lumbar fusion was associated with a reduction in mean pain rating from 7.0 to 1.4, as well as restoration of disc height and foraminal height and lumbar lordosis [17]. There were less postoperative VAS scores in the oblique fusion with transforaminal endoscopic discectomy group compared to posterior lumbar fusion, and the operating time and blood loss were also lower. VAS and Oswestry scores showed improvement at each time point with addition of biportal decompression to oblique fusion for severe central stenosis, with 85% obtaining good-to-excellent results based on the modified Macnab criteria (similar to the open transforaminal fusion except for less blood loss) [17]. Likewise, when performed perpendicular to the axis of the spine with lateral screw fixation and PED, lower VAS scores than with MIF were observed, with equivalent fusion rates and marked reduction in multifidus atrophy (4.1% vs 20.8%) [18]. That atrophy gap is not just a pretty picture number. It realistically represents less paraspinal stripping during surgery, and it's a difference that, even if pain scores at the end of surgery are comparable between groups, may have consequences for the chronic low back pain or adjacent-segment stress further down the road. In patients with combined central or foraminal herniation, endoscopic discectomy combined with oblique fusion yielded significant improvements in canal and foraminal size, and Oswestry scores [18]. One longer-term randomized comparison of decompression alone versus decompression plus fusion revealed no difference in back pain relief, but did show improved SF-362 vitality, social functioning, and mental health scores. The split result is not as bad as it is disappointing: adding extra technical precision or instrumentation doesn't necessarily add to the amount of back-pain relief available, but it could add to other quality-of-life and stability benefits that a pain score cannot capture. Overall, it appears that the endoscopic assistance allows for better visualization and less soft-tissue disruption which improves the short-term recovery and preserve the paraspinal muscles, and that medium- and long-term pain and function outcomes are similar to those of conventional minimally invasive fusion.

Economic considerations

The clinical benefits are accompanied by an economic benefit which none of the reviewed studies directly measured, and hence any economic conclusion here is inferred and not measured [18]. Reported decreases in blood loss, transfusion requirements, and hospital stay suggest less downstream costs for blood products, nursing and bed-days2378. In one small series, endoscopic transforaminal fusion has been associated with notably short length of hospital stay (ETBS), averaging slightly more than one night, presumably reducing the costs associated with the procedure even more if this trend was replicated in larger numbers of patients. On the other hand, there's a big initial investment: Endoscopic towers, navigation systems, robotic platforms (if applicable), and the specialized expandable cages and disposable instruments. No reviewed studies considered this considering a formal ROI or break-even analysis. Additionally, longer operative times in some techniques, especially the biportal transforaminal fusion, have an implicit cost associated with the use of the operating room that has not been quantified anywhere in this literature [18]. In the absence of prospective economic modelling, the hypothesis that endoscopic decompression and lateral fusion would save money overall would seem plausible because of the above, but it is not proven.

Limitations of current evidence

All the comparisons above are based on evidence that is indeed quite weak in its structure, and that should be said right out rather than glossed over [18]. There are very few studies that are prospective randomized trials. Studies are mostly retrospective case series or one arm cohort studies. One prospective randomized comparison and one long-term randomized trial emerged from the sources reviewed, with only the latter having a higher attrition rate than the design called for. Within each series of data on each technique, sample sizes remain small with most having a few dozen or lower patients for each case series, which is inadequate to identify rare, but serious, complications like major vascular or neurologic injury. Surgeon heterogeneity should not be a footnote to the above learning curve discussion, but its own limitation [19]. The results reported can be as much an outcome of the surgeon's skill as of the technique and more than one series explicitly depended on the expertise of an endoscopic surgeon who was not as familiar with the technique. The combination of uniportal and biportal endoscopy, trans-Kambin, posterolateral, and interlaminar corridors, as well as varied cage geometries and expansion methods, varied navigation platforms (electromagnetic, optical, Oarm) are combined in these studies. It can be tricky to compare results across so many hardware and corridor types, since treating dissimilarities as similar ones can lead to undesirable comparisons.

