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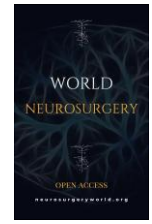
Journal homepage: neurosurgeryworld.org




Technical Note

# Innovative One-hole Split Endoscopy for Posterior Atlantoaxial Lateral Mass Joint Fusion: Technical Details and Clinical Application

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A R T I C L E I N F O

*Keywords*:
Atlantoaxial instability or dislocation
one-hole split endoscopy
atlantoaxial fusion
endoscopic cervical surgery

A B S T R A C T

**Background:** Posterior atlantoaxial arthrodesis remains a cornerstone in the surgical management of atlantoaxial instability or dislocation (AA I/D). However, its application is frequently complicated by substantial intraoperative blood loss and postoperative axial pain. The increasing use of endoscopic spinal surgery provides a promising avenue for addressing these issues.

**Methods:** This study introduces an innovative, minimally invasive technique for atlantoaxial fusion, one-hole split endoscopy for posterior atlantoaxial lateral mass joint fusion. We designed a detailed surgical protocol and perioperative management strategy, followed by a preliminary clinical application to evaluate the technical advantages and clinical feasibility.

**Results:** A 12-year-old boy, diagnosed with AAI, os odontoideum, and myelopathy, underwent the novel endoscopic fusion procedure in conjunction with atlantoaxial screw fixation. Postoperative images confirmed successful reduction of the atlantoaxial lateral mass joint and satisfactory graft fusion. At the six-month follow-up, computed tomography reconstruction revealed continuous bony bridging across the lateral mass joint space, indicating an initial osseous fusion.

**Conclusion:** To our knowledge, this is the first clinical application of posterior atlantoaxial lateral mass joint fusion using one-hole split endoscopic system, demonstrating its clinical feasibility and technical advantages, and offering a novel, efficient, precise, and safe option for procedures involving the craniovertebral junction.

## 1. Introduction

Atlantoaxial instability or dislocation (AAI/D), a relatively prevalent cranio-cervical anatomical instability disorder, is associated with the compression of the upper cervical spinal cord and medulla oblongata. If left untreated or managed inappropriately, this may result in irreversible neurological deficits and potentially fatal outcomes [1]. The unique anatomical configuration of the atlantoaxial region allows the vertebral bodies to avoid directly bearing the weight of the head with mechanical loads transmitted through the lateral masses of C1 and C2. Consequently, the stability of atlantoaxial lateral mass joints is critical to ensure sufficient mechanical strength to maintain normal physiological functions [2]. Over the past few decades, posterior atlantoaxial arthrodesis combined with screw fixation has gradually become the most effective surgical approach for treating AAI/D [3]. However, the traditional Goel-Harms technique requires extensive tissue dissection of the suboccipital and posterior cervical musculature, which may contribute to numerous complications including substantial blood loss, tissue damage, stiffness, pain, and functional impairment [4, 5]. Therefore, it is essential to investigate novel surgical techniques that can achieve comparable biomechanical stability while simultaneously minimizing iatrogenic injury [6, 7].

Recent advancements in imaging and navigation technologies have facilitated the extensive utilization of endoscopic techniques, including the full-endoscopic technique, one-hole split endoscopy, and unilateral biportal endoscopy [8], particularly in lower cervical, thoracic, and lumbar spinal decompression and fusion surgeries [9, 10]. Growing evidence suggests that these minimally invasive endoscopic procedures yield clinical outcomes comparable to those of traditional open surgeries

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https://dx.doi.org/10.31487/j.WNEURO.2025.01.06
Received 8 June, 2025; Accepted 26 June, 2025
Available online 3 July, 2025

while offering a lower incidence of complications [11]. By minimizing tissue dissection and disruption, these techniques optimize the preservation of anatomical structures, effectively reducing intraoperative blood loss and postoperative scarring [12]. The direct proximity of the endoscope to the surgical target provides a clear operative field and superior visualization, facilitating precise anatomical identification and meticulous hemostasis, which collectively minimize surgical trauma and enhance procedural outcomes.

In recent years, anterior and posterior endoscopic techniques are widely used in the management of various cervical spine disorders [13]. However, no studies have yet explored the application of posterior endoscopic techniques for the treatment of AAI/D. Herein, we present the first report of atlantoaxial lateral mass joint fusion performed by using one-hole split endoscopy system. By analyzing the key technical details and preliminary clinical applications, we aimed to evaluate the technical advantages and clinical feasibility of this novel approach.

