



1 Year-follow-up of transforaminal surgical approach in the management of migrated disc herniation: a cross-sectional study

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Background: Transforaminal percutaneous endoscopic lumbar discectomy (TPELD) recently confirms its superiority compared to typical open discectomy in the treatment of very high-grade migrated disk herniation. In Vietnam, this technique has been applied in recent years; however, lack of reports and evidence.

Objectives: In this study, the authors would like to share their surgical experience and report the initial results in their center, after successfully performing TPELD for very high-grade migrated disk herniation in 40 patients.

Patients and methods: Forty patients, who underwent TPELD to remove the nucleus of very high-grade migrated disk herniation, were enrolled in this study. The study was carried out from April 2019 to April 2021. Preoperative and postoperative MRI were compared to demonstrate the removed disk. Postoperative visual analog score, Oswestry disability index, and modified Macnab criteria were obtained after 1 month, 6 months, and 1 year and were compared.

Results: There were no major complications related directly to this technique. Seven patients were operated at L3-4, 28 patients at L4-5, and 5 patients at L5-S1. Mean visual analog score for leg pain improved from 7.36 ± 0.64 preoperatively to 1.22 ± 1.16 at 6 months postoperatively and 1.34 ± 1.47 at 1 year postoperatively ($P < 0.01$). The mean preoperative Oswestry disability index improved from 67.1 ± 8.79 preoperatively to 12.1 ± 13.48 at 1 year postoperatively ($P < 0.01$). Excellent or good global outcomes were obtained in 95%.

Conclusions: TPELD is a minimally invasive treatment with effective and safe results of very high-grade migrated disk herniation. Improvement of several pain scores can be observed in the 12-month follow-up after surgery.

Keywords: discectomy, migrated disk herniation, percutaneous endoscopic, transforaminal

Introduction

Migrated disk herniation is literally divided into three types: low-grade migrated disk herniation, high-grade migrated disk herniation, and a very high-grade one. Choi *et al.*^[1] defined a high-grade migrated disk herniation as a herniation greater than the height of the posterior border of the intervertebral space. Kim *et al.*^[2] described a very-high migrated disk herniation as a herniation migrating to the interior margin of the upper or lower vertebral. This type of herniation is still challenging clinicians to decide which interventions could bring completely herniated removal with the highest safety for patients. The initial choice of treatments preferred open surgery or minimal invasive discectomy with several successful case reports. A less invasive

HIGHLIGHTS

- Transforaminal percutaneous endoscopic lumbar discectomy is a minimally invasive treatment with effective and safe results of very high-grade migrated disk herniation.
- Improvement of several pain scores can be observed in the 12-month follow-up after surgery.
- The mean visual analog score for leg pain improved from 7.36 ± 0.64 preoperatively to 1.22 ± 1.16 at 6 months postoperatively and 1.34 ± 1.47 at 1 year postoperatively ($P < 0.01$).
- The mean preoperative Oswestry disability index improved from 67.1 ± 8.79 preoperatively to 12.1 ± 13.48 at 1 year postoperatively ($P < 0.01$).
- Excellent or good global outcomes were obtained in 95% of cases.

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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intervention, transforaminal percutaneous endoscopic lumbar discectomy (TPELD) is rarely used, due to the difficulties in manipulation caused by deep disk herniation in the spinal canal and anatomical obscured vision^[3]. However, recently, with the application of flexible and bendable instruments in revealing and removing migrated hernias, TPELD overcomes the limitations and confirms its superiority compared to typical open discectomy in the treatment of very high-grade migrated disk herniation, including less damage to soft tissue, less destruction of bone tissue due to the natural opening, less blood loss, and short recovery and hospitalization^[4,5]. In Vietnam, this technique has been

applied in recent years; however, lack of reports and evidence. Therefore, we would like to share our surgical experience and report the initial results in our center, after successfully performing TPELD for very high-grade migrated disk herniation in a number of patients.

Materials and methods

This is a prospective study in order to evaluate the initial results of 40 patients after TPELD to remove the nucleus of a very high-grade migrated disk herniation. The study was carried from April 2019 to April 2021. The study has been reported in line with the strengthening the reporting of cohort, cross-sectional and case-control studies in surgery (STROCSS) criteria^[6].

