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Reviewer Comments

#1

Is the amount of pars removal standardized? Have you examined that on the postoperative images? After removing the pars, i.e., part of the lateral lamina, despite preserving (most of) the facet joint itself, are you not worried about a significantly reduced resistance of the remaining lamina, possible leading to a fracture? Did you focus on that in your postoperative imaging?

The amount of the remained facet joint is very important. To assess the amount of remained facet joint, X-ray is not sufficient and CT scan is required. Unfortunately, in this prospective study, postoperative CT scan was not routinely performed. Therefore, we have to described it in the limitations as follows.

First, the amount of pars interarticularis removal was not standardized in the “radical decompression” procedure, and the bony resection at the pars interarticularis was widened as the L5–S1 disc was detected at the caudal area of the L5 nerve root. Therefore, the amount of remaining facet joint should be affected by the original size or swelling of the nerve root. Further analysis using postoperative computed tomography is needed to assess the relationship between the amount of remaining facet joints and postoperative segmental instability.

#2

You mention, that in case of a disc bulge or herniation, you additionally performed a discectomy/herniotomy, which was the case in 13 patients. Did you separately look at this subgroup, since additional manipulation of the disc is mostly seen as an additional risk factor for developing an instability?

Thank you very much. As your suggestion, discectomy can cause instability, therefore, we classified patients into a disc group (Group D) and a non-disc group (Group ND) according to whether a discectomy was performed intraoperatively and performed subgroup analysis. As a result, it seemed that discectomy did not affect the segmental stability.

#3

Obviously, in all cases you performed your technique of “radical decompression”, which includes an extensive extraforaminal decompression. However, it seems to me, that you did not differentiate preoperatively the extent of compression in the extraforaminal area. Did you also perform this “radical” decompression extraforaminally, even if the preop images did not show any extraforaminal compression?

We believe that routine decompression from intraforaminal region to extraforaminal region is the simplest way to avoid insufficient decompression. In discussion, following was added.

Decompression limited to the area of nerve compression may be effective in preserving the remaining bone tissue. Murata et al. investigated the localization of nerve root impingement in cases with symptomatic L5–S1 foraminal stenosis using 3D image fusion with MRI/computed tomography and found that the area for decompression should be extended to the intraforaminal region in approximately 75% of cases and to the extraforaminal region in approximately 80% of cases (22). Furthermore, an imaging study by Takahashi et al. revealed that more than half of the

nerve root compressions in the extraforaminal region could be missed on conventional two-dimensional MRI, indicating that this was not an appropriate modality to specify the localization of nerve root compressions in patients with symptomatic foraminal stenosis at L5-S1 (23). Given that the localization of nerve compression is mediolaterally wide from the intraforaminal region to the extraforaminal region in many cases and that its exact localization is difficult to specify by the conventional modality, we believe that routine decompression from the intraforaminal region to the extraforaminal region is a simple method to obtain secure decompression and to minimize the risk of insufficient decompression.

Reference

22. Murata S, Minamide A, Iwasaki H, et al. Microendoscopic decompression for lumbosacral foraminal stenosis: a novel surgical strategy based on anatomical considerations using 3D image fusion with MRI/CT. *J Neurosurg Spine*. 2020;33:789–795.
23. Takahashi K, Myo Min Latt, Tsubakino T, et al. Reliability of conventional two-dimensional magnetic resonance imaging for diagnosing extraforaminal stenosis in lumbosacral transition. *SSRR 2023* (article in press).

Reference 23 has just accepted and is not available online yet. Therefore, we attached PDF file. Please kindly refer to it.

#4

You mention, that you excluded patients with a spondylolysis. Nevertheless, oftentimes a spondylolisthesis (not necessarily based on a spondylolysis) is the cause of a foraminal stenosis in the level L5/S1. You also included these patients. However, I am missing a clear subgroup analysis, which is important in my opinion.

As you mentioned, spondylolysis oftentimes causes foraminal stenosis. However, we believe the pathogenesis of foraminal stenosis due to spondylolysis (with spondylolisthesis) is different from others. Thus, we excluded spondylolysis in this study. Degenerative spondylolisthesis was not excluded in this stud. Subgroup analysis by the presence of spondylolisthesis is important. However, only one case with degenerative spondylolisthesis was included in this study and the subgroup analysis could not be conducted. We added it in limitations.

Second, only one case of spondylolisthesis was included in this study, and the effect of preoperative sagittal translation on segmental stability could not be investigated. Therefore, it is unclear whether “radical decompression” causes segmental instability in patients with spondylolisthesis.

#5

There is literature out there about different techniques of treating foraminal stenosis at the level L5/S1 surgically; ranging from different techniques of only decompression all the way to additional fusion. Why did you not compare/discuss your results/outcome with this existing literature in more detail?

Thank you very much. Unilateral biportal endoscopy is getting popular these days, Thus we added some information regarding the technique. I hope the comparison between other surgical techniques is acceptable for you.

Various types of surgeries for LFS have been reported (1,3,4,28,29,30), including microendoscopic decompression, unilateral biportal endoscopy, and PLIF. Microendoscopic

decompression may be ideal because of its minimal invasiveness (6) and the usefulness of decompression of the extraforaminal region under a bright, magnified surgical field (6). Regrettably, this procedure is technically demanding, and the learning curve is rather steep (6). **Unilateral biportal endoscopy is also minimally invasive; however, lower lumbar level (L4–5, L5–S1) is an independent risk factor for unsatisfactory outcomes (30). In addition, microendoscopy and biportal endoscopy are not available in every country.** PLIF enables adequate decompression and stabilization simultaneously (5). However, it carries the risk of a higher rate of infection (7), nonunion at L5–S1 (8), and adjacent segment degeneration (31). Furthermore, a randomized controlled trial comparing the results of decompression alone to those of decompression with instrumented fusion for LFS found no significant additional benefits from fusion (32). Our “radical decompression” does not require specific equipment and devices, is not technically demanding, should have fewer complications, does not cause segmental stability, and offers secure decompression from the intraforaminal region to the extraforaminal region.

#6

There are a few typos in the text. For instance, in line 69 the “1” is missing in L5/S1. Or in line 105, the word “of” is missing in the sentence. Please go over the text to improve these basics.

Thank you very much. We checked carefully again. In addition, we are not a native English speaker, therefore, we used a language editing service after the revision again. (This “response to reviewers” were not included in the editing service.)

[Answer to reviewer B]

I agree with the authors' technique for full-scale foraminal/extraforaminal decompression at the level of L5-S1. Even with total facetectomy and partial resection of the sacral alar, a thorough decompression of the L5 nerve root is essential to treat intractable L5 radiculopathy.

Thank you very much for the comment. Your comment encourages us to proceed our further study.

[Answer to reviewer C]

Firstly, I would like to congratulate the authors for describing this new technique of addressing LFS, which is many times missed on scans.

Following are some queries and suggestions:

Thank you very much for your suggestions. We would like to answer your questions and queries one by one.

Page 3, Line 77: Microendoscopic? Do the authors imply microscopic surgery or endoscopic (either transforaminal or interlaminar)

Line 282: What do authors mean by microendoscopy? Microscopic surgery using tubular retractors? Please discuss about the actual endoscopic surgeries: Transforaminal or interlaminar or unilateral biportal endoscopy as these are now becoming popular for non-fusion decompression surgeries.

Microendoscopic surgery requires specialized equipment. The most popular system is the METRx® system (Medtronic, Memphis, TN, USA), which includes a serial tubular dilator, tubular retractor, and flexible arm assembly to secure the retractor to the table. Please kindly refer to the following

paper.

Reference

Suzuki A, Nakamura H. Microendoscopic Lumbar Posterior Decompression Surgery for Lumbar Spinal Stenosis: Literature Review. *Medicina (Kaunas)* 2022;58:384.