## 2. Technology Description

### 2.1. Case Selection and Condition Assessment

This study was approved by the Ethics Committee of the institution, and informed consent was obtained from patients or their guardians. Radiological findings serve as the primary objective basis for AAI/D diagnosis. Diagnosis should be comprehensively evaluated based on the integrity of the atlantoaxial anatomical structures and congruency of the three atlantoaxial joints [1, 14]. Anterior dislocation is the most prevalent form, typically defined as an atlantodental interval (ADI) greater than 3 mm in adults and 5 mm in children. In contrast, posterior or rotational dislocations may present with normal ADI but demonstrate abnormal congruency of the atlantoaxial lateral mass joints [15, 16]. Surgical intervention is recommended for patients with symptomatic AAI/D to prevent progressive or acute neurological decline, which may result in respiratory center suppression and potentially fatal outcomes [17]. Patients scheduled for surgery should be thoroughly evaluated to rule out comorbidities such as tumors, tuberculosis, infections, acute fractures, congenital cranio-cervical anomalies, and a history of prior atlantoaxial surgery. Comprehensive neurological examination and detailed radiological evaluation are essential prior to surgery. Open-mouth, lateral, and dynamic cervical radiographs are used to evaluate the cervical vertebral sequence and dislocation reducibility. Cervical computed tomography (CT) with three-dimensional reconstruction is performed to assess the dislocation severity, deformity, and lateral mass morphology. Computed tomography angiography is performed to examine the course and variations in the vertebral arteries. Additionally, cervical magnetic resonance imaging (MRI) is performed to determine spinal cord compression and to identify the presence of cerebellar tonsillar herniation or syringomyelia [18-20].

### 2.2. Surgical Techniques and Procedures

To facilitate intraoperative localization and minimize pressure-related injuries, the patient is positioned prone on a Jackson table, with the head securely stabilized in a Mayfield headrest, and the table is adjusted to the reverse Trendelenburg position. Administer cranial traction under general anesthesia and maintain it throughout the surgical procedure. Determine the optimal traction weight based on the degree of atlantoaxial joint reduction, with a maximum limit of one-fifth of the patient’s body weight.

Prior to endoscopic navigation, the C1/C2 segment is localized under C-arm fluoroscopic guidance, and a 2.5 to 3.0 cm longitudinal skin incision is made along the midline of the neck. After incising the skin and superficial fascia, dissect the soft tissue laterally for 1.5-2.0 cm to expose the paravertebral muscle space. Using a blunt-tipped guiding rod, bluntly separate the trapezius, splenius capitis, and semispinalis capitis muscles along the direction of the muscle fibers in a stepwise manner, carefully avoiding sharp dissection and lateral injury to the deeper structures. Stop the dissection when the guiding rod contacts C2 lamina. Keep the rod oriented toward the dorsolateral region of the C1/C2 joint to avoid injury to the C2 nerve root and the venous plexus. Meanwhile, under the guidance of the rod, insert soft tissue dilators of increasing diameters sequentially to gradually establish a working channel. Finally, the endoscopic system and operating arms are inserted through the established soft tissue channel. During the procedure, C-arm fluoroscopic navigation is used to confirm the orientation and depth of the guiding rod, dilation channel, and endoscopic lens in real-time, ensuring precise positioning and operational safety.

After inserting the endoscopic system, establish a continuous irrigation environment using water medium to obtain a clear and stable endoscopic view. While performing electrocoagulation under endoscopic visualization, clear the soft tissue surrounding the C2 isthmus. Then carry out subperiosteal blunt dissection along the C2 isthmus toward the cranial side to expose the bony boundaries, thereby providing an anatomical reference for joint capsule localization. Subsequently, further expose and explore the C1/C2 lateral mass joint capsule. Special attention should be paid to the fact that this area lies just anterior to the C2 nerve root and the venous plexus. At this stage, caution should be exercised. Use a nerve retractor to gently retract the C2 nerve root together with venous plexus in the cranial direction to ensure protection of these critical neurovascular structures under endoscopic visualization. Thereafter, excise the capsule with electrocautery, then use the spherical high-speed burr to debride hypertrophic bone at the joint margins to maximize joint space exposure. Abrade the lateral mass articular surfaces to expose the subchondral bone with a 2-mm spherical burr. Keep the burr continuously visible under endoscopic guidance to prevent excessive depth and damage to the retropharyngeal soft tissues.

After exposing the fresh bony surface, perform bone grafting within the joint space. Select the allogeneic cancellous bone granules (size about 2-5 mm) as fusion materials. Direct the granules into the joint space using a graft delivery cannula and a pusher system. During delivery, maintain close apposition between the cannula and the lateral mass joint to prevent graft material from spilling into blind areas, which simultaneously provides effective shielding of the C2 nerve root and venous plexus, thus preventing neurovascular compression or injury caused by bone granules or instruments. Intraoperatively, monitor the bone graft volume under real-time endoscopic visualization to ensure adequate compaction while avoiding excessive joint distraction. In most cases, unilateral lateral mass joint fusion is sufficient to maintain atlantoaxial stability; if necessary, bilateral fusion can be performed to enhance biomechanical symmetry.

Thereafter, we perform the atlantoaxial internal fixation using a soft tissue dilatation channel on one side and an intermuscular approach on the other side. First, through the dilatation channel, identify the entry points and screw directions for the C1 lateral mass and C2 pedicle under C-arm fluoroscopic navigation. Based on lateral fluoroscopic images, evaluate the screw trajectories in terms of angle and depth, and then sequentially drill, tap, and place the C1 lateral mass screw and C2 pedicle screw. On the contralateral side, use an intermuscular approach to bluntly separate the trapezius, splenius capitis, and semispinalis capitis muscles, thereby exposing the underlying bony landmarks. Under C-arm fluoroscopic guidance, place the C1 lateral mass and C2 pedicle screws in the same manner.

