Clinical Case Report

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Percutaneous endoscopic lumbar discectomy by transfacet joint approach

A case report

Cong Ning, MD[a], Yuanyi Wang, PhD[a], Feng Xu, PhD[a], Wenjing Zhang, PhD[b], Wei Liu, MD[a], Zhenshan Lv, MD[a], Yadong Liu, PhD[a], Changfeng Fu, PhD[a,*]

Abstract

Rationale: The accurate and smooth establishment of a working cannula guarantees rapid and minimally invasive treatment effects using percutaneous endoscopic lumbar discectomy (PELD) for lumbar disc herniation (LDH). With anatomic variations such as a hyperplastic superior articular process (SAP), the conventional transforaminal approach cannot achieve an ideal result.

Patient concerns: A 48-year-old male patient suffered waist and left lower limb pain, with exacerbation of symptoms after exertion.

Diagnoses: L5-S1 disc herniation, hyperplastic SAP of S1.

Interventions: To demonstrate the segment responsible for compression, a lumbar nerve root block was carried out. This was followed by PELD via a transfacet joint approach at L5-S1.

Outcomes: The patient experienced an improved quality of life postoperatively (i.e., visual analog score for pain = 1 and Oswestry disability index = 88). Lumbar function and stability were preserved as of the 1-month postoperative follow-up.

Lessons: The transfacet joint approach could extend the indications for PELD and present an alternative option in selected cases. A new concept of "subsidence foramen" is raised to characterize this anatomic variation, and it may guide working access establishment of PELD. In addition, reading imaging results carefully and individualizing treatments promote the use of PELD as minimally invasive surgery.

Abbreviations: CT = computed tomography, LDH = lumbar disc herniation, MRI = magnetic resonance imaging, ODI = Oswestry disability index, PEID = percutaneous endoscopic interlaminar discectomy, PELD = percutaneous endoscopic lumbar discectomy, PSE = percutaneous spinal endoscopy, SAP = superior articular process, VAS = visual analog scale.

Keywords: disc herniation, lumbar, percutaneous endoscopic lumbar discectomy, transfacet joint

1. Introduction

Percutaneous spinal endoscopy (PSE), as an effective operation approach with minimal invasion, developed rapidly along with the industrial progress over the last two decades. Yeung et al[1] and Hoogland et al[2] started a boost of percutaneous endoscopic lumbar discectomy (PELD) by proposing their lumbar approaches and decompression techniques with different concepts, respectively, around the year 2000; then Zhou and his group[3] generalized and spread these techniques in China. PSE has become a commonly seen surgery favored by patients and surgeons. As a minimally invasive surgical option, PSE surgeries are associated with immediate pain relief, shorter operative times, faster recoveries and shorter hospital stays, require only local anesthesia, and cause less intraoperative bleeding.[4–7] By virtue of these advantages, PSE, especially PELD, has an ongoing increasing contribution in the treatment for painful degenerative diseases of the lumbar.[8,9]

To date, various newly designed approaches with matched surgical instruments have been put forward by clinicians to manage different anatomical conditions and surgical targets.[10–12] These innovations have broadened the indications for PSE, which is no longer restricted to minimally invasive lumbar discectomy, but has been progressed to full spine endoscopy. As the rapid evolution of PSE, accumulating obstacles, which may not be taken into serious consideration due to the long-term proficiency of open surgeries, were presented and shattered by PSE clinicians. Among various situations encountered in PELD by clinicians, narrowed intervertebral foramen represents some of the most challenging crests that disrupt the accessibility in the transforaminal approach, which is more frequently seen at the L5-S1 level.[13]

The L5-S1 segment has the most typical lumbar intervertebral foramen, whose shortened longitudinal and transverse diameters

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C.N. and Y.W. contributed equally to this work.

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[a] Department of Spine Surgery, The First Hospital of Jilin University, [b] Department of Anesthesia, China-Japan Union Hospital of Jilin University, Changchun, People's Republic of China.

[*] Correspondence: Changfeng Fu, Department of Spine Surgery, The First Hospital of Jilin University, Changchun 130021, People's Republic of China (e-mail: fucf1976@163.com).