The follow up is likewise not consistent. Most series follow patients for 12 months or fewer, and within any one series the time point of VAS assessment was different from one study to another5789 [19]. This leaves true long-term fusion rates, adjacent segment disease and later implant failures like cage subsidence or cage migration only partially understood or even in the one trial that followed patients for 10 years, more patients failed than expected as they grew older. In addition, a few of the reviewed papers reported consulting or royalty relationships with the implants or instrumentation studied, suggesting the potential for reporting bias associated with implant and instrument sponsorship that has not yet been independently verified. Almost all series are from single, high-volume specialist centers which also brings up the point of surgeon-heterogeneity above, as this could skewer results to be less generalizable to lower-volume centers that are still on the learning curve [19]. Finally, several series have employed very strict EMG criteria to limit inclusion and single-center cohorts with narrow indications to limit comparisons, and this reduces the selection bias within each study but also results in favorable comparisons that may be relevant only to carefully selected patients479, rather than outside of it

Future directions

These are the gaps that need to be addressed and not only the introduction of new technology that will determine where this field will continue to go. In early applications, robotic planning of screw and cage trajectories has already resulted in improved placement accuracy and reduced radiation exposure [20]. Those benefits could be extended with tighter integration with real-time image guidance, and the steep system learning curve could be reduced, as well. Systems that have been developed to display navigation information on a display that is projected onto the surgical field, such as non-bony anatomy like discs and nerve roots, may help to reduce the disorientation of having to switch between the endoscope and an external monitor during surgery, although reference-frame drift during surgery has yet to be addressed for current platforms [20]. Patient-specific implants are beginning to be 3D-printed, with results demonstrating greater fusion grade than standard polyetheretherketone implants—and they could be especially useful in the limited working space provided by endoscopy. Combining vertical and horizontal expansion with adjustment of lordosis, 4th generation expandable cages are still being developed, and might overcome the potential under restoration of segmental lordosis with small endoscopic cage footprints. Current platforms are likely to benefit from further developments in machine-learning trajectory planning, semi-autonomous robotic decompression and improvements in the haptic feedback, all of which would be logical targets for future studies, but none of these are described in the studies here reviewed [20]. Their impact will depend on future prospective studies that validate them against the rest of the techniques described above. Indeed, bridging the surgeon and implant-heterogeneity gaps mentioned above (via multicenter registries, standardized timing of outcomes, and reporting of separate technique- and operator-experience effects) would do more to empower this evidence base than any single new device [20].

Conclusion

Key Findings

Based on available evidence, the goal of performing an endoscopic neural decompression procedure in tandem with lateral lumbar interbody fusion techniques such as LLIF and OLIF is feasible and safe when indirect decompression is inadequate to provide sufficient decompression of the neural elements. The included studies consistently showed improved pain, functional outcome, radiographic decompression and perioperative parameters with the combined endoscopic–lateral approaches with acceptable rates of complications. While there are several permutations of this technique (such as SED-OLIF, OLEDIF, biportal Endo-OLIF, Endo-LLIF and OLIF-TELD), they are all attempting to achieve the biomechanical benefits of lateral interbody fusion in conjunction with direct endoscopic visualization to address compressive pathology which is not accessible through the lateral corridor. The observed clinical benefits are biologically plausible since the lateral interbody fusion provides disc height and indirect decompression; while the endoscopic decompression allows for direct visualization of the removal of the residual disc fragment, osteophytes, hypertrophied ligamentum flavum, and foraminal pathology. The two complementary procedures may increase the indications of minimally invasive lateral fusion while decreasing the number of patients requiring staged posterior decompression in well-selected patients.

Although short-term results are good, there is a significant variation in the published studies regarding patient groups, surgical techniques, outcome measures, and follow-up periods. Thus, the literature available at this time shows that combined endoscopic – lateral fusion procedures are feasible and have proven to be effective in the short-term, but it is not yet possible to draw firm conclusions about the long-term effectiveness relative to the other procedures.

Strengths and Limitations of the Current Evidence

Literature reports some promising (though limited in overall methodology) data on the safe and effective use of both combined endoscopic and lateral fusion procedures. Most of the studies were retrospective, single-center studies, and the number of patients and follow-up periods were relatively small and mostly ranged from one or two years. There are no randomized controlled trials, and the outcome reporting is not standardized, making direct comparisons between techniques limited; certainty regarding the available evidence is reduced by this.

