Case Report

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Unilateral biportal endoscopy combined with collagen membrane for adjacent segment pathology-lumbar spinal stenosis with floating cauda equina

A case report

Haiyun Zhang[a], Gangning Feng[b,*]

Abstract: Unilateral biportal endoscopy (UBE) has emerged as an effective alternative to open surgery for the treatment of adjacent segment pathology (ASP) -induced lumbar spinal stenosis (LSS), offering advantages such as minimal invasiveness and accelerated recovery. An 84-year-old female patient who underwent lumbar 4–5 (L4–L5) vertebral fusion 13 years ago presented with intermittent claudication over the past year; visual analog scale (VAS) score was 9. She was diagnosed with ASP and LSS. The patient was treated with UBE surgery at our institution. During spinal endoscopic surgery, when dural tears or partial dural defects are encountered, intact but dissociated cauda equina nerve roots can be observed floating loosely within the spinal canal intraoperatively—a phenomenon we termed the cauda equina floating sign (CEFS). After adequate decompression of the spinal canal, a medical absorbable collagen membrane was applied to cover and protect the cauda equina. The procedure was successfully completed with an estimated blood loss of 50 mL and an operative time of 2.5 h. Postoperatively, the patient's lower limb symptoms were significantly relieved. She was able to ambulate on postoperative day 5 and was discharged on day 8. Her VAS score was 3. At the 6-month follow-up, her symptoms had substantially improved, and she had resumed normal daily activities. Magnetic resonance imaging at the 1-year postoperative follow-up demonstrated adequate spinal canal decompression. The patient's low back and lower limb pain were also significantly relieved, with a VAS score of 1. The combination of UBE and a medical absorbable collagen membrane may represent an effective therapeutic strategy for CEFS and could potentially reduce the risk of cerebrospinal fluid leakage.

Keywords: adjacent segment pathology, cauda equina floating sign, lumbar spinal stenosis, medical absorbable collagen membrane, unilateral biportal endoscopy

1. Introduction

Adjacent segment pathology (ASP) is a common complication following lumbar fusion surgery, frequently co-occurring with lumbar spinal stenosis (LSS).[1] LSS is among the most prevalent spinal disorders in the elderly, affecting approximately 103 million individuals worldwide.[2]

LSS syndrome is a clinical condition characterized by compression of the cauda equina, nerve roots, and neurovascular complex, typically resulting from degenerative changes.[3] Patients commonly present with symptoms including radicular pain in the lower limbs or neurogenic claudication—characterized by pain in the buttocks or lower extremities during walking or standing, which is often alleviated by sitting or lumbar flexion.[4]

When conservative treatment fails, surgical intervention should be considered in a timely manner. Traditional open surgery, the standard treatment for symptomatic lumbar disc herniation, often employs lumbar fusion to stabilize the decompressed segment. However, the associated surgical trauma and long recovery can increase biomechanical stress on adjacent segments and the sacroiliac joint, thereby accelerating degeneration and potentially

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leading to pain and functional limitations in the back and lower limbs.[5]

In the present case, the patient was treated for postoperative ASP-induced LSS, accompanied by a floating cauda equina utilizing unilateral biportal endoscopy (UBE) combined with a medical absorbable collagen membrane. Following the procedure, the patient's symptoms were markedly alleviated.

2. Case report

2.1. Patient information

An 84-year-old female with a history of lumbar instrumented fusion 13 years earlier presented with a 1-year history of low back pain, right lower limb pain, numbness, and claudication. Visual analog scale (VAS) score was 9. Lumbar spine magnetic resonance imaging revealed a postfusion state at lumbar 4–5 (L4–L5) and secondary LSS at L3–L4 caused by disc herniation and ligamentum flavum hypertrophy (Fig. 1A). This finding was corroborated by lumbar computed tomography (CT) (Fig. 1B), while lumbar radiographs confirmed satisfactory instrumentation positioning at L4–L5 (Fig. 1C, D). A diagnosis of ASP with concomitant LSS was established. After informed consent was obtained, the patient underwent UBE decompression at the L3–L4 level. The study protocol received approval from the Ethics Committee of Yinchuan Hospital of Traditional Chinese Medicine, Ningxia (Approval No: 2025–255).