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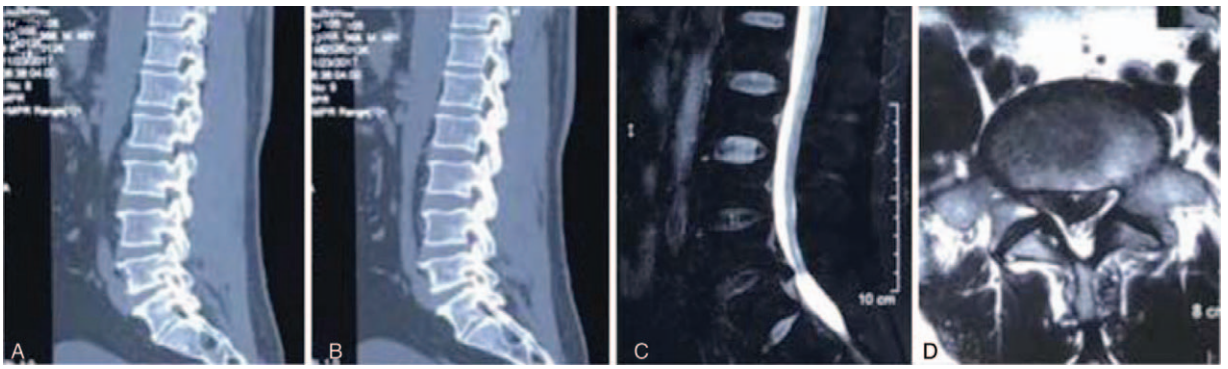

Figure 1. Preoperative sagittal CT showing that the left foramen is narrow and collapsed caused by hyperplastic SAP of S1 (A and B). Preoperative MRI shows the compressed dural sac due to L5-S1 disc herniation (C) and central type LDH (D). CT = computed tomography, LDH = lumbar disc herniation, MRI = magnetic resonance imaging.

caused by degenerated disc height and articular process hypertrophy have resulted in difficulties and failures in working access establishment.[14,15] To achieve better understanding of the access difficulties induced by foraminal anatomy structural aberrance, we propose a new concept of subsidence foramen, characterized by a hyperplastic superior articular process (SAP) and a degenerated foraminal transverse diameter (Fig. 1), which may impede the access of the working cannula during foraminoplasty and increases the risk of exiting root injury greatly.[16] Then we present a new minimally invasive approach which relieves the compression caused by L5-S1 disc herniation through the facet joint.

2. Case report

This study was approved by the Ethics Committee and the Institutional Review Board of the First Hospital of Jilin University.

A 48-year-old male patient had waist pain followed by the pain in his left buttock and left lower leg for 1 year. The pain became worse over a 1-month period because of overexertion. The patient came to our hospital for a checkup, was diagnosed with "lumbar disc herniation," and subsequently was transferred to the in-patient department.

On physical examination, his vitals showed a body temperature of 36.5°C, blood pressure of 133/80 mm Hg, heart rate of 80 beats per minute, respiratory rate of 22 breaths per minute, and blood oxygen saturation of 99%. The patient's lumbar vertebrae range of motion was obviously restricted since he entered the ward with a limp. The pertinent nervous system examination results included left lower extremity muscle strength 3/5, straight leg raise test was 60°, and normal deep tendon reflexes. The visual analog scale (VAS) score was 8 and the Oswestry disability index (ODI) score was 56.

A computed tomography (CT) scan showed the L5-S1 disc herniation with calcification of the disc fibrous ring, secondary spinal canal stenosis, and hypertrophy of S1 SAP. Magnetic resonance imaging showed compression of the dural sac by the L5-S1 disc herniation (Fig. 1). As a result, this patient was diagnosed with a lumbar disc herniation (L5-S1) and offered surgical intervention.

A lumbar nerve root block was performed the day before the operation under local anesthesia to determine the segments of lumbar vertebrae that were responsible for the symptoms, and to predict the postoperative outcome. Compression of the S1 nerve root was caused by herniation of the L5-S1 disc. A transforaminal endoscopic lumbar discectomy via a lateral approach was performed the next day.