Page 3, Line 81: Kindly provide reference for stating 'PLIF may be considered gold standard' (for foraminal stenosis without instability)

The expression "PLIF may be considered gold standard" is not scientific since no gold standard exists for the surgical method. Thus, we change it to "PLIF is a common procedure used to treat this pathology"

Page 5 line 131: As the study was done approximately 10 years back, what is the 5 and the latest follow-up of the patients?

Our institution is a spine center in the region and many of the patients came from a long distance. Therefore, prospective study was planned only for two years. Further retrospective study with longer follow up period is now planned. Please kindly wait for the result coming up.

Line 140: When the stenosis is in the L5-S1 foraminal region, what is the justification of removing L4 lamina, as there is no compression in that area.

Thank you very much for your comment. L5 nerve root and pedicle will be easier to be identified after fenestration at L4-5. This procedure makes it easier to proceed the further process. We added the following sentence in the discussion.

Line 217-218

In our procedure, fenestration was first performed at L4–5 to identify the L5 nerve root and pedicle, which facilitates further process.

Line 144: Was the upper portion/ tip of S1 Superior articular process removed? Lumbar foraminal stenosis has 2 soft tissue and 2 bony factors which usually cause the compression of the root. Disc, foraminal flavum, posterior spurs and SAP tip. How many patients had SAP tips compressing the root and was SAP tip removed to free the root in the foramen.

Our explanation was not sufficient and did not include how we dealt with SAP of S1. We routinely resect SAP tips. We changed the following sentence in Line 108-111. Unfortunately, after resecting SAP, nerve root is already decompressed and we could not investigate how many of the patients had SAP tip compression. Thank you very much for pointing.

Conventional unilateral fenestration of L4–L5 was performed using a high-speed air drill (17), followed by resection of the pars interarticularis (4) and the tip of the superior articular process of S1.

Line 148: The caudal portion of the L5 transverse process was resected to release the up–down stenosis, and the sacral ala was partially resected to release the anteroposterior stenosis: please give reference for the terminologies: up-down stenosis and anteroposterior stenosis

The stenosis in the intraforaminal region is classified as cephalon-caudal entrapment, antero-

posterior entrapment (Kunogi J, Hasue M. Diagnosis and operative treatment of intraforaminal and extraforaminal nerve root compression. Spine 1991;16:1312-1320.). However, no classification exists for the stenosis in the extraforaminal region. Terminology is important, therefore, we changed the sentence in Line 115-116. Thank you very much for pointing out.

The caudal portion of the L5 transverse process and sacral ala was partially resected to release nerve root impingement in the region.

Line 171: Although excluded from the study, how many patients with JOABPEQ >90 were operated and what were the indications for operating patients with JOABPEQ >90?

JOABPEQ comprised of 5 domains, including pain-related disorder, lumbar spine disorder, gait disturbance disorder, social life disturbance, and psychological disorder. Some patients have good score in some domains and not in others. Please kindly refer to the paper.

Reference

20. Fukui M, Chiba K, Kawakami M, et al. JOA Back Pain Evaluation Questionnaire (JOABPEQ)/JOA cervical Myelopathy Evaluation Questionnaire (JOACMEQ). The report on the development of revised versions. April 16, 2007. The Subcommittee of the Clinical Outcome Committee of the Japanese Orthopaedic Association on Low Back Pain and Cervical Myelopathy Evaluation. J Orthop Sci 2009;14:348-365.

How many patients had comorbidities? Did it correlate with patients where poor outcome was observed?

What was the average surgical time and average blood loss in the patients. Was adequate exposure possible in obese patients?

Thank you very much. It is an important issue. We identified some of the patients had diabetes and hypertension. Since there was no surgical site infection in this study, no subgroup analysis was performed. We added some information of complications and operation time and blood loss. Thank you very much for your suggestions.

The operative duration and the intraoperative blood loss were 149 ± 31 minutes and 58 ± 23 gram, respectively. No intraoperative dural tears or postoperative surgical site infections were observed.