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CASE REPORT

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A rare case of lumbar facet fracture-dislocation and review of the literature

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Key Clinical Message

Lumbar facet fracture-dislocation is rare, often due to hyperflexion with rotational force. Abnormal scoliosis on radiography is a key sign, prompting further imaging. Facetectomy and laminectomy ensure safe reduction, while instrumented fusion is an effective surgical treatment.

Abstract

Traumatic lumbar facet dislocation is an uncommon condition, particularly when unilateral lumbar facet dislocation is accompanied by a contralateral facet fracture. The patient had a locked facet joint at the left L4–L5, a fracture of the right superior articular process of L5 and a comminuted fracture at the peritrochanteric region of the right femur following a fall. Emergent operation was conducted, starting with open reduction and fixation for the right proximal femur, followed by posterior open reduction and posterolateral fusion with instrumentation, without interbody fusion, for the lumbar spine injury. The patient exhibited positive outcomes throughout the follow-up. This article highlights the trauma mechanism of lumbar facet dislocation, emphasizing hyperflexion with rotational force. Abnormal local scoliosis is a distinctive imaging sign of facet joint dislocation. Facetectomy and laminectomy are recommended for safe reduction and instrumented fusion is considered a safe and effective surgical treatment for facet joint dislocation injuries.

KEYWORDS

dislocation, locked facet, lumbar spine, trauma

1 | INTRODUCTION

Traumatic spinal injuries can manifest in various forms, including fractures, dislocations or their combination. Lumbar facet injuries, particularly when they do not result in neurological damage, are infrequent outcomes after severe trauma.[1]

We have documented a remarkable case involving a unilateral lumbar facet dislocation accompanied by a fracture of the contralateral superior articular process (SAP) of the facet joint. Herein, we elaborated upon the potential mechanisms of trauma responsible for such an occurrence. Furthermore, we have comprehensively reviewed existing literature concerning the trauma mechanism, clinical presentation and management of lumbar facet dislocations. Through this comprehensive review of the complex and challenging injury, it becomes particularly valuable for physicians managing spinal trauma in clinical practice.

2 | CASE HISTORY AND EXAMINATION

A 36-year-old man presented in the emergency room after an accident involving an 8-m fall. The initial treatment followed the advanced trauma life support protocols. During the primary assessment, he was fully conscious and his cardiovascular status was stable. He reported intense pain in his back and right hip region. The bladder and anal sphincters were normal. He did not experience any abnormal sensations such as tingling or numbness in his thigh and he did not have any lower limb weakness. Knee extension, dorsiflexion of the ankle and big toe, and plantarflexion of the ankle in both lower limbs were all normal, with muscle power graded as 5.

FIGURE 1 Pelvic X-ray image revealing a comminuted fracture of the right proximal femur and focal scoliosis in the L4–L5 region.

3 | METHODS (DIFFERENTIAL DIAGNOSIS, INVESTIGATIONS, AND TREATMENT)

3.1 | Imaging

Pelvic X-ray imaging revealed several notable findings, including a comminuted fracture of the right proximal femur. In addition, an abnormal focal scoliosis in the L4–L5 region was noted (Figure 1). The patient was then taken for serial computed tomography (CT) scans. No intracranial hemorrhage was found on brain CT. The chest CT demonstrated a left scapular fracture, multiple left-rib fractures and bilateral lung contusions with minimal pneumothorax. Abdominal CT revealed spleen and liver laceration with a small hemoperitoneum. Fractures of the right L5 upper endplate and vertebral body, L4 spinous process, left transverse process of L1–L4 and intertrochanteric region of the right femur were also noted.

CT and magnetic resonance imaging (MRI) of the lumbar spine were also conducted for further evaluation. These examinations indicated an abnormal focal scoliosis in the L4–L5 region with a concave curve to the right side, grade I anterolisthesis of L4 on L5 with a left L4–L5 facet joint dislocation and fracture of the right L5 SAP. Fracture of the superior endplate of L5 and disruption of the L4–L5 intervertebral disc were also noted. The posterior ligamentous complex injury at the L4–L5 level was also disrupted. In addition, a small epidural hematoma was observed at L4–L5, resulting in mild compression of the thecal sac (Figures 2 and 3).