2.2. Surgical technique

The L3/L4 disc space and the target surgical level were identified with C-arm fluoroscopy with the patient under general anesthesia. The endoscope and radiofrequency probe were introduced through their respective incisions. Under endoscopic guidance, a partial laminectomy was performed using a high-speed drill. During the resection of the ligamentum flavum, severe adhesion and partial fusion with the dura mater were observed. Following ligamentum flavum removal, a floating cauda equina was visualized within the spinal canal (Fig. 2A, Video 1). Adequate decompression of the L4 nerve root was successfully achieved.

To prevent postoperative neural adhesion, a medical absorbable collagen membrane (Fujian Bio-Tech Bioengineering Co., Ltd., China; National Medical Device Registration Certificate No. 20173130514) was applied for coverage (Fig. 2B). Following thorough decompression of the spinal canal, the arthroscopic irrigation was

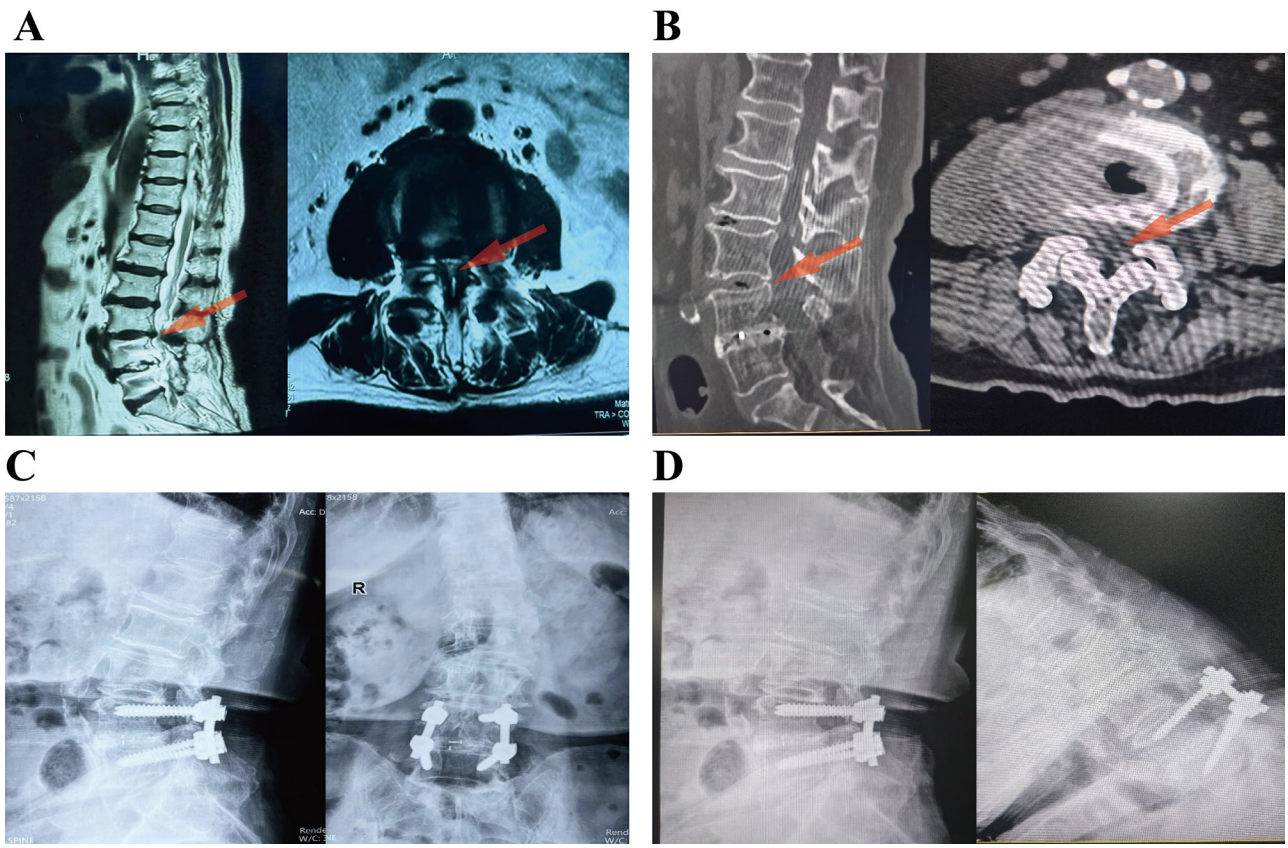