Finally, remove the intraoperative cranial traction device, insert the pre-bent titanium rods, apply appropriate compression to the bilateral screw-rod system, and then complete final fixation. Before wound closure, ensure hemostasis within the surgical field and remove any residual bone debris. A drainage tube may be placed on the fusion side if necessary.

### 2.3. Perioperative Management Protocol

Prophylactic analgesia is initiated one day preoperatively to alleviate pain and accelerate recovery. Celecoxib or etoricoxib is recommended for adults, whereas acetaminophen or ibuprofen is recommended for pediatric patients with weight-based dosing adjustments. Postoperative analgesia begins with intravenous administration for the first 48 hours, followed by scheduled oral analgesics. Dosages are adjusted based on visual analog scale (VAS) scores for optimal pain management. Given the presence of metallic implants, prophylactic antibiotics are necessary. Postoperative neurological recovery should be actively assessed, early limb function exercises should be encouraged, and activities should be initiated with cervical collar protection. In addition, advocates for early rehabilitation training under the guidance of physiotherapists. Conduct the necessary radiological follow-ups within one week postoperatively, including X-ray, CT, and MRI scans. Evaluate postoperative neurological function and cervical mobility using the Japanese Orthopaedic Association (JOA) score and Neck Disability Index (NDI) score, with follow-up continuing for 12 months.

## 3. Clinical Application

### 3.1. Cases and Conditions

Based on the study design, we recruited a 12-year-old boy diagnosed with AAI and os odontoideum for the preliminary clinical practice. The young patient complained of neck pain accompanied by gait instability and difficulty gripping. As the condition progressed, the child exhibited urinary difficulties, limb weakness, and ambulatory impairment but no respiratory distress or urinary incontinence. Neurological examination revealed sensory abnormalities below the shoulders, an asymmetric reduction in limb strength, increased muscle tone, hyperreflexia, and positive pathological reflexes. VAS: 5, JOA: 6, NDI: 57%. Cervical spine radiographs show anterosuperior displacement of the C2 vertebral body, with bony separation between the odontoid process and the C2 body. The odontoid process appears rounded and blunted. The ADI is within the normal limits. The morphology and alignment of C3-C7 vertebral bodies are preserved (Figures 1A & 1B). Dynamic radiographs reveal significant anterior translation of the anterior arch of the atlas relative to the C2 vertebral body during flexion. In extension, the anterior translation is nearly reduced, but a mild posterior shift occurs simultaneously (Figures 1C & 1D). Cervical CT, reconstruction, and angiography revealed os odontoideum, no abnormalities in the ADI, and dens not extending beyond the McRae's line. The C1 lateral mass was displaced anteriorly and laterally relative to the C2, with no deformities or anomalies in the C1/C2 vertebrae or lateral masses. The vertebral artery showed no high riding, ectopia, or tortuosity (Figures 1F-1J). MRI revealed compression at the cranio-cervical junction with abnormal intramedullary signals and no evidence of Chiari malformation or syringomyelia (Figure 1E).

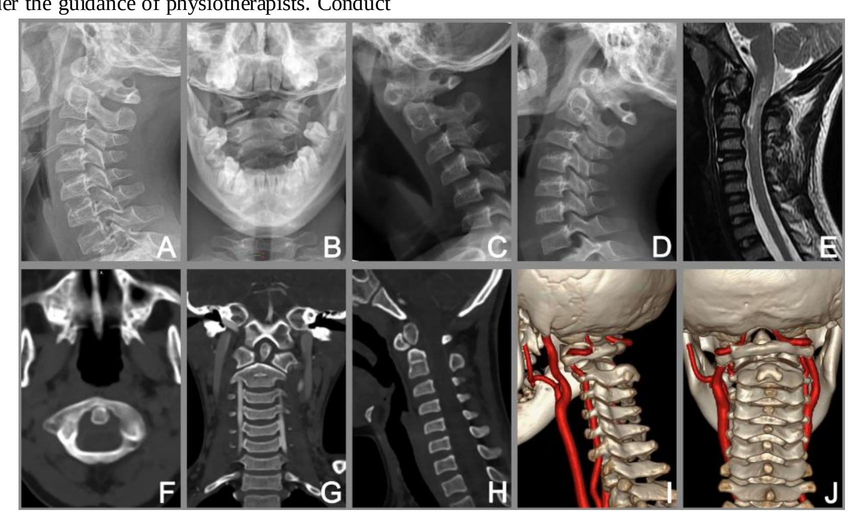


**Fig. 1.** Preoperative cervical images of the pediatric patient with atlantoaxial instability. **A & B)** Lateral cervical X-ray and open-mouth odontoid view show anterior-superior displacement of C2 vertebra and odontoid separation. **C & D)** Dynamic X-rays indicate the significant instability of atlantoaxial joint. **E)** MRI reveals compression at the cranio-cervical junction with intramedullary signal changes. **F & H)** CT scans show the os odontoideum, not extending

beyond McRae's line, with normal atlantodental interval. **I & J)** Three-dimensional reconstructions indicate malalignment of the atlantoaxial lateral mass joints, with no abnormalities of the vertebral artery.