3.2 | Treatment

Because of an unstable fracture of the left proximal femur, internal fixation was first performed to achieve stability. Based on the thoracolumbar injury classification and severity (TLICS) score system, the patient's spinal injury scored 7 points (4 points for the distraction morphology category and 3 points for the disruption of the posterior ligamentous complex). Operative treatment was deemed necessary because his TLICS scores exceeded 5.

Considering the unstable nature of the spine injury and the need to restore the spinal alignment, an open reduction of the locked facet at the L4–L5 level on the left side via hemilaminectomy and facetectomy, followed by bilateral posterior L4–S1 instrumented fusion, was performed.

3.3 | Operative procedure

After general anesthesia induction, the patient was placed in the prone position. A subperiosteal exposure of the L4–S1 spinous processes and lamina was performed

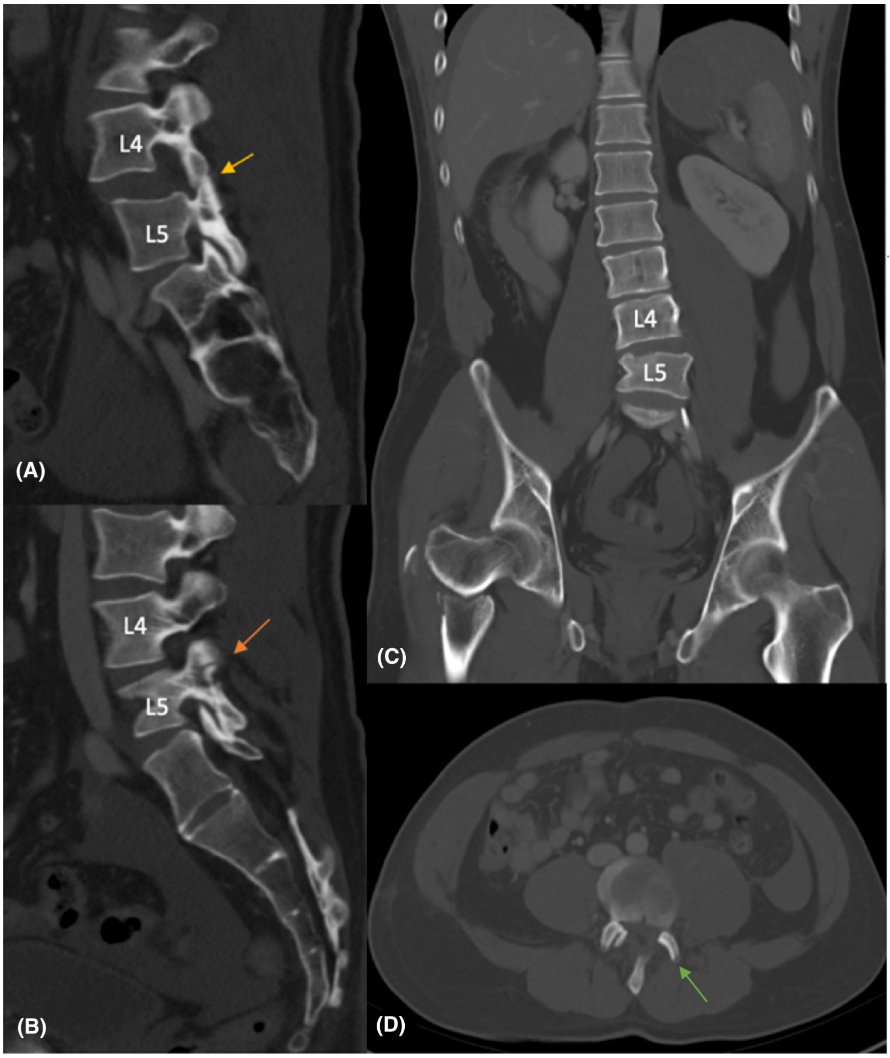

FIGURE 2 Computed tomography (CT) scans showing a locked facet joint at left L4–L5 (yellow arrow) (A), fracture of the right superior articular process (SAP) of the L5 (orange arrow) (B), fracture of the L5 vertebral body that involved the right superior endplate, focal scoliosis with a concave on the right side (C) and the "naked facet sign" (green arrow) at the left L4–L5 region (D). In a normal facet joint observed on the axial cut of a CT scan, the 'hamburger sign' is evident (right side). This sign indicates that the inferior articular process (IAP) of the superior segment covers the SAP of the lower segment, resembling the layers of a hamburger. However, when a facet joint becomes dislocated, the IAP is misplaced. In such cases, the characteristic imaging appearance is referred to as the "naked facet sign," suggesting the disruption of the normal alignment of the articular processes.

using a midline posterior approach. Once the locked facet joint at the left L4–L5 level was identified, partial laminectomy and facetectomy were carried out to facilitate the reduction of the dislocated joint (Figure 4). After SAP excision, immediate relief of tension in the previously locked facet joint was noted, underscoring the tightly constrained initial position. Subsequently, the examination of the central canal through the laminectomy site revealed hyperemia of the dural sac with marked hematoma. For adequate decompression of the injured dura sac, a sublaminar decompression was performed to relieve the pressure on the structures within the canal. Subsequently, bilateral posterolateral fusion was performed from the L4 to S1 levels along with pedicle screw instrumentation (Figure 5). The autologous cancellous bone obtained during laminectomy was used as a bone graft. Additional bone graft material substitutes (60% hydroxyapatite and 40% β-tricalcium phosphate) and demineralised bone matrix were used. After meticulous control of bleeding, the surgical site was carefully closed in layers.

4 | CONCLUSION AND RESULTS (OUTCOME AND FOLLOW-UP)

4.1 | Postoperative care

After the surgery, no neurological deficits or complications were observed. A Taylor brace was prescribed for protective support for 3 months. In addition, the patient was instructed to refrain from bearing weight on the right lower limb for 6 weeks. Effective pain management was achieved using oral medications. Until discharge, the patient was mobilized with wheelchair assistance; eventually, he was cleared to return home. After discharge, the patient gradually increased their mobility and activity, progressing to sitting, standing, and walking with the aid of a walker, while avoiding excessive bending, twisting, or lifting. Physical therapy initially focused on gentle range-of-motion and isometric exercises, as well as controlled strengthening exercises, particularly targeting the core muscles. Starting in the 7th week, the intensity of strengthening exercises was increased, and

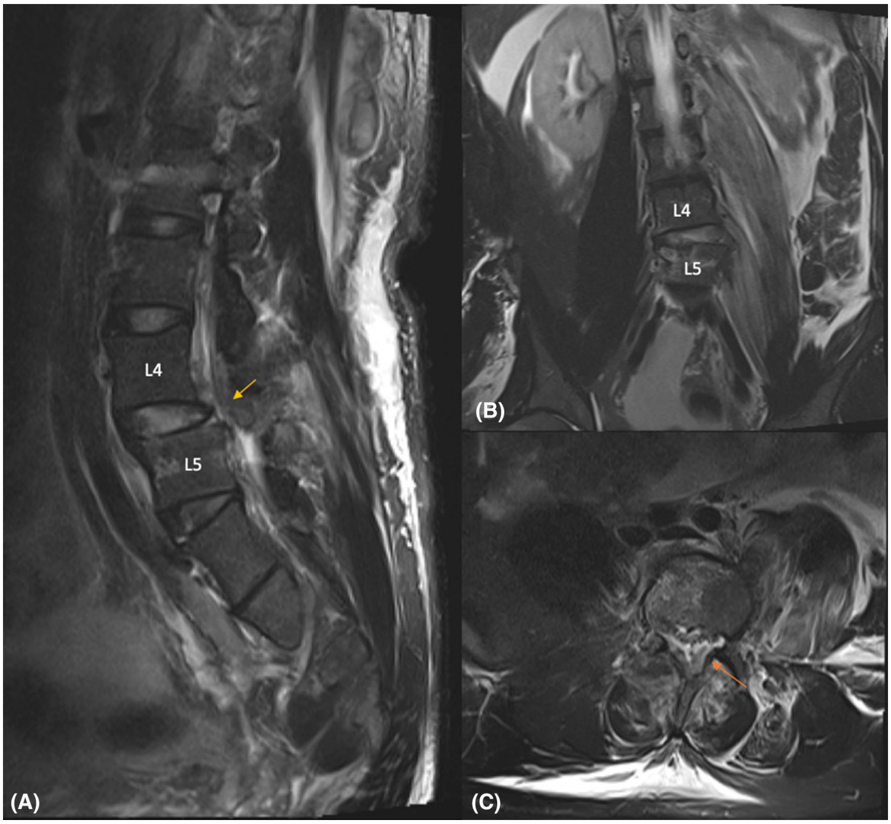

FIGURE 3 L-spine magnetic resonance images (T2-weighted images) revealing grade 1 spondylolisthesis of L4 on L5 and left lateral recess stenosis (yellow arrow) (A), L4–L5 disc injury (B,) and mild compression of thecal sac by epidural hematoma (orange arrow) (C).