Figure 1. Preoperative imaging findings. (A) Preoperative lumbar magnetic resonance imaging. Sagittal view demonstrates hypertrophic ligamentum flavum and L3–L4 disc herniation leading to LSS. Axial view at the L3–L4 level confirms severe spinal canal narrowing. (B) Preoperative lumbar CT imaging. Axial CT scan at L3–L4 reveals significant spinal canal stenosis. (C, D) Lumbar radiographs. The views indicate well-positioned instrumentation at L4–L5 without evidence of abnormal translation or angulation at L3–L4, suggesting no signs of lumbar instability. The red arrows indicate the lesion site. CT, computed tomography; LSS, lumbar spinal stenosis.

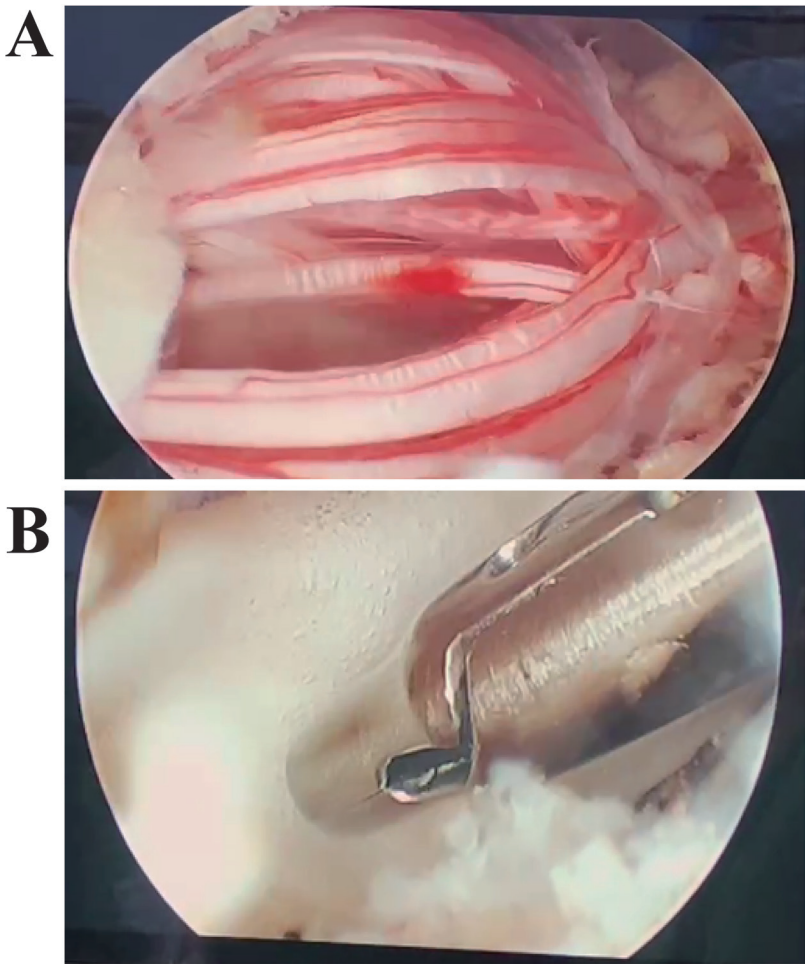


Figure 2. Intraoperative endoscopic findings. (A) Intraoperative view showing the cauda equina floating within the spinal canal. (B) A medical collagen membrane was applied intraoperatively to cover the neural structures.

terminated. A medical absorbable collagen membrane was then applied to cover the cauda equina. Subsequently, a drainage tube was positioned approximately 1 cm superficial to the membrane. Meticulous hemostasis was achieved postoperatively, and the working portal and endoscope were withdrawn. The skin incision was finally closed with absorbable sutures.