### 3.2. Surgical Procedure

The child underwent one-hole split endoscopic lateral mass joint fusion in combination with screw-rod fixation. Intraoperative real-time fluoroscopy combined with endoscopic navigation enabled precise localization, clear structural visualization, and accurate anatomical delineation (Figure 2A). Under direct endoscopic visualization, the surgeon carried out protective dissection of the surrounding soft tissues and adequately loosened the atlantoaxial joint (Figures 2B-2D). We used a spherical drill to remove the articular cartilage and enlarge the bone grafting space, effectively avoiding high-risk areas while minimizing unnecessary soft tissue damage (Figure 2E). During the bone grafting procedure, the graft delivery cannula and pusher system provided a stable pathway and precise guidance (Figures 2F, 2G). Next, axial screws (3.5 mm diameter and 20 mm length) were inserted into the bilateral C1 lateral masses and C2 pedicles. After confirming the proper position with C-arm fluoroscopy, titanium rods were placed and fixed (Figure 2H). The operation proceeded smoothly without major complications and required approximately 120 min, with an intraoperative blood loss of approximately 30 ml. The key steps of the procedure are illustrated in the (Supplementary Video).

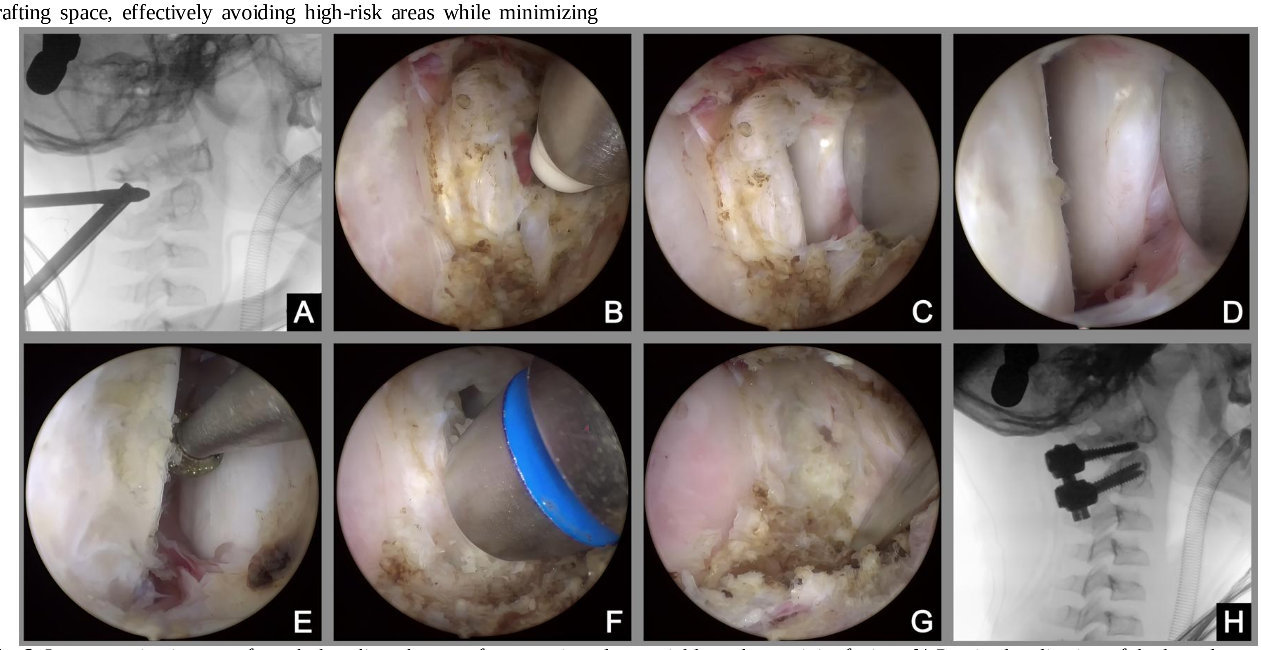


**Fig. 2.** Intraoperative images of one-hole split endoscopy for posterior atlantoaxial lateral mass joint fusion. **A)** Precise localization of the lateral mass joint under C-arm fluoroscopic guidance. **B)** Clear endoscopic visualization of the C2 isthmus and joint capsule. **C)** Lateral mass joint visible after retraction of the C2 nerve root and joint capsule. **D)** Close-up view showing the joint space and C1 lateral mass facet. **E)** Endoscopic grinding of the lateral mass articular surface with a spherical burr. **F)** Insert allograft cancellous bone into the joint space using a graft rod. **G)** Direct visualization of successful lateral mass joint graft fusion. **H)** Confirmation of the implant position and atlantoaxial reduction with intraoperative fluoroscopy.

### 3.3. Clinical Outcomes Evaluation

Postoperatively, the child recovered well from anesthesia and was transferred to the general ward after brief observation. Upon regaining consciousness, active limb flexion-extension exercises were initiated, and neurological assessment indicated marked improvement in somatosensory function and limb strength compared to the preoperative status without any new neurological deficits. The drain was removed on postoperative day two when the output was < 10 mL/day. Postoperative imaging confirmed atlantoaxial joint reduction, well-positioned fixation, and satisfactory graft fusion (Figures 3A-3D). The child was discharged on postoperative one week after incision suture removal without any surgery-related complications or symptoms such as dysphagia or dyspnea. Neurological assessment revealed recovery of key limb muscle strength to 4+ with independent ambulation. The scores were as follows: VAS, 2; JOA, 13 (improvement rate, 63.6%); NDI, 57%.