Subjects

Of the 40 patients, there were 14 women and 26 men; the mean age was 43.79 years old, ranging from 18 to 64 years old. All patients presented unilateral radicular leg pain, with or without back pain, altered sensation, motor weakness, or decreased tendon reflexes. They all had been failure of medication for at least 4 weeks, had clinical symptoms corresponding with an MRI of very high migrated disk herniation at a single level. Very high-grade migrated disk herniation was defined as herniation migrating to the inferior border of the upper or lower pedicle^[2] (Fig. 1, Figure 2). Exclusion criteria consisting of spinal stenosis, spinal instability, spondylolisthesis, and other comorbidities including: acute inflammation, infection, bone fractures, or cancer. Cases of a high iliac crest impeding the transforaminal entrance were also excluded from the study.

All patients undergoing TPELD had a postoperative MRI to confirm the migrated disk herniation had been totally removed. We also evaluated the clinical outcomes of patients through pain improvement on the visual analog scale (VAS), Oswestry disability index (ODI) score, and modified Macnab scores^[7]. Patients were discharged from the hospital 1 day after surgery and periodically examined after 1 month, 6 months, and until at least 1 year.

Surgical procedure of transforaminal percutaneous endoscopic lumbar discectomy

Preparation of the patient and direction of the transforaminal approach

All patients underwent preoperative MRI to determine the location of the migrated herniation, the direction of the entry, and the approach angle of the guide needle. The patient is placed in the prone position on the special X-ray transparent operating table. The surgery was performed under local anesthesia with lidocaine 1% and intravenous sedation/analgesia with fentanyl. The use of analgesia - sedation should ensure that the patient is awake during surgery (but not too shallow). The skin entry point was determined on the spinal lateral projection of the C-arm view, usually 10–15 cm from the midline, depending on the patient's body size. The needle direction was between the posterior spinous process and the posterior margin of the articular facet. A 18G needle was inserted through the skin, to the intervertebral foramen, into the disk. The disk access site and the needle angle depend on the location and direction of the migrated herniation. It should be as close as possible to the annular puncture site. If the disk herniation migration is upward, the needle angle should be upward, and vice versa (Fig. 3). Once the needle reached the disk,

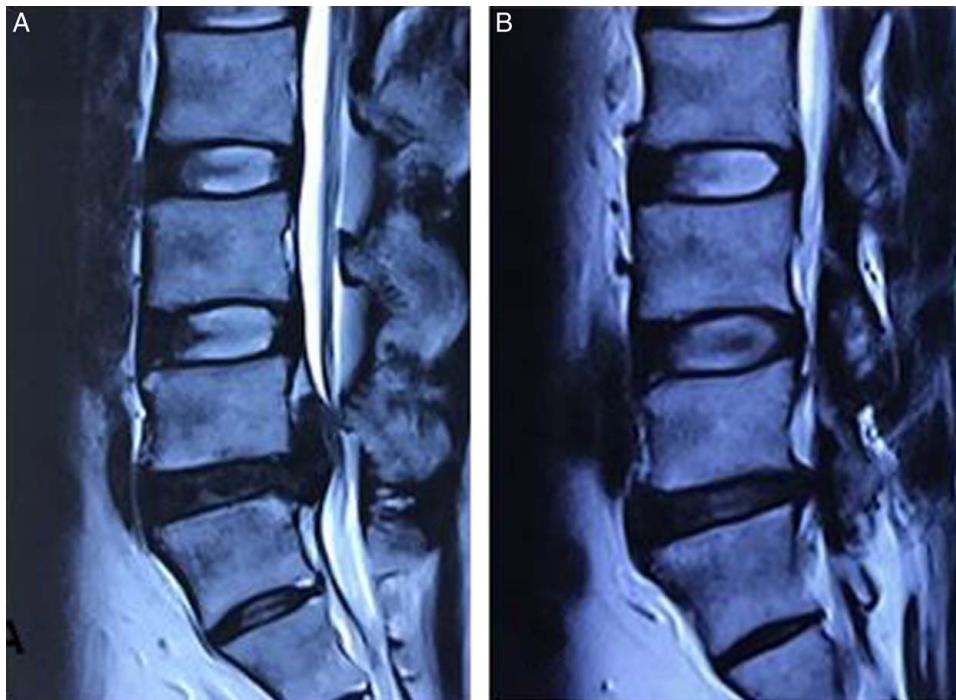


Figure 1. MRI of a 35-year-old female patient. (A) Preoperative MRI shows a very far migrated disk herniation at L5-S1 with an upward drift. (B) Postoperative MRI shows that the disk herniation mass was completely removed.

