Congenital hypoplasia of the lumbar pedicle with spondylolisthesis: report of 2 cases

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Congenital hypoplasia of the spinal pedicle is a rare condition. Previously reported cases were treated conservatively or with posterior instrumented fusion. However, the absence or hypoplasia of the lumbar pedicle may increase the difficulty of pedicle screw fixation and fusion. Herein, the authors describe 2 cases of rare adult congenital hypoplasia of the right lumbar pedicles associated with spondylolisthesis. The patients underwent anterior lumbar interbody fusion with a stand-alone cage as well as percutaneous pedicle screw fixation. This method was used to avoid the difficulties associated with pedicle screw fixation and to attain solid fusion. Both patients achieved satisfactory outcomes after a minimum of 2 years of follow-up. This method may be an alternative for patients with congenital hypoplasia of the lumbar spinal pedicle.

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KEY WORDS congenital hypoplasia; lumbar pedicle; spondylolisthesis

Congenital hypoplasia of the spinal pedicle is an uncommon anomaly. When it occurs, it mostly involves the cervical or thoracic spine; the absence of a lumbar or sacral pedicle is rare.3,5,6,9,20,26 The majority of cases with an absence or hypoplasia of the lumbosacral pedicles are asymptomatic, and they are usually discovered incidentally. Low-back pain is the most frequently reported symptom.6 The rarer cases present with intractable low-back pain or neurological impairment requiring surgery. Most patients are treated with posterior instrumented fusion; however, hypoplasia of the lumbar pedicle may increase the difficulties associated with the pedicle screw fixation and fusion. Herein, we present 2 cases of unilateral hypoplasia of the pedicles in the lumbar spine with concurrent spondylolisthesis, leading to low-back pain and radicular pain of the lower extremities. The surgical strategy in these cases consisted of anterior lumbar interbody fusion (ALIF), followed by percutaneous pedicle screw fixation (PPF) without posterior decompression.

Case Reports

Case 1

History and Examination

A 63-year-old man presented with chronic low-back pain and severe radicular pain in the right lower extremity. Prior conservative treatment with physical therapy and medication was unsuccessful. Physical examination revealed decreased muscle power in bilateral low-back pain or neurological impairment requiring surgery. Most patients are treated with posterior instrumented fusion; however, hypoplasia of the lumbar pedicle may increase the difficulties associated with the pedicle screw fixation and fusion. Herein, we present 2 cases of unilateral hypoplasia of the pedicles in the lumbar spine with concurrent spondylolisthesis, leading to low-back pain and radicular pain of the lower extremities. The surgical strategy in these cases consisted of anterior lumbar interbody fusion (ALIF), followed by percutaneous pedicle screw fixation (PPF) without posterior decompression.
lumbar spine revealed hypoplasia of the right L-4 pedicles and articulating processes (Fig. 2 left). On the left side, there was degeneration of the L4–5 facet joints, with fracture of the pars interarticularis (Fig. 2 right).

**Treatment**

We performed an ALIF with the SynFix system (Synthes Spine Inc.) and screws. The percutaneous pedicle screws were fixed via the paramedian approach on the left side of L4–5. Posterior decompression was not performed during surgery.

**Postoperative Course**

The patient’s postoperative VAS scores for low-back and radicular pain reduced to 1 and 0, respectively. Physical examination revealed normalization of muscle power in bilateral big toe dorsiflexion (MRC Grade 5/5). The dynamic radiograph of the lumbosacral spine revealed bony fusion with no evidence of pseudarthrosis at the 2-year follow-up (Fig. 3).

**Case 2**

**History and Examination**

An 84-year-old man presented with chronic low-back pain and radicular pain that radiated to the bilateral lower extremities. Preoperative VAS scores for the low-back and radicular pain were both 8. Physical examination revealed decreased muscle power in both right and left big toe dorsiflexion (MRC Grades 2/5 and 4/5, respectively). There was also a reduction in the power of bilateral ankle dorsiflexion (MRC Grade 4/5 bilaterally). All modalities of sensation were intact. The deep tendon reflexes were 2+ bilaterally. The standing weight-bearing radiographs of the lumbar spine revealed hypoplasia of the right L-5 pedicle and Meyerding Grade I spondylolisthesis at the L4–S1 level (Fig. 4). A CT scan of the lumbar spine demonstrated hypoplasia of the right L-5 pedicle, fracture of the L-5 pedicle root, and L4–5 foraminal stenosis (Fig. 5).

**Treatment**

The patient’s low-back and radicular pain did not improve with conservative treatment; therefore, we performed an ALIF using the SynFix system with screws at the L4–5 and L5–S1 levels. Additionally, we used PPF via the paramedian approach bilaterally at the L-4 and S-1 levels. Posterior decompression was not performed during surgery. The pedicle screws were augmented with polymethylmethacrylate (PMMA) cement due to severe osteoporosis (bone mineral density of the femoral neck –3.3).

**Postoperative Course**

The patient’s postoperative VAS scores for low-back and radicular pain reduced to 1 and 0, respectively. Physi-
cal examination revealed improved muscle power in bilateral big toe dorsiflexion: MRC Grades 4/5 and 5/5 on the right and left sides, respectively. Additionally, bilateral ankle dorsiflexion normalized to MRC Grade 5/5. The dynamic radiograph of the lumbosacral spine revealed solid bony fusion with no evidence of pseudarthrosis at the 2-year follow-up (Fig. 6).

Discussion

Dysgenesis or agenesis of the spinal pedicle is thought to result from a large retrosomatic cleft during embryological development. These clefts can occur in a variety of locations within the vertebral arch. They can also occur in the pedicles and have been reported from levels T-12 to S-1. Their cause is uncertain. Congenital hypoplasia of a pedicle at the lumbosacral junction can result in accompanying dysfunction or deformity of the facet joint, which is more critical to biomechanical stability than the hypoplasia of the pedicle itself.

The main role of facet joints in the lumbosacral spine is to stabilize extension and rotation stress. Biomechanical tests have revealed that total unilateral facetectomy significantly increases the instability of the lumbosacral spine axial rotation and flexion. Another function of the facet joint is to distribute the axial load at each level. The load carried by facet joints varies from 9% (neutral) to 15% (extension). If one of these joints is incompetent, the contralateral joint must bear a greater load. Case 1 in this study showed a similar type of overload and instability in the lumbar spine, resulting in severe degenerative changes in the contralateral L4–5 facet joints. Kaito et al. reported a similar case that was missing the right L-5 pedicle, which led to severe degenerative changes in the contralateral facet joint.

Radiological evaluation of these patients typically begins with conventional radiography and frequently includes CT, myelography, and MRI. According to Wietner et al., this congenital anomaly has the following radiographic features: 1) the false appearance of an enlarged ipsilateral neural foramen because of the absent pedicle; 2) a dysplastic, dorsally displaced ipsilateral articular pillar and lamina; and 3) a dysplastic ipsilateral transverse process. The spectrum of this anomaly also includes the absence of the ipsilateral pillar or the entire ipsilateral neural arch, as well as other osseous anomalies in more than half of the cases.

The main data collected from the literature are shown in Table 1. Previously reported cases of pedicle hypoplasia or absence were mostly asymptomatic; if present, the only symptom was low-back pain that was well controlled by conservative treatment. The rarer cases presenting with intractable low-back pain or neurological impairment required surgery. Most of the patients were treated with posterior instrumented fusion. However, lumbar pedicle hypoplasia can increase the difficulties associated with pedicle screw fixation and fusion.

The optimal surgical method for spondylolisthesis re-
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mains controversial. Several authors have demonstrated the effectiveness of ALIF in terms of the following advantages: preservation of posterior midline complexes, low risk of neural complication, less blood loss, and high fusion rate. Although a stand-alone ALIF cage is an effective construct for low-grade spondylolisthesis, nonunion and pseudarthrosis are possible complications. Recent studies have shown that ALIF with PPF can be performed to attain the surgical goals and successful outcomes in the management of isthmic spondylolisthesis. However, hypoplasia of the lumbar pedicle also increases the difficulty of performing PPF. In the cases featured in this paper, we performed PPF only for normal pedicles. We used a stand-alone cage augmented with screws to increase stability given concerns of pseudarthrosis. Both patients underwent the combined procedures without posterior decompression, and solid fusions were achieved.

Although Patel et al. also performed posterior instrumented fusion without decompression, 2-level fusion was applied in their patients. In our study, both patients underwent only single-level fusion; this allowed for the preservation of adjacent normal spinal segments. Our patients reported satisfactory functional outcomes at the 2-year follow-up. Anterior lumbar interbody fusion with a stand-alone cage followed by PPF can provide solid fusions and avoid the difficulties associated with pedicle screw fixation, as demonstrated in our 2 adult patients, in whom successful fusion and satisfactory functional outcomes were reported at the 2-year follow-up. This method may be an alternative for patients with congenital hypoplasia of the lumbar spinal pedicle with spondylolisthesis.

**Conclusions**

Congenital hypoplasia of the lumbar spine pedicle is rare. Therefore, it is important to recognize this anomaly as an unusual cause of low-back and radicular pain. Lumbar pedicle hypoplasia can increase the difficulty of pedicle screw fixation and fusion. Anterior lumbar interbody fusion with a stand-alone cage followed by PPF can provide solid fusions and avoid the difficulties associated with pedicle screw fixation, as demonstrated in our 2 adult patients, in whom successful fusion and satisfactory functional outcomes were reported at the 2-year follow-up. This method may be an alternative for patients with congenital hypoplasia of the lumbar spinal pedicle with spondylolisthesis.

**Acknowledgments**

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**References**

2. Choi KC, Kim JS, Shim HK, Ahn Y, Lee SH: Changes in the adjacent segment 10 years after anterior lumbar interbody

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**TABLE 1. Literature summary of cases of hypoplasia or absence of lumbar pedicle**

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Level &amp; No. of Cases</th>
<th>Age (yrs)/Sex</th>
<th>Signs &amp; Symptoms</th>
<th>Radiological Findings</th>
<th>Management</th>
<th>Outcome</th>
<th>FU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patel et al., 2013</td>
<td>Bilat L-5, 1</td>
<td>13/F</td>
<td>LBP, radiculopathy</td>
<td>Bilat hypoplasia of L-5 VB &amp; pedicle; spondylolisthesis Grade I</td>
<td>PI over L-4 &amp; S-1, w/o decompression</td>
<td>Resolution of pain &amp; good bony fusion</td>
<td>18 mos</td>
</tr>
<tr>
<td>Lt S-1, 1</td>
<td>10/F</td>
<td>LBP, radiculopathy</td>
<td>Absent lt S-1 pedicle, Grade I anterolisthesis</td>
<td>PI over bilat L-5, rt S-1 &amp; lt S-1alar screw w/o decompression</td>
<td>Resolution of pain &amp; good bony fusion</td>
<td>5 mos</td>
<td></td>
</tr>
<tr>
<td>Kaito et al., 2005</td>
<td>Rt L-5, 1</td>
<td>54/M</td>
<td>LBP, radiculopathy</td>
<td>Absence of rt L-5 pedicle</td>
<td>Conservative treatment</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Sener et al., 1991</td>
<td>Rt L-5, 1</td>
<td>34/M</td>
<td>LBP</td>
<td>Absence of rt L-5 pedicle</td>
<td>Conservative treatment</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Polly &amp; Mason, 1991</td>
<td>Rt L-6, 1</td>
<td>12/F</td>
<td>LBP, radiculopathy</td>
<td>Absence of rt L-6 pedicle, conjoined nerve root at L6–S1</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Lt L-4, 1</td>
<td>14/M</td>
<td>LBP</td>
<td>Absence of rt L-4, T-L scoliosis</td>
<td>Conservative treatment</td>
<td>Resolution of pain</td>
<td>6 mos</td>
<td></td>
</tr>
<tr>
<td>Lt L-5, 1</td>
<td>19/F</td>
<td>LBP</td>
<td>Absence of rt L-5 pedicle</td>
<td>L4–S1 PLF</td>
<td>Resolution of pain</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>Lt L-5, 1</td>
<td>17/M</td>
<td>LBP</td>
<td>Absence of rt L-5 pedicle, spondylolisthesis</td>
<td>PLF</td>
<td>Resolution of pain</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>Mizutani et al., 1989</td>
<td>Lt L-1, 1</td>
<td>10/M</td>
<td>LBP</td>
<td>Absence of lt L-1 pedicle &amp; VB, hypoplasia of lt T-12, L-2, L-3, &amp; L-5 pedicles</td>
<td>Conservative treatment</td>
<td>Resolution of pain</td>
<td>2 yrs</td>
</tr>
<tr>
<td>Lederman &amp; Kaufman, 1986</td>
<td>T11–12, 1</td>
<td>12/M</td>
<td>Nonspecific ab pain, no LBP</td>
<td>Hypoplasia of lt T-11 pedicle, absence of rt T-12 pedicle</td>
<td>No further workup or therapy</td>
<td>No back pain</td>
<td>NR</td>
</tr>
</tbody>
</table>

ab = abdominal; FU = follow-up; LBP = low-back pain; NR = not reported; PI = posterior instrumentation; PLF = posterior lateral fusion; T-L = thoracolumbar; VB = vertebral body.

Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions
Drafting the article: Hsieh. Critically revising the article: SH Lee. Administrative/technical/material support: HC Lee, Hsieh, Chen. Study supervision: HC Lee, SH Lee, Oh, Hwang, Park.

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