At the 6-month postoperative follow-up visit, the patient was re-evaluated. At this time, the child’s pain symptoms completely resolved, and autonomous movement and ambulation were restored. Bladder function returned to normal, although mild somatic sensory deficits persisted. A follow-up CT with three-dimensional reconstruction demonstrated stable atlantoaxial internal fixation with no signs of screw loosening or breakage (Figures 3E & 3F). Continuous bony bridging was observed across the atlantoaxial lateral mass joint space, indicating an initial osseous fusion (Figures 3G & 3H). No signs of osteolysis or bone resorption were noted in the fusion area, suggesting a favorable prognosis. Postoperatively, the patient wore a cervical orthosis for three months, during which no complications occurred.

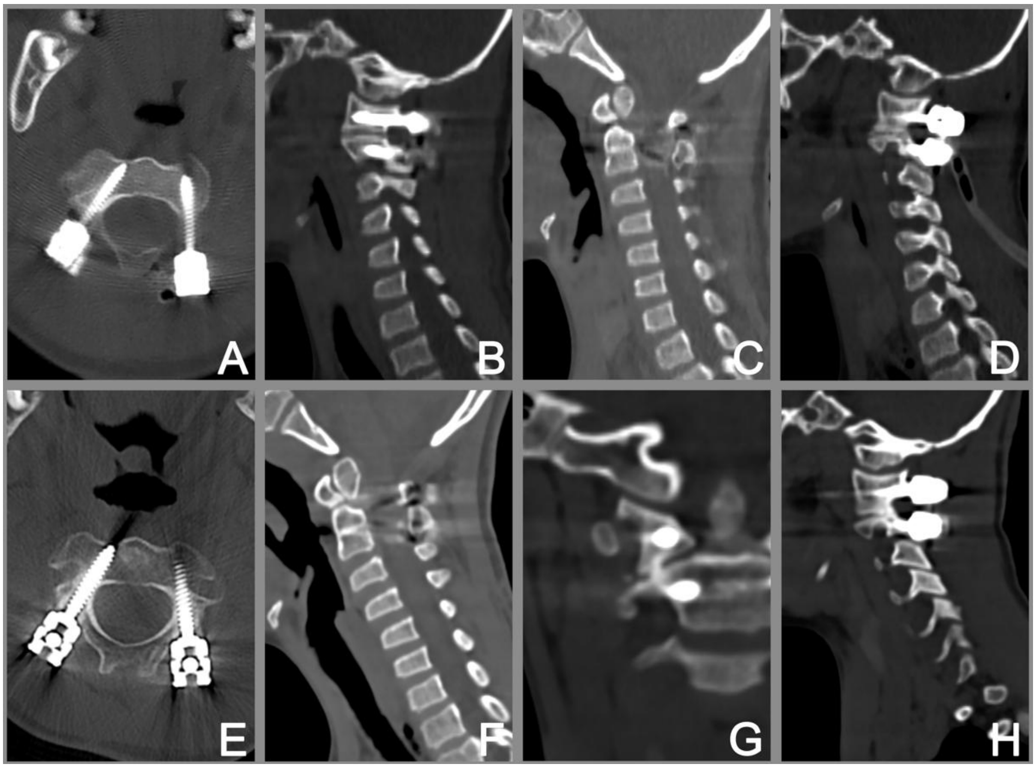


**Fig. 3.** Postoperative and follow-up CT images of one-hole split endoscopy for posterior atlantoaxial lateral mass joint fusion. **A & B)** Multiplanar images demonstrate that precise screw placement, **C)** atlantoaxial reduction achieved with no spinal canal stenosis, and **D)** the bone graft within atlantoaxial lateral mass joint space. **E)** Six-month follow-up showed stabilization of the internal fixation device, **F)** no spinal cord compression is observed, and **G & H)** formation of the continuous bony bridge visible within the lateral mass joint space.

## 4. Discussion

In this study, the innovative one-hole split endoscopy for posterior atlantoaxial lateral mass joint fusion technique was successfully applied to a typical case involving a 12-year-old male patient, who presented with neck pain and limb weakness, and the Imaging studies revealed AAI, os odontoideum, and myelopathy. In conventional open surgery, extensive soft tissue dissection and muscle attachment disruption often result in chronic axial neck pain and functional impairment accompanied by increased surgical trauma, intraoperative hemorrhage, and postoperative complications [21, 22]. Although studies have demonstrated that the transmuscular interspace approach for atlantoaxial fusion, which preserves key muscle attachment points, significantly reduces iatrogenic injury compared with traditional techniques while maintaining equivalent surgical efficiency and efficacy, challenges remain [23, 24]. Unfortunately, the depth of the suboccipital structures and the relative displacement of C1/C2 limit the clarity and visualization of open surgical approaches, including the transmuscular interspace route, hindering the optimal balance between exposure and visualization. The widespread adoption of endoscopic techniques has established their advantages in terms of safety, operability, enhanced visualization, minimal damage, faster recovery, and comparable efficacy [25, 26]. To our knowledge, this is the first application of posterior endoscopic techniques for atlantoaxial fusion, demonstrating the feasibility and efficacy of endoscopy in the treatment of AAI/D. This approach provides clear visualization of the lateral mass joint and surrounding tissues, which effectively reduces the risk of vertebral artery and nerve root injury, significantly enhances the operability of the fusion procedure, and minimizes unnecessary tissue dissection, thereby preserving the stability of craniovertebral junction.

Similar to other spinal endoscopic procedures, accurate preoperative fluoroscopic localization and working channel placement are essential for rapid anatomical structure identification under endoscopic guidance, thereby preventing disorientation and reducing vascular and nerve injury risk [27]. Thereafter, adequate exposure of the C2 isthmus is key to identifying the atlantoaxial lateral mass joint under endoscopy. Furthermore, the operator must possess in-depth knowledge of atlantoaxial anatomy to prevent inadvertent major injuries. If feasible, it is preferable to receive standardized cadaveric training before performing this procedure [28]. On the other hand, unlike the steep learning curve of traditional open or transmuscular approaches, clear endoscopic visualization of the atlantoaxial joint reduces procedural difficulty and shortens the learning curve to some extent. Nonetheless, proficiency in open atlantoaxial fixation and fusion techniques remains essential as they may still be the preferred option for certain clinical conditions [29].

Autologous iliac bone or allograft bone, interarticular fusion cages, or titanium cages are options for joint fusion fillers [30, 31]. Studies have suggested that interbody fusion cages can effectively maintain biomechanical stability of the atlantoaxial joint, thereby enhancing fusion rates [32]. Additionally, Wang *et al.* employed customized 3D-printed titanium cages for personalized surgical treatment [6]. However, in pediatric patients, immature skeletal structures make interbody fusion cages prone to excessive joint distraction, potentially impeding normal bone development. Instead, intra-articular bone grafting combined with screw-rod fixation offers sufficient biomechanical stability and favorable fusion outcomes. Thus, we opted for intra-articular bone grafting alone in pediatric cases. At postoperative follow-up, CT revealed continuous bony bridging across the atlantoaxial lateral mass joint space, indicating that preliminary osseous fusion had been achieved. This finding suggests that with the biomechanical stability provided by the screw-rod fixation system, allogeneic cancellous bone can demonstrate a favorable fusion potential. Although more long-term outcomes require continued observation, the current results support the feasibility and safety of this technique.

## 5. Conclusion

This is the first study to highlight the clinical feasibility and potential technical advantages of one-hole split endoscopy for posterior atlantoaxial lateral mass joint fusion. As minimally invasive spine surgery continues to advance, this procedure may expand the utility of endoscopic procedures to the craniovertebral junction, and lay the groundwork for large-scale prospective cohort studies and broader clinical adoption.

## Limitations

This study should be viewed as a successful exploration of the novel technique's feasibility, offering valuable guidance for future research in this field. There have several limitations that should be acknowledged. First, owing to the limited number of cases, the current conclusions were drawn from a single clinical experience. Further large-scale cohort studies and prospective randomized controlled trials are required to compare the clinical parameters with those of traditional open surgery, including hospital stay, operative time, blood loss, inflammatory markers, and axial pain. In addition, although this study completed three-month postoperative follow-up with encouraging outcomes, long-term data beyond one year are lacking. Therefore, the impact of this procedure on long-term functional recovery and late-onset complications cannot be fully assessed. Ongoing follow-up aims to achieve a more comprehensive clinical evaluation.

## Acknowledgments

Not applicable.

## Conflicts of Interest

None.

## Funding

The present research was supported by the National Natural Science Foundation of China (Grant number: 82360422), the Joint Project on Regional High-Incidence Diseases Research of Guangxi Natural Science Foundation (Grant number: 2024GXNSFAA010073), the Guangxi Young and Middle-aged Teacher’s Basic Ability Promoting Project (Grant number: 2023KY0115), the Bethune Charity Foundation's "Constant Learning and Improvement-Medical Research" project. The sponsor had no role in the study design, data collection, or data interpretation, as well as in manuscript writing and the decision to submit for publication.

## Author Contributions

Conceptualization and study design: Jiang Xue, Chong Liu. Methodology: Jiang Xue, Xinli Zhan. Technical support: Tengyue Zhu. Writing and editing: Jiang Xue, Chengqian Huang. Funding acquisition: Chong Liu, Xinli Zhan. Data compilation: Shaofeng Wu, Songze Wu. Validation and visualization: Jiang Xue, Liyi Chen. Supervision and final approval: Chong Liu, Xinli Zhan. All authors have reviewed and approved the final version of the manuscript and agreed to its content.

## Ethics Approval

This study was conducted in accordance with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of First Affiliated Hospital of Guangxi Medical University (Approval Number: 2024-E0859).

## Consent to Participate

Written informed consent was obtained from the parents of the minor patient included in the study.

## Consent for Publication

Written informed consent for publication was obtained from the parents of the minor patient. All identifying details have been anonymized to ensure confidentiality.