2.3. Postoperative cerebrospinal fluid leakage

A drainage tube was placed postoperatively. Drain output gradually decreased from postoperative day 1 to day 5 (Table 1). By day 5, the drainage volume was 59 mL. The patient reported no discomfort, such as headache, dizziness, or nausea, and the drain was subsequently removed.

2.4. Postoperative imaging and follow-up

The patient's symptoms improved significantly after surgery; VAS score was 3. The drainage tube was removed on the fifth postoperative day. No local bleeding or fluid leakage was observed after drain removal. Postoperative imaging confirmed adequate decompression of the spinal canal (Fig. 3). Postoperative radiographic assessment was not influenced by the medical absorbable collagen membrane. Upon follow-up inquiry, the patient reported substantial relief of symptoms. Although mild lower back pain persisted during ambulation on postoperative day 5, symptoms such as bilateral lower limb pain and weakness had markedly improved (Video 2). Additionally, the surgical incision was notably smaller compared with conventional open approaches (Figure S1, Supplemental Digital Content, https://links.lww.com/SPRES/A5). Magnetic resonance imaging at the 1-year postoperative follow-up demonstrated adequate spinal canal decompression (Fig. 4). The patient's low back and lower limb pain were also significantly relieved (Video 3), with a VAS score of 1.

Table 1

Postoperative drainage volume of the patient.

Postoperative day	Cerebrospinal fluid drainage volume (mL)
Day 1	400
Day 2	360
Day 3	300
Day 4	200
Day 5	59

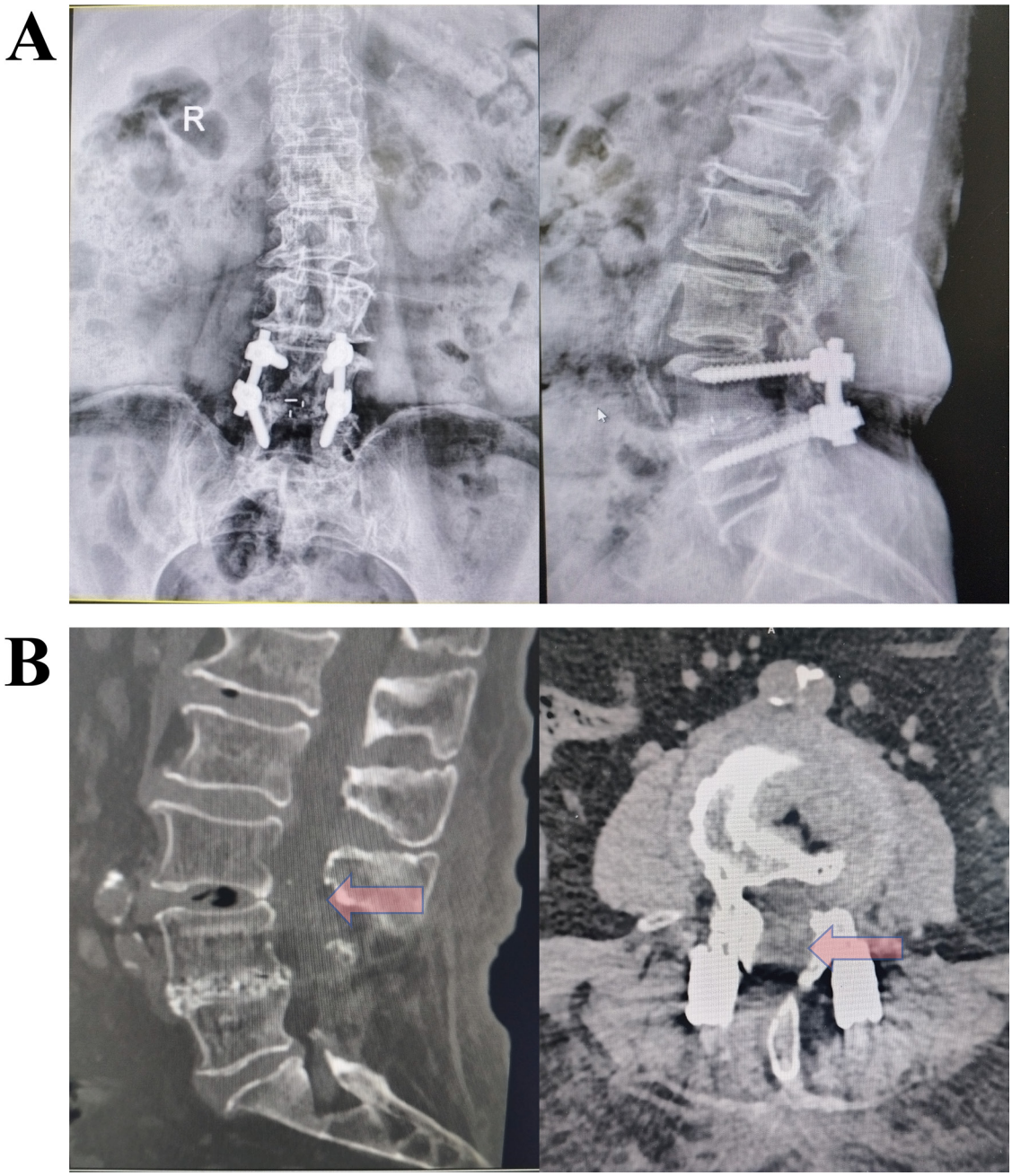


Figure 3. Postoperative X-ray and CT scans demonstrating adequate decompression of the lumbar spinal canal. (A) Postoperative lumbar radiographs show stable lumbar alignment.(B) Postoperative CT scans confirm adequate decompression of the spinal canal. CT, computed tomography.

3. Discussion

This report demonstrates the successful management of a case of ASP with LSS and a floating cauda equina using UBE. The intraoperative finding of the floating cauda equina prompted the application of a medical absorbable collagen membrane, thereby mitigating postoperative cerebrospinal fluid leakage. The membrane, primarily composed of type I collagen, supports the regeneration of tissue defects.

This medical absorbable collagen membrane serves as an adjunctive material for dural defect repair. Composed primarily of type I collagen, it promotes tissue repair.[6] When applied over the cauda equina, it reduces direct contact between the nerve roots and surrounding fluids (e.g., cerebrospinal fluid and blood), providing an additional protective barrier. Covering exposed nerve roots, the cauda equina, or the spinal cord surface, helps prevent postoperative fibrotic scar adhesion and encapsulation while minimizing cerebrospinal fluid leakage. The patient experienced a rapid postoperative recovery, achieving early ambulation. These findings suggest that UBE combined with a medical absorbable collagen membrane may represent a promising approach for managing such complex cases.