For the procedure, the patient was positioned in the right lateral position with cushioning placed under the right side of the waist. The median line was marked through the spinous process of the lumbar vertebrae. The L5-S1 intervertebral space was confirmed under C-arm fluoroscopy, and an intersection point between the line and space was formed. The puncture point was determined to be 10 cm to the left and 1 cm cranial to the intersection point. The patient was prepped and draped in standard sterile fashion and 0.8 wt% of lidocaine was used for local infiltration anesthesia around the skin, fascia, and the facet joint. Aided by C-arm fluoroscopy, the SAP of S1 was touched by the 16-gauge puncture needle, which was fixed to the facet capsule of L5-S1, and then 20 mL of 0.8 wt% lidocaine was injected (Fig. 2). An 8 mm skin incision was made at the puncture point and the needle was replaced with a guide wire. The soft tissue was expanded step by step using a scale 4 reaming device, and a facet-plasty was performed. A Tommy needle was inserted through the facet joint into the spinal canal. Under the guidance of C-arm fluoroscopy, the Tommy needle arrived at the median line of the spinal canal from a positive view and the posterior-superior edge of the lower vertebral body (S1) from the lateral view (Fig. 2). Next, the cannula and the transforaminal endoscope were inserted to replace the Tommy needle. The calcified ligamentum flavum and the outer fibrous ring at the posterior edge of the vertebra that was causing compression to the nerve root were removed. This completely decompressed the dorsal and ventral sides of the nerve root. The autonomous pulsation of the dural sac could be observed when the nerve root was completely relieved. The blood flow to the nerve root surface was obviously improved and the nerve root was restored (Fig. 2). In the straight leg raise test performed during the operation, the nerve root moved freely when it was stretched. One day after the operation, the patient's VAS score was 1, the muscle strength of the left lower extremity increased to 4/5, and the straight leg raise test result was negative.

Three days after surgery, a lumbar CT showed that the disc herniation was excised and L5-S1 dural sac compression was relieved (Fig. 3). Three-dimensional CT showed a passage made through the L5-S1 facet joint connecting spinal canal (Fig. 3). Follow-up conducted 1 month after the operation revealed that