## Data Availability

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

## Abbreviations

**AAI/D:** Atlantoaxial Instability or Dislocation
**ADI:** Atlantodental Interval
**CT:** Computed Tomography
**MRI:** Magnetic Resonance Imaging
**VAS:** Visual Analog Scale
**JOA:** Japanese Orthopaedic Association
**NDI:** Neck Disability Index

## Supplementary Material

Supplementary Video

## References


[1] Qing-shui Yin, Jian-hua Wang "Current Trends in Management of Atlantoaxial Dislocation." *Orthop Surg*, vol. 7, no. 3, pp. 189-199, 2015. View at: Publisher Site | PubMed

[2] Sun Y Yang, Anthony J Boniello, Caroline E Poorman, et al. "A review of the diagnosis and treatment of atlantoaxial dislocations." *Global Spine J*, vol. 4, no. 3, pp. 197-210, 2014. View at: Publisher Site | PubMed

[3] Da-Geng Huang, Ding-Jun Hao, Bao-Rong He, et al. "Posterior atlantoaxial fixation: a review of all techniques." *Spine J*, vol. 15, no. 10, pp. 2271-2281, 2015. View at: Publisher Site | PubMed

[4] Aaron Gelinne, Martin Piazza, Deb A Bhowmick "Minimally invasive modification of the Goel-Harms atlantoaxial fusion technique: a case series and illustrative guide." *Neurosurg Focus*, vol. 54, no. 3, pp. E14, 2023. View at: Publisher Site | PubMed

[5] Robert E Elliott, Omar Tanweer, Akwasi Boah, et al. "Atlantoaxial fusion with screw-rod constructs: meta-analysis and review of literature." *World Neurosurg*, vol. 81, no. 2, pp. 411-421. View at: Publisher Site | PubMed

[6] Kan-Lin Hung, Yong Lu, Yinglun Tian, et al. "Minimally Invasive Surgery for Posterior Atlantoaxial Lateral Mass Joint Fusion (MIS-PALF): A Muscle-Sparing Procedure for Atlantoaxial Instability or Dislocation." *J Bone Joint Surg Am*, vol. 106, no. 23, pp. 2215-2222, 2024. View at: Publisher Site | PubMed

[7] Zhenji Xu, Ji Wu, Fei Chen, et al. "Atlantoaxial intra-articular cage fusion by posterior intermuscular approach for treating reducible atlantoaxial dislocation: a technique note with case series." *Eur Spine J*, vol. 33, no. 8, pp. 3060-3068, 2024. View at: Publisher Site | PubMed

[8] Christoph P Hofstetter, Yong Ahn, Gun Choi, et al. "AOSpine Consensus Paper on Nomenclature for Working-Channel Endoscopic Spinal Procedures." *Global Spine J*, vol. 10, no. 2 Suppl, pp. 111S-121S, 2020. View at: Publisher Site | PubMed

[9] Lynn B McGrath, Gabrielle A White-Dzuro, Christoph P Hofstetter "Comparison of clinical outcomes following minimally invasive or lumbar endoscopic unilateral laminotomy for bilateral decompression." *J Neurosurg Spine*, vol. 30, no. 4, pp. 491-499, 2019. View at: Publisher Site | PubMed

[10] Daniel A Carr, Isaac Josh Abecassis, Christoph P Hofstetter "Full endoscopic unilateral laminotomy for bilateral decompression of the cervical spine: surgical technique and early experience." *J Spine Surg*, vol. 6, no. 2, pp. 447-456, 2020. View at: Publisher Site | PubMed

[11] Xiao-Bing Zhao, Ya-Jie Ma, Hai-Jun Ma, et al. "Clinical Efficacy of Posterior Percutaneous Endoscopic Unilateral Laminotomy with Bilateral Decompression for Symptomatic Cervical Spondylotic Myelopathy." *Orthop Surg*, vol. 14, no. 5, pp. 876-884, 2022. View at: Publisher Site | PubMed

[12] Jae-Won Jang, Dong-Geun Lee, Choon-Keun "Park Rationale and Advantages of Endoscopic Spine Surgery." *Int J Spine Surg*, vol. 15, no. suppl 3, pp. S11-S20, 2021. View at: Publisher Site | PubMed

[13] Chuan-Ching Huang, Jamal Fitts, David Huie, et al. "Evolution of Cervical Endoscopic Spine Surgery: Current Progress and Future Directions-A Narrative Review." *J Clin Med*, vol. 13, no. 7, pp. 2122, 2024. View at: Publisher Site | PubMed

[14] Gang Zheng, Fengjin Zhou, Bo Yuan, et al. "Novel Radiographic Parameters for Posterior Atlantoaxial Dislocation Secondary to Os Odontoideum and Its Clinical Significance." *World Neurosurg*, vol. 178, pp. e692-e699, 2023. View at: Publisher Site | PubMed

[15] Shenglin Wang, Chao Wang, Ming Yan, et al. "Novel surgical classification and treatment strategy for atlantoaxial dislocations." *Spine (Phila Pa 1976)*, vol. 38, no. 21, pp. E1348-E1356, 2013. View at: Publisher Site | PubMed