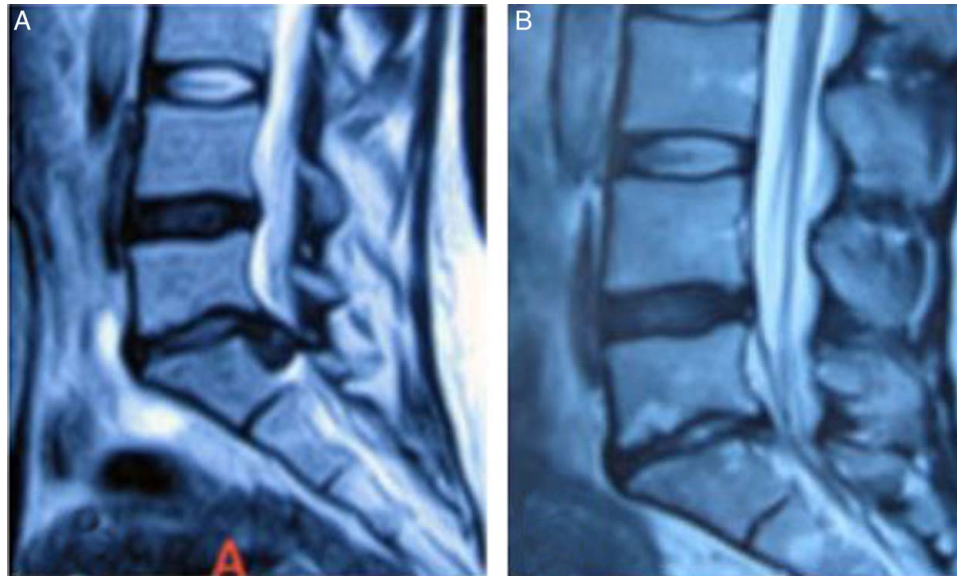


Figure 2. MRI of a 65-year-old male patient. (A) Preoperative MRI showed a very high-grade migrated disk herniation at L5-S1 with a downward drift (B) Postoperative MRI showed that the disk herniation mass was also completely removed.

an epidural anesthesia can be induced prior to disk removal, which helps to relieve pain during instrument placement and foraminoplasty.

Entry widening

Entry was expended from the guide needle, followed by the sequential dilatation of the tract, the foraminoplasty drilling system, and finally the working sheath placement. The beveled working sheath positioned across the disk to the epidural space for better visibility (“half-and-half” technique). In very far migrated disk herniation or foraminal stenosis (due to facet joint hypertrophy, ligament thickness, etc.), foraminoplasty is needed. Foraminoplasty is partly removal of the superior articular process and possibly the inferior articular process and the pedicle, using

chisels, reamers, drills, or a laser knife through the working sheath system. It helps to clearly observe the epidural space, neural structures, and help endoscope reach the disk herniation. The endoscope system then placed via the working sheath, prepared for exposure. The surgeon, under endoscope view, gently adjusted the working sheath system to be close to the herniated disk, for more convenient and safer exposure and removal. Decompression from the abdomen will allow enough working space to access the migrating disk herniation either upward or downward.

Exposure of the disk herniation mass

Exposure of the disk herniation mass usually begins with approaching the annulus puncture. It is important to clearly