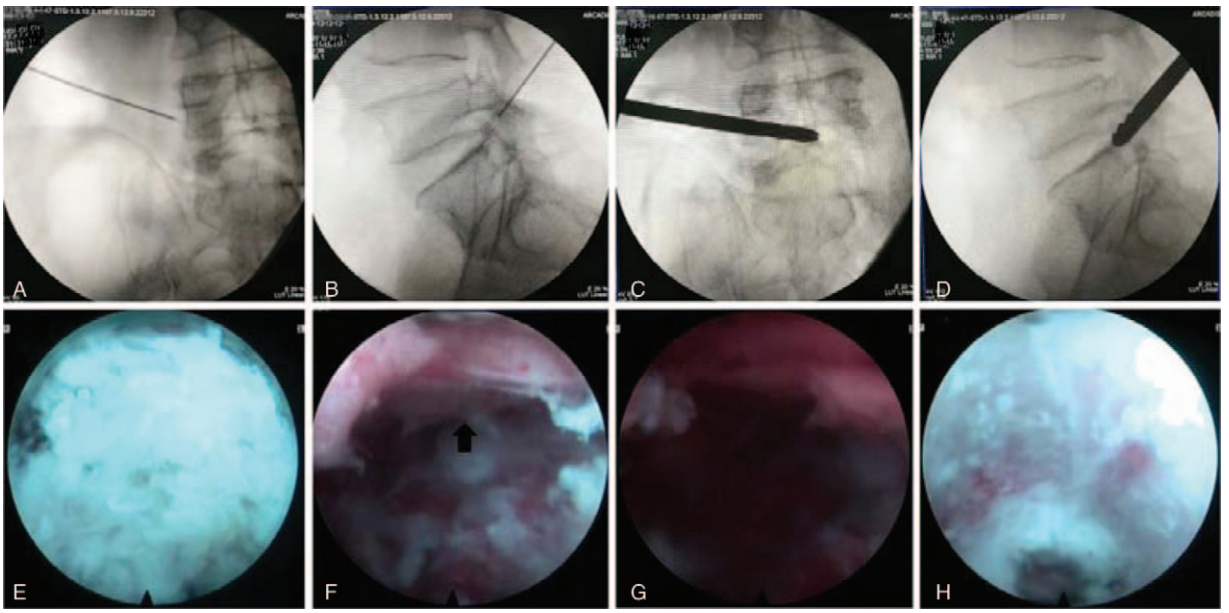

Figure 2. C-arm fluoroscopy monitored PELD. The 16-gauge puncture needle was inserted percutaneously to the left facet capsule of L5-S1 (A and B). Foraminoplasty was achieved using the reamer. The tip of the reamer passed the midline of the spinal canal (C) and reached the posterior-superior end of L5 (D). Disc herniation decompressing on ventral nerve was detected distinctly (E). The blood flow to the nerve root (black arrow) was restored after decompression (F). The space between ventral dural sac and disc was enlarged (G). Artificial foramen without bleeding was identified under endoscopy (H). PELD = percutaneous endoscopic lumbar discectomy.

the VAS score was 1 and the ODI score was 88. X-ray of the functional position demonstrated that lumbar stability was preserved postoperatively, according to the Dupuis method.[17] In brief, the angle between L5 and S1 was less than 10° and there was no translation of L5 on S1 in flexion or extension (Fig. 4).

3. Discussion

Spine has great anatomical variation among races and individuals. In the very same unit, the structures of vertebra are different from each other according to their segment and function. In the full spinization of PSE, anatomical variation is a restrictive issue. It is widely acknowledged that percutaneous endoscopic interlaminar discectomy (PEID) can overcome the barriers of anatomical variations such as narrow intervertebral foramen and high iliac crest in the treatment of LDH.[18,19] However, the interlaminar approach is generally suitable for axillary and migrated disc herniation. In this approach, a working cannula is placed through the space between the spinal cord and the nerve root, which might stretch the nerve root leading to sensory or motional paralysis of the corresponding area. On the contrary, introducing a working cannula through a transforaminal approach allows passage to the midline of spinal canal without causing scar tissue on the back.[20] The LDH in this case belongs to the central type, and it is more appropriate to consider performing lateral transforaminal discectomy.

Nevertheless, for patients with high iliac crests, hypertrophy of the transverse process, or hyperplastic joints, the traditional transforaminal approach appears to be inadequate. Surgical advances have improved the transforaminal approach. Ao et al[21] created a double-cannula foraminoplasty device to treat LDH. The treatments were effective and no serious complications resulted.[21] Choi et al[11] reported the use of a transforaminal endoscopic system through an transiliac approach to remove protruding discs of L5-S1 segments. The success of the above operations depends on the correct placement of the working passage.

Conventional open transfacet approach has been used widely in spine surgery, it is an appropriate surgical approach for decompressing the disc which compresses ventral dural sac and the hypertrophied yellow ligament which compresses from posterior part of the spinal canal.[22] Stillerman et al[23] proposed a cadaveric analysis of transfacet pedicle-sparing approach for thoracic disc removal, which is effective and advantageous on many aspects. In 2010, modified transfacet approach with fusion was introduced, which demonstrated better exposure and more effective disc removal,[24] and accumulating clinical studies supported the safety and the efficacy of the approach.[25] And in PSE, this approach has been modified to the keyhole approach, which is also a posterior approach sharing similar principle with PEID. The transfacet approach we are proposing is a supplement of lateral approach, in which blunt bone reamers were firstly utilized in the facet joint surface plasty.

In this case, the left SAP of S1 was ventrally inclined, resulting in collapse and narrowing of the left intervertebral foramen in the L5-S1 segments. This allowed only the L5 exiting nerve root to pass through. The foramen was rather distal from the midline of the spinal canal at L5-S1, which caused the decompression area to be further away from the foraminal entry. The placement of the operating cannula through the foramen significantly increases the risk of nerve root injury and inevitably results in postoperative numbness of the corresponding area. Conventional foraminoplasty is not suitable in this case, since SAP requires significant tissue excision to enlarge the foramen and ensure adequate space for cannula placement. This process becomes difficult in cases of degenerated and hypertrophic SAP. Moreover, an extended angle and proper cranial angle are needed when creating the working passage; however, the angular support is inadequate in foraminoplasty of a subsidence foramen. As a consequence, PELD via L5-S1 facet joints becomes a logical step.

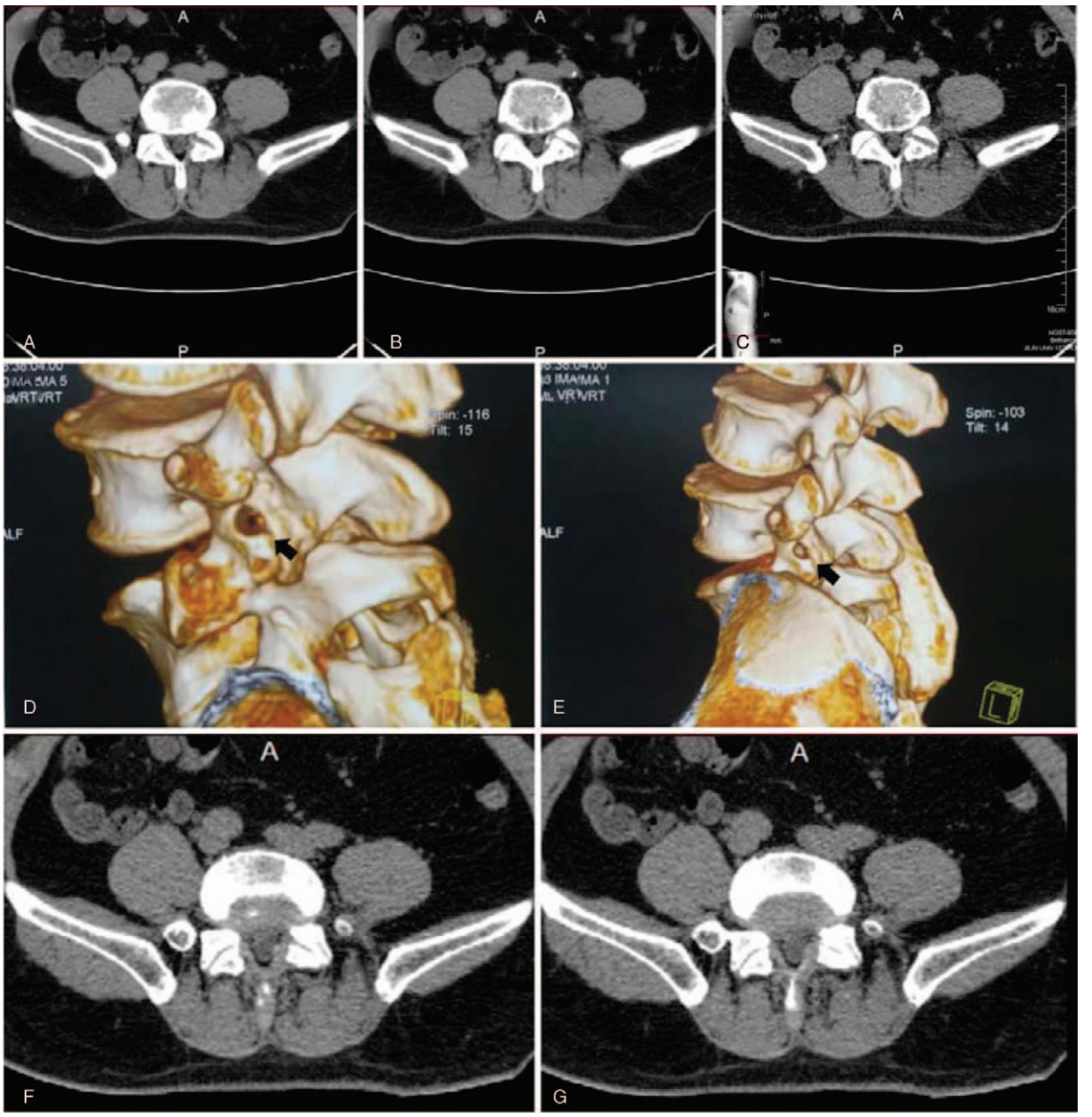

Figure 3. Postoperative CT shows the working tract through the left facet joint (A–C). Three-dimensional CT revealed that the passage (black arrow) was made through the facet capsule (D and E). Postoperative CT demonstrates the decompressed dural sac and restored spinal canal (F and G). CT = computed tomography.