[16] Qing Wang, Shuai Dong, Fang Wang "Os odontoideum: diagnosis and role of imaging." *Surg Radiol Anat*, vol. 42, no. 2, pp. 155-160, 2020. View at: Publisher Site | PubMed

[17] Shenghua Ning, Sidong Yang, Wenyuan Ding, et al. "Posterior atlantoaxial dislocation without fracture or neurological symptoms treated by transoral-posterior approach surgery: a case report and literature review." *Eur Spine J*, vol. 28, no. Suppl 2, pp. 37-40, 2019. View at: Publisher Site | PubMed

[18] Roy Riascos, Eliana Bonfante, Claudia Cotes, et al. "Imaging of Atlanto-Occipital and Atlantoaxial Traumatic Injuries: What the Radiologist Needs to Know. Review." *Radiographics*, vol. 35, no. 7, pp. 2121-2134, 2015. View at: Publisher Site | PubMed

[19] Shaoyin Duan, Shaomao Lv, Feng Ye, et al. "Imaging anatomy and variation of vertebral artery and bone structure at craniocervical junction." *Eur Spine J*, vol. 18, no. 8, pp. 1102-1108, 2009. View at: Publisher Site | PubMed

[20] John Bailitz, Frederic Starr, Matthew Beecroft, et al. "CT should replace three-view radiographs as the initial screening test in patients at high, moderate, and low risk for blunt cervical spine injury: a prospective comparison." *J Trauma*, vol. 66, no. 6, pp. 1605-1609, 2009. View at: Publisher Site | PubMed

[21] K Daniel Riew, Annie L Raich, Joseph R Dettori, et al. "Neck Pain Following Cervical Laminoplasty: Does Preservation of the C2 Muscle Attachments and/or C7 Matter?" *Evid Based Spine Care J*, vol. 4, no. 1, pp. 42-53, 2013. View at: Publisher Site | PubMed

[22] Atul Goel, Sonal Jain, Abhidha Shah, et al. "Atlantoaxial Fixation for Odontoid Fracture: Analysis of 124 Surgically Treated Cases." *World Neurosurg*, vol. 110, pp. 558-567, 2018. View at: Publisher Site | PubMed

[23] Zhenji Xu, Ji Wu, Haibin Wang, et al. "Posterior Reduction and Temporary Fixation Through Intermuscular Approach for Odontoid Fracture." *Oper Neurosurg (Hagerstown)*, vol 28, no. 6, pp. 772-778, 2025. View at: Publisher Site | PubMed

[24] Alexander Spiessberger, Alexandra Stauffer, Fabian Baumann, et al. "Splitting of the semispinalis capitis muscle as a less invasive approach for atlantoaxial fusion - A technical note." *J Clin Neurosci*, vol. 62, pp. 260-263, 2019. View at: Publisher Site | PubMed

[25] Hyungjoo Kwon, Jeong-Yoon Park "The Role and Future of Endoscopic Spine Surgery: A Narrative Review." *Neurospine*, vol. 20, no. 1, pp. 43-55, 2023. View at: Publisher Site | PubMed

[26] Phattareeya Pholprajug, Vit Kotheeranurak, Yanting Liu, et al. "The Endoscopic Lumbar Interbody Fusion: A Narrative Review, and Future

Perspective." *Neurospine*, vol. 20, no. 4, pp. 1224-1245, 2023. View at: Publisher Site | PubMed

[27] Yad Ram Yadav, Angelo Lucano, Shailendra Ratre, et al. "Practical Aspects and Avoidance of Complications in Microendoscopic Spine Surgeries: A Review." *J Neurol Surg A Cent Eur Neurosurg*, vol. 80, no. 4, pp. 291-301, 2019. View at: Publisher Site | PubMed

[28] Umesh Srikantha, Kiran S Khanapure, Aniruddha T Jagannatha, et al. "Minimally invasive atlantoaxial fusion: cadaveric study and report of 5 clinical cases." *J Neurosurg Spine*, vol. 25, no. 6, pp. 675-680, 2016. View at: Publisher Site | PubMed

[29] Ruipeng Song, Daoyang Fan, Han Wu, et al. "Management of Unusual Atlantoaxial Dislocation." *Spine (Phila Pa 1976)*, vol. 42, no. 8, pp. 573-577, 2017. View at: Publisher Site | PubMed

[30] Sharath Kumar Anand, Regan M Shanahan, Ali A Alattar, et al. "Atlantoaxial facet fixation using cervical facet cage: technical case report and review of the literature." *Childs Nerv Syst*, vol. 40, no. 7, pp. 2193-2197, 2024. View at: Publisher Site | PubMed

[31] Mazda K Turel, Mena G Kerolus, Vincent C Traynelis "Machined cervical interfacet allograft spacers for the management of atlantoaxial instability." *J Craniovertebr Junction Spine*, vol. 8, no. 4, pp. 332-337, 2017. View at: Publisher Site | PubMed

[32] Fabian Sommer, Sertac Kirnaz, Jacob L Goldberg, et al. "Safety and Feasibility of DTRAX Cervical Cages in the Atlantoaxial Joint for C1/2 Stabilization." *Oper Neurosurg (Hagerstown)*, vol. 22, no. 5, pp. 322-327, 2022. View at: Publisher Site | PubMed