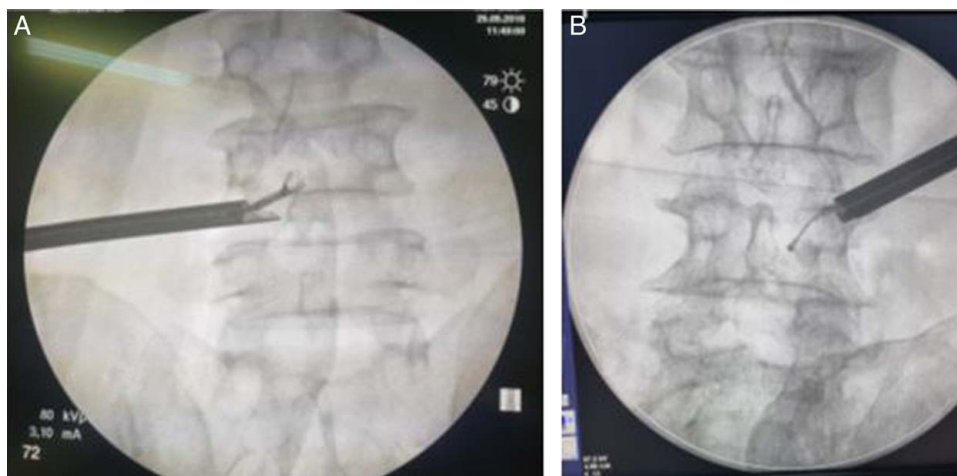


Figure 3. Applying TPELD to remove very high-grade migrated disk herniation. (A) Using a curved probe, dissect the migrated disk herniation mass upward. (B) Using a curved probe, dissect the migrated disk herniation mass downward. A. VAS score. B. ODI score. C. MacNab Criteria.

dissected the anatomical structures surrounding the annulus fibrosus under endoscope view. The inner and outer layer of the annulus, the posterior longitudinal ligament complex, and the outer epidural layer are separated from the surrounding epidural fat and epidural fibrous sheath. The outer layer of the annulus fibrosus and posterior longitudinal ligament can be exposed with straight forceps and radiofrequency ablation. The epidural space inside is usually difficult to observe because the disk herniation fragments have adhered to the surrounding fibrous tissues. Since it was completely revealed, the disk herniation mass will be well identified and ready for further manipulation. The tip of the working sheath can be gently rotated toward the disk herniation mass for easier observation and manipulation (Fig. 3).

Removal of migrated disk herniation

We use curved forceps to dissect along the disk puncture. A bendable probe is effectively used to check the direction of disk herniation and dissect them under the guidance of the C-arm and the endoscopic system (Fig. 3). The disk herniation then is completely removed by these flexible instruments, in a whole or by small pieces, from the corresponding vertebral disk, the annulus fibrosus, and also from very far migration. Hemostasis and decompression were performed effectively by radiofrequency ablation. After the removal of the entire herniation, well-decompressed epidural fibrous sheath and the nerve roots are confirmed by their pulsation. We use a straight and curved probe to check and assure no herniation left. Through the endoscopic system, abnormal signs such as dural damage or epidural bleeding were

carefully evaluated. After completing the hemostasis process, we remove the endoscopic system and finally finish with a suture.

Result

The surgical procedure was performed mostly at L4-5 with 28 cases (70%), followed by seven cases (17.5%) at L3-4, and five cases (12.5%) at L5-S1. The disk herniation commonly migrated downward in 29 cases, 11 cases left was upward. The mean VAS score before surgery was 7.36 ± 0.64 and decreased immediately 1 month after surgery with 1.42 ± 1.15 , after 6 months was 1.22 ± 1.16 , and after 1 year was 1.34 ± 1.47 ($P < 0.01$). The mean ODI score before surgery was 67.1 ± 8.79 , and decreased after 6 months 10.8 ± 9.81 , after 1 year 12.1 ± 13.48 ($P < 0.01$). (Fig. 4A, B)

According to the Macnab scale, 1 year after surgery the number of patients with excellent and good results accounts for 95% (very good result observed in 18 cases (45%), good in 20 cases (50%), fair results were reported in two cases (5%). No patients were with poor results or experienced complications during and after surgery. Two patients who still had numbness and paresthesia postsurgery were managed with analgesia and became stable after 3 months of treatment (Fig. 4C).