The key to the success of this operation is to establish an accurate and suitable working passage without destroying the mechanical stability of the lumbar vertebrae. The placement of the working cannula avoids the restriction of the SAP to its head inclination angle, allowing it to easily arrive at the target area of decompression. On the other hand, when using the bone reamer to establish the working tract, the surroundings were mostly articular cartilage, that is, less rigid than hypertrophic tissue, and there were no important anatomical structures such as blood vessels or nerves in that location. This also allows for the smooth insertion and passage of the working cannula without prolonging the operating or X-ray time. One month after the operation, the functional position X-ray showed that all the force lines were in the normal range and the VAS score for his backache was 1. The results of the follow-up showed that the cannula which had passed through the facet joints did not damage the local stability of the lumbosacral vertebrae and the joints maintained their effective functions.

The transfacet joint approach cannot be applied universally. Ventrally inclined SAP and sufficient distance between the facet and the midline suggested that this access route was approximately the same distance and had the same relationship to the travelling nerve root as would the classic transforaminal approach. In other words, if this approach is used in an anatomically normal patient, nerve injury might occur as a result of the close distance between the facet and the nerve, and the insufficient extended angle of the working passage could result in unexpected consequences. Reading imaging results carefully will help clinicians to determine the most appropriate approaches in different cases. Additionally, blunt bone reamers are essential.

Figure 4. Functional X-ray 1-month after surgery shows no translation or slip at L5-S1. In flexion and extension, the angle between the tangent of the upper and inferior end-plate was 9° (A) and 8° (B), respectively.

Though sharp-head reamers might have advantages in removing solid tissues, the probability of nerve injury elevates due to the anatomical uncertainty stated above.

Immediate complications can be also predicted and avoided effectively if given enough attention during the perioperative period. First, in order to avoid occurrence of bleeding in the facet joint, the reamer should be used gently and replaced step by step. Continued expansion should follow the direction of the previous tract to minimize damage to the articular cartilage. Second, to protect the function of the facet joint, it is necessary to precisely examine the direction of the advancing needle before the operation using the C-arm. The working cannula should be installed with minor angle error to maximally protect the integrity of the joint capsule. Third, previous trauma to the lumbar vertebrae and lumbosacral transitional vertebrae are defined as contraindications to this procedure. In brief, adequate imaging assessments should be employed to evaluate the patient's lumbar stability before considering this type of operation.

Finally, as to the entire course of treatment, some tips are summarized below. First, the operative indication is central disc herniation, in which more than 60% of the area of foramen is covered by hyperplastic SAP. Second, the artificial foramen should be fully expanded with the 9 mm reamer during the operation, to ensure the movement of the surgical instruments under the endoscope. In addition, the working cannula should be placed along the articular surface. Third, the term of follow-up should be prolonged and attention should be paid to the stability of the lumbar region.

4. Conclusions

In conclusion, in cases of lumbar disc herniation with intervertebral foramen covered by hyperplastic SAP, PELD via the transfacet joint approach could replace the traditional surgical management procedures. This approach extends the indications of PELD greatly, and treating LDH with minimally invasive surgery will become significantly popular.

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Author contributions

Conceptualization: Yuanyi Wang.
Data curation: Wei Liu.
Funding acquisition: Changfeng Fu.
Investigation: Zhenshan Lv.
Methodology: Feng Xu, Wei Liu.
Project administration: Changfeng Fu.
Software: Yadong Liu.
Supervision: Feng Xu, Zhenshan Lv, Changfeng Fu.
Visualization: Yadong Liu.
Writing – original draft: Cong Ning.
Writing – review & editing: Yuanyi Wang, Wenjing Zhang.

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