While there are several systematic reviews and network meta-analyses available that indicate minimally invasive lumbar interbody fusion procedures yield similarly broad improvements in pain, disability, and safety, they are based on procedures by category. So, it cannot be said that all combined endoscopic–lateral techniques would be equally effective, and their conclusions should not be considered as proof of this. Moreover, although direct endoscopic visualization can decrease the potential complications of inadequate decompression and nerve root injury, it cannot prevent complications from infection, hardware failure, excessive tissue manipulation, or fusion failure. Therefore, great caution should be used in interpreting current evidence.

Patient Selection

Patient selection is the most crucial aspect of successful combined endoscopic–lateral fusion. Patients with mild or moderate lumbar stenosis will have a significant increase in risk of requiring further decompression of the posterior-posterior fascia following lateral fusion in the case of severe or fixed central canal stenosis.

In a large retrospective cohort study, it was found that about one-third of patients who underwent lateral lumbar fusion later went on to require additional decompression of the posterior spine, and that this complication became much more common with Schizas grade D stenosis patients. The strongest independent predictor of second-stage surgery was grade D stenosis, which had an odds ratio of 17.77 compared to lower severity grades of stenosis. The results should encourage further discussions on the feasibility of planned endoscopic decompression at the time of LLIF/OLIF in carefully selected patients with more advanced stenosis to potentially reduce the need for staged posterior surgery. However, these are all observations based on retrospective data and need to be further validated by prospective multicenter studies before they are broadly adopted.

Future Directions

To conclude, further research is needed to focus on well designed prospective multicenter studies and randomized controlled trials that compare combined (endoscopic-lateral) fusion procedures with traditional LLIF/OLIF, MIS-TLIF, and other surgical methods that are already established. Long-term outcomes of achieving full fusion, adjacent-segment degeneration, re-operation rates, implant durability and functional recovery will be determined by standardized inclusion criteria, independent outcome assessment, validated patient-reported outcome measures, and follow-up beyond 5 years.

Further research is needed to examine the learning curve of these technically challenging interventions, to define the competency level threshold for surgeon credentialing, and to quantify the relationship between increasing surgical experience and complication rates and outcomes. The cost-effectiveness analysis should also take into account the operative time, instrumentations, hospitalization, rehabilitation and revision surgery to define the overall value of these techniques in the present healthcare system. New technologies could further improve the accuracy of the procedure and patient safety, such as surgical navigation, robotics, augmented reality, and AI-supported surgical planning. Their use in the endoscopic-assisted lateral fusion operation should be assessed in controlled clinical trials prior to general use.

Overall Conclusion

Endoscopic neural decompression and lateral lumbar interbody fusion is a new advancement of minimally invasive spine surgery. Combined with direct endoscopic decompression of the nerves, these procedures could surpass significant limitations of lateral fusion surgery while offering even more treatment options for the patient with advanced lumbar degenerative disease. They are technically feasible, have a favourable peri- operative profile and are showing good short-term clinical results in the right patient. The literature is still largely dominated, however, by retrospective studies with a variety of methods and short-term follow-up. This means that, for all patients, combined endoscopic–lateral fusion may be a useful adjunct to the surgeon's armamentarium, but further trials are needed to compare this technique with current lateral endoscopic procedures.

Take-Home Messages

Conclusion: Endoscopic decompression in combination with LLIF/OLIF is an effective minimally invasive technique that can be considered for selected patients in which only indirect decompression will not provide an adequate decompression of the nervous elements.

Existing data indicate that combined endoscopic–lateral fusion surgery is safe and effective in the short-term, however, study designs are retrospective, surgical techniques are variable, and long-term outcomes are limited. In cases of severe (Schizas grade D) lumbar canal stenosis, patients also seem to be more likely to benefit from scheduled endoscopy compared to staged posterior decompression, with the combination of the two procedures.

Acknowledge

The authors confirm that all individuals listed as authors made substantial, equal contributions to the development of this work, including the abstract, introduction, methodology, discussion, and conclusion. The collaborative nature of this project reflects the shared responsibility and joint effort of all team members.

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