Discussion

Although some authors initially applied interlaminar surgery and open surgery in the treatment of far migrated disk herniation^[3,8], today, due to the strong development of modern surgical

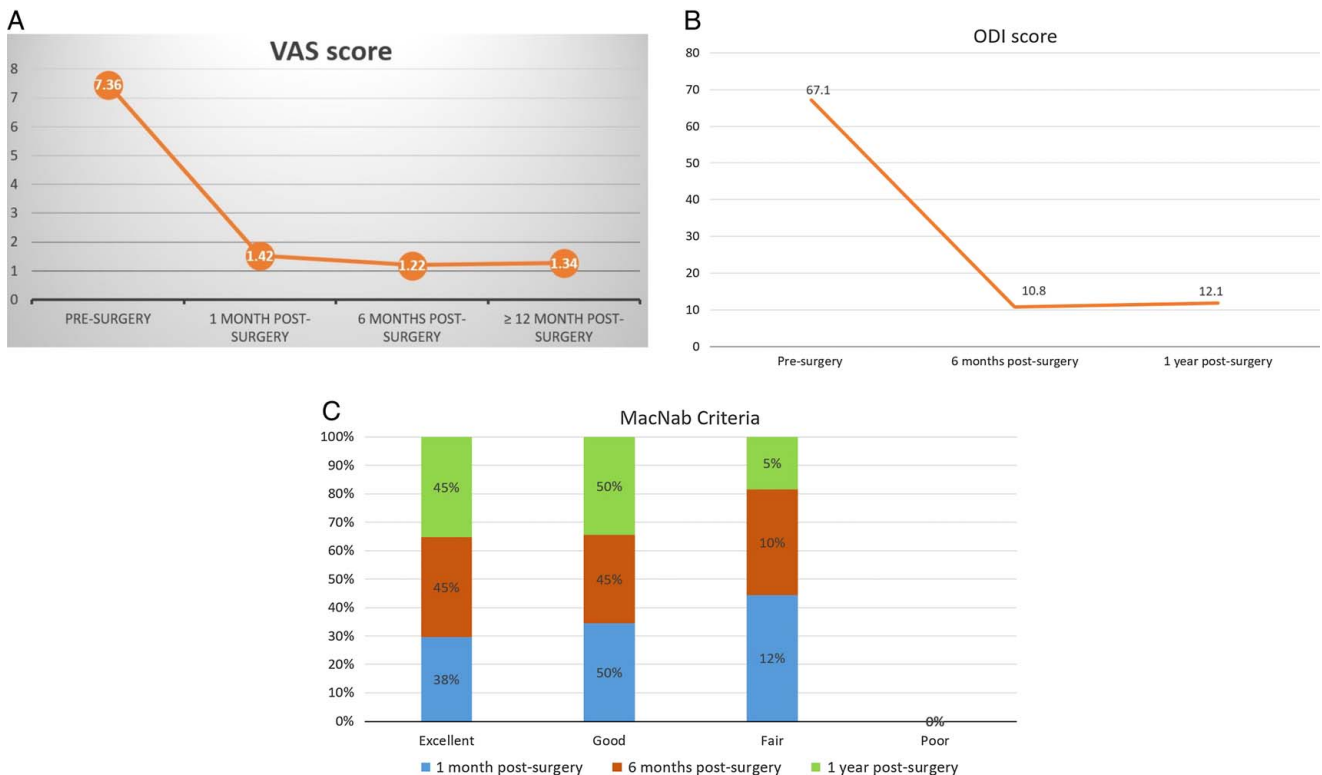


Figure 4. (A) VAS score for leg pain before surgery and 1 month, 6 months, and over 1 year after surgery. (B) ODI score before surgery, 6 months, and over 1 year after surgery. (C) MacNab criteria 1 month, 6 months, and over 1 year after surgery.

instruments and the advancement in endoscopy, the application of TPELD is gradually preferred^[9]. The use of this minimally invasive technique in the management of disk herniation with far migration has several advantages compared to the two above approaches. First, there is a lower risk of dural injury with TPELD due to two reasons: the dura is pushed toward the abdomen by migrated disk herniations; and the dura mater or nerve roots are not necessary to be removed in order to expose the herniation. Second, the TPELD can expose anatomical layers without experiencing the obstruction of the entry caused by overlapping posterior laminae as in the interlaminar approach, which leading to time consuming and ineffective performance^[10]. Third, in the transforaminal access, the disk components consisting of the primary disk and migrated disk fragments can be removed entirely through the foramen. In contrast, with the posterior interlaminar approach, disk fragments may remain and lead to recurrent disk herniation or incomplete decompression. Finally, the whole surgery was performed under local anesthesia, unlike the interlaminar or open surgery where spinal anesthesia or general anesthesia are performed to ensure patient safety. Clearly, an approach through the intervertebral foramen is a less invasive intervention^[11,12].