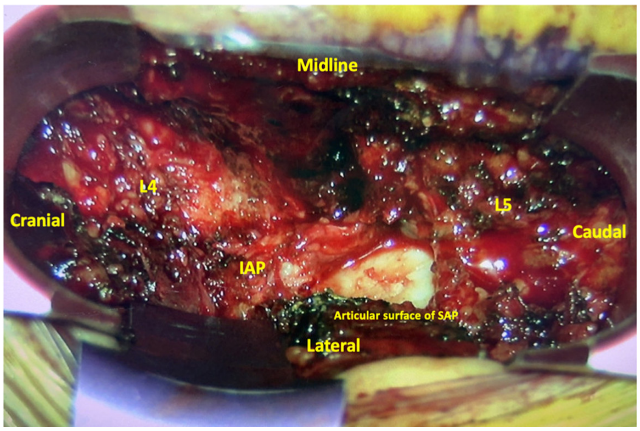

FIGURE 4 Intraoperative image revealing a dislocation of the left L4–L5 facet joint, with the SAP of L5 stuck over the IAP of L4. IAP, inferior articular process; SAP, superior articular process.

low-impact aerobic activities such as walking, swimming, or stationary cycling were introduced. Training in activities of daily living was also implemented. Partial weight-bearing on the right lower extremity was permitted during this period. Following 3 months of brace protection, the primary goals were to achieve near-normal strength, flexibility, and endurance, and to return to pre-injury activity levels, with a strong emphasis on preventing re-injury. Advanced strengthening, sport-specific, and work-related training were then initiated. Additionally, the patient received education on long-term spine health, including proper posture, body mechanics, and strategies to avoid re-injury.

4.2 | Outcomes

At the fifth-month follow-up, the patient was pain-free, fully recovered in terms of daily activities and ambulated without assistance. A Taylor brace was used only for protective purposes during extended periods of walking or riding. At the one-year follow-up, the patient was able to walk without assistance or brace support, and there were no neurological signs. The follow-up radiograph at this time demonstrated good alignment of the lumbar spine and no signs of implant failure (Figure 6).

5 | DISCUSSION

Facet dislocations are frequently observed in the cervical spine. Bilateral facet dislocations are more common than unilateral ones.[2,3] However, facet fracture dislocations are rare in the lumbar spine and have limited literature. The facet joints of the lumbar spine are characterized by a more vertical orientation with stability ensured by the robust muscular and capsuloligamentous structures and the larger size of the vertebrae.[4] Facet dislocations in the

FIGURE 5 Postoperative L-spine X-ray images (AP and lateral view) showing bilateral posterior instrumented fusion from L4 to S1. The local scoliosis deformity was also corrected.

FIGURE 6 The latest follow-up L-spine radiograph (AP and lateral view) at the post-operative 1 year showed good alignment of the lumbar spine and no signs of implant failure.

lumbar spine are typically observed at the lumbosacral junction. This tendency is partially ascribed to the coronal alignment of the facet joints in this region in contrast to the higher levels of the lumbar spine where the facet joints are characterized by a more sagittal orientation.[5,6]

Aihara et al. reviewed 50 cases of fracture–dislocation at the lumbosacral region and classified the injury into five types.[7] The present case could fall into a type 3 injury, characterized by unilateral lumbosacral facet dislocation and a contralateral lumbosacral facet fracture.

A combination of hyperflexion, distraction and rotation has been identified in patients experiencing L4–L5 facet dislocations.[8] Fok et al. suggested that the initial injury typically involves transverse process fractures as the powerful paraspinal muscles attempt to counteract hyperflexion–distraction forces. After transverse process fractures, the sequence of damage progresses and includes the rupture of the facet capsule, ligamentum flavum and subsequent failure of the intervertebral disc. In cases of higher-energy impacts, facet joint dislocation may occur, with or without an associated fracture.[9] However, upon closer look at previously documented cases of lumbar facet dislocation, most cases were associated with some form of restraints, typically involving a seat belt in the case of a motor-vehicle head-on collision.[4–6,8,10,11] Based on these cases, traumatic dislocations of the lumbar spine are also attributed to hyperextension injuries. Zenonos proposed the pathophysiology of this injury as follows: when a seatbelt is used, it secures the thoracic spine via the shoulder harness and the pelvis via the waist harness. Using the thoracic spine as a pivot point, the body's forward momentum, along with the remaining thoracolumbar spine, compels the spine to pivot forward. The magnitude of force increases with the distance from this pivot point, known as the moment arm. Simultaneously, the waist harness immobilizes and secures the pelvis, leading to a significant extension–distraction force at the lower lumbar and lumbosacral junction.[12]