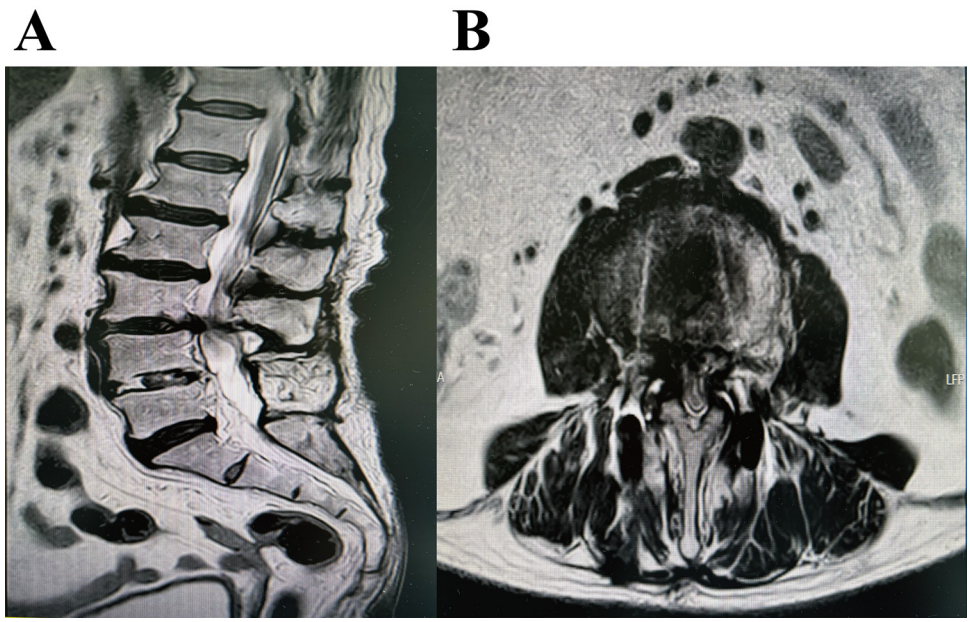


Figure 4. Magnetic resonance imaging at the 1-year postoperative follow-up demonstrated adequate spinal canal decompression. (A) Postoperative MRI shows stable lumbar alignment without significant thecal sac or nerve root compression. (B) Postoperative MRI demonstrates no obvious stenosis of the spinal canal or neural foramina, with adequate decompression of neural structures. MRI, magnetic resonance imaging.

ASP occurs at spinal levels adjacent to previously operated segments and can lead to the recurrence or worsening of neurological symptoms, often necessitating revision surgery.[7] ASP may further progress to secondary LSS. Treatment options include both nonsurgical and surgical approaches, with surgical management generally yielding favorable outcomes.[8] The endoscopic approach for ASP yields satisfactory clinical results, offering the benefits of minimal invasiveness and accelerated recovery.

The "cauda equina floating sign (CEFS)" described in this article specifically refers to the intraoperative observation during spinal endoscopic surgery where, in the presence of dural tears or partial dural defects, intact yet dissociated cauda equina nerve roots are seen floating loosely within the spinal canal. It is not intended to define a novel disease entity, but rather to provide a more precise description of the unique floating appearance of the cauda equina under the specific condition of dural integrity disruption. This sign differs from the physiological undulation of nerve roots under an intact dura mater, as well as from the pulsatile reexpansion of the dural sac following adequate decompression. It more directly visualizes the floating state of the cauda equina within the canal, resulting from dural integrity disruption. Furthermore, CEFS lies in providing surgeons with a direct visual clue to the possible presence of a dural tear or defect. This sign indicates a risk of cerebrospinal fluid leakage, necessitating dural substitution or coverage repair during the procedure.

Postoperative cerebrospinal fluid leak is a known complication of posterior lumbar procedures with an incidence of 1.8%–17.4%.[9] The patient in this case report also presented with this condition. Following the intraoperative application of a medical absorbable collagen membrane, the volume of postoperative cerebrospinal fluid output significantly decreased. However, this outcome cannot be entirely attributed to the membrane alone, as factors such as postoperative wound healing, overall postoperative management, and the specific placement of the drainage tube may have contributed. Our findings suggest that the medical absorbable collagen membrane holds potential therapeutic value in the management of cerebrospinal fluid leak. The combined UBE and medical absorbable collagen membrane technique may represent an effective surgical approach for ASP with LSS, especially in the presence of a floating cauda equina.

4. Conclusions

This case report successfully demonstrates the treatment of a patient with ASP-LSS and floating cauda equina using UBE combined with a medical absorbable collagen membrane. As a promising minimally invasive technique, the combination of UBE and a medical absorbable collagen membrane may represent an effective therapeutic strategy for CEFS and could potentially reduce the risk of cerebrospinal fluid leakage.

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Ethical statement

The study protocol received approval from the Ethics Committee of Yinchuan Hospital of Traditional Chinese Medicine, Ningxia (Approval No: 2025–255). Written informed consent was obtained from the patient for the publication of this case report and accompanying images. This study was conducted in accordance with the Declaration of Helsinki.

Conflicts of interest

The authors have no conflicts of interest to disclose.

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Data availability statement

All data generated or analyzed during this study are included in this published article and its supplementary information files.

Author contributions

FG and ZH jointly completed the data collection and paper writing. All authors reviewed and approved the final manuscript.

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