The use of surgical tools such as chisels, reamers, drills, and a laser knife will be very effective in expanding the intervertebral foramen. Foraminoplasty is a procedure to remove part of the superior facet joint, and possibly part of the lower one and the vertebral pedicle. After removing the anatomical obstructions, it helps to bring clear observation of the epidural space, nerve roots, and disk herniation fragments. Therefore, foraminoplasty is considered to be the key for the success of the operation^[13]. In the procedure, the guide needle should be placed in the lower part of the foramen to avoid nerve damage. After placing the round-headed working sheath system, it is advisable to gently rotate the working sheath head up or down towards the disk herniation mass, under the observation of the endoscopic system and C-arm, for easier manipulation. Using flexible instruments such as curved forceps, articulated forceps, and a bendable probe help the surgeon to reach the distal end of the disk herniation and remove fragments. The bendable probe will help dissect the distal tip of the disk herniation and release the adherent soft tissue. Curved forceps will help track the disk herniation and remove it under the guidance of both endoscopy and C-arm systems^[14].

One of the most important aspects of the TPELD technique is to control epidural bleeding during disk removal and decompression^[15]. It can be caused by epidural vein injuries and by congestion around the disk herniation fragments. Uncontrolled bleeding will obstruct the surgeon's view, resulting in surgery failure or an epidural hematoma. Fortunately, in our study, there were no cases with epidural bleeding during surgery. Through our experience, to prevent this complication, it is important to avoid placing blind instruments into the epidural space. More important, the surgeon needs to be very careful and slowly dissect along the disk herniation, until reaching the tip of the migrated mass. Otherwise, if the complication happened, it is necessary to stop bleeding directly by radiofrequency ablation or insert hemostatic materials for a few minutes. Another concern during the manipulation with epidural instruments is the risk of a dura tear^[16]. Though this complication is rare since the boundary between the dura and the disk herniation is often apparent, when it occurs, switching to open surgery for reparation is imperative. It is also important for the surgeon to always clearly delineate the

anatomical boundary between nerve roots and the surrounding soft tissues.

Our study showed that the L4-5 disk was the most commonly herniated level with 28 cases (70%). According to the modified Macnab score, excellent or good results accounted for 90%. This was consistent with the study of Lee *et al.*^[17] on 116 patients undergoing percutaneous endoscopic lumbar discectomy, with 56.0% patients had L4-5 herniated disk, and satisfactory results in Macnab criteria was 78.9% in the far herniated disk. Postoperative pain improvement and disability were evaluated through the VAS and ODI score as the main outcomes. Significant improvements were well-maintained within at least 1 year of follow-up in the VAS score (from 7.36 ± 0.64 to 1.34 ± 1.47) as well as the ODI score (from 67.1 ± 8.79 to 12.1 ± 13.48).

The main limitations of the study were the lack of a control group, the short follow-up, and the small number of study patients. However, for the minimum 1-year-follow-up period, our study has partly reflected the safety and effectiveness of endoscopic surgery in releasing nerve compression. Since the percentage of patients with very high-grade migrated disk herniation was low in clinical practice, the number of patients in our study is considerably acceptable. With a longer follow-up period and a larger number of patients, a controlled study would bring more values in evaluating TPELD safety and efficiency in very high-grade migrated disk herniation and also in assessing disk degeneration or conditions related to disk collapse after the intervention.

Conclusion

TPELD is a minimally invasive treatment which may bring effective and safe results of very high-grade migrated disk herniation. It would be associated with early clinical improvement of radicular leg pain and function as well as a removed disk. Improvement of several pain scores can be observed in the 12-month follow-up after surgery.

Ethical approval and consent

The study was approved by our Institutional Review Board of Viet Duc University Hospital. All patients provided informed consent.

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None.

Author contribution

H.M.D.: conceptualization, data curation, formal analysis, investigation, methodology, software, supervision, validation, visualization, writing – original draft, writing – review and editing; H.T.N.D.: software, validation, visualization, writing – original draft, writing – review and editing; L.H.N.: data curation, formal analysis, investigation, methodology, writing – original draft, writing – review and editing.

Conflicts of interest disclosure

The authors have no conflicts of interest to declare.

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Data availability statement

Data is available upon reasonable request.

Provenance and peer review

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