In the presented case, it is hypothesized that the rotation centre was located in the L4–L5 region. This hypothesis is based on the observed injuries to the L4–L5 intervertebral disc and the fracture of the upper L5 vertebral body. The sequence of events began with the patient's initial effect on the right buttock, generating the first rotational force. During the second effect on the left posterior chest wall, combined with the body's momentum, a second rotational force was created, in addition to a flexion force. These combined forces ultimately led to the facet dislocation of the left side at the L4–L5 level and a fracture of the right L5 SAP. Associated injuries included damage to the posterior ligamentous complex and fractures involving the L5 vertebral body, L4 spinous process and left transverse processes of L1–L4.

Patients with lumbar facet dislocation typically present with severe back pain. Diagnosing lumbar facet dislocation based solely on physical examination can be challenging. According to a review by Cho et al., unilateral facet dislocations tend not to result in neurological deficits, whereas bilateral dislocations, particularly those accompanied by significant spondylolisthesis, can lead to neurological deficits.[1] Nevertheless, the absence of neurological deficits should not deter the appropriate investigation, particularly following high-energy trauma. Since the physical examination findings can be inconsistent and potentially misleading, a careful review of imaging studies is crucial for a more accurate diagnosis in cases of suspected lumbar facet dislocation. CT of the spine is the preferred diagnostic test, which can reveal characteristic findings such as the "reverse hamburger sign" or the "naked facet sign."[1,10,13] In the present case, the "naked facet sign" was found on the left L4–L5 facet joint. Because of the locked situation of the left L4–L5 facet joint, this case displayed an abnormal focal scoliosis deformity in both the anteroposterior X-ray view and CT scan. Alongside the characteristic imaging findings, this represents another imaging manifestation of the facet joint dislocation.

MRI is valuable for assessing injuries to soft tissues such as the anterior and posterior longitudinal ligaments (ALL and PLL), intervertebral disc, ligamentum flavum and interspinous ligaments and detecting any potential epidural hematomas.[1,13] Such severe spinal injuries typically affect all three spinal columns to varying extents. If an MRI indicates injury of the ALL, PLL, and/or intervertebral disc, the overall spinal stability is considered exceedingly poor. Consequently, extreme caution should be exercised when managing such cases. A case of delayed onset of facet dislocation was also reported and it was believed to be a result of ligamentous damage.[11]

The standard treatment for lumbar facet dislocation is typically open reduction and instrumented fusion. The fusion levels depend on the stability. Miz and Engler reported a case with unilateral facet dislocation of L5 on S1, where the right inferior facet of L5 was locked anterior to the right superior facet of S1. To reduce this dislocation, they removed the tip of the right superior facet of S1 and maneuvered the inferior facet of L5 over the remaining portion of the facet of S1. After reduction, a posterolateral fusion was performed, extending from L4 to the sacrum. Incorporating L4 into the fusion was decided based on the existence of ligamentous and fascial disruption, including the interspinous ligament damage between L4 and L5.[14] In unilateral facet dislocation, partial facetectomy may be employed to assist in the reduction of a dislocated joint. However, preserving the integrity of apophyseal joints can still play a role in preventing future redislocations. Rhea et al. presented a case with unilateral L3–L4 jumped facet. A lamina spreader was gently used to reduce the facet joint without drilling or removing any part of the articular process.[5] On the contrary, some documented cases demonstrated that a successful reduction may not be possible without partially removing the locked facet joint.[1,6] Tsirikos AI et al. stated that decompressive laminectomy is typically discouraged in the absence of neurological signs because of concerns about potentially worsening spinal stability.[15] Nevertheless, in cases involving bilateral locked facets, laminectomy may be considered to aid in the reduction process, even if there is no neurological deficit present.[8,12] Connolly et al. recommended an early intervention strategy for lumbosacral facet dislocations, which involves performing open reduction promptly, followed by internal fixation using pedicle screws and concluding with posterolateral fusion.[16]

In the present case of unilateral facet dislocation, our approach involved a series of surgical steps. Initially, the affected SAP was removed to alleviate the pressure at the dislocation site. Subsequently, the inferior articular process (IAP) and a portion of the unilateral lamina were resected to achieve effective nerve decompression. Instead of simple reduction of the dislocated facet joint, this surgical method was performed because a firmly stuck dislocated facet joint was noted intraoperatively. If successful closed reduction is warranted, a forceful maneuver is required, which may cause excessive stretching or even further injury to the nerves during the process. Second, we were concerned about the possibility of iatrogenic compression of the spinal canal or the lateral recess in closed reduction, which potentially results in postoperative neurological symptoms. This compression might have been caused by a preexisting hematoma or inward squeezing of the facet joint capsule or ligamentum flavum. Third, because instrumented fusion surgery is anticipated, the removal of the facet joints or the lamina will not affect postoperative stability. Overall, decompressive facetectomy and laminectomy are feasible and safe surgical methods for a patient with unilateral facet dislocation.

Despite the integrity of the right pedicle of L5, implanting a pedicle screw might not be feasible because of fractures that affect the L5 SAP and vertebral body, which extended to the right L5 superior endplate. To ensure surgical stability, a three-level fusion was performed, spanning from L4 to S1 using pedicle screws for surgical fixation; the screws on the right side were inserted only at the L4 and S1 levels. Our goal was to minimize the extent of fusion while prioritizing the stability of surgical fixation.

Tsirikos et al. recommended additional anterior interbody fusion in conjunction with posterolateral fusion for lumbosacral facet dislocations. This recommendation is based on the perspective that lumbosacral dislocation is notably unstable.[15] In addition, Song and Lee suggested that posterolateral fusion and posterior pedicle screw augmentation without anterior support may increase the risk of spinal collapse.[8] Extending the interbody fusion may be prompted by several factors, including the need for a more extensive discectomy because of disc fragmentation or herniation, particularly in cases with a compromised posterior column. In addition, this extension may be considered when there are concerns about achieving adequate stabilization in the presence of factors such as poor bone quality or vertebral body fractures that restrict the ability to securely purchase screws. Cho et al. suggested performing MRI before proceeding with an anterior or posterior approach for anterior interbody fusion, particularly for the assessment of the ligamentous integrity. They opted not to perform an interbody fusion with a cage because of compromised ALL. They were worried that a cage may migrate into the retroperitoneal space.[1] In our case, both the ALL and PLL remained intact. However, with the evidence of endplate fracture and intervertebral disc injury, we preserved the ligaments and did not perform anterior interbody fusion because of concerns about potential exacerbation of instability.

We have highlighted several strengths of our report. First, rather than focusing solely on the classical imaging findings of facet dislocation, such as the ‘reverse hamburger sign’ on CT scans, we introduced the unique radiographic finding of ‘focal scoliosis,’ which can assist physicians in identifying this type of spinal injury. Second, we have provided a comprehensive summary of the possible mechanisms of lumbar facet dislocation and proposed the specific mechanism that may have led to the injury in this patient. Finally, drawing from previous reports, we have outlined the various surgical strategies available. While we advocate facetectomy and laminectomy for reduction, followed by pedicle screw-instrumented fusion as a treatment for facet joint dislocation, we emphasize the importance of individualized treatment.

6 | CONCLUSION

This report describes the trauma mechanism of lumbar facet dislocation, emphasizing hyperflexion with rotational force. The key to diagnosis lies in imaging, including CT and MRI. The characterization of abnormal local scoliosis is also one of the unique imaging signs of unilateral facet joint dislocation. We advocate facetectomy and laminectomy with pedicle screw-instrumented fusion to treat facet joint dislocation.

AUTHOR CONTRIBUTIONS

Chien Chieh Wang: Writing – original draft; writing – review and editing. **Tsung-Mu Wu:** Writing – original draft; writing – review and editing. **Chi-Sheng Chien:** Supervision; writing – review and editing. **Chi-Ming Huang:** Writing – original draft; writing – review and editing. **Kin Weng Wong:** Conceptualization; supervision; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

None of the authors had any conflict of interest in relation to this report.

DATA AVAILABILITY STATEMENT

Data generated during this study is available from the corresponding author on reasonable request.

ETHICS STATEMENT

Not required for case reports.

CONSENT

A written informed consent was obtained from the patient for the publication of this report and accompanying images.

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