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Surgical Treatment and Outcomes of Adjacent Segmental Disease by Additional Extension-fixation Decompression and Fusion without Removing Prior Fixation by Using Domino Connector

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Purpose: Adjacent segmental disease (ASDis) represents symptomatic adjacent segment degeneration causing pain or neurological deficit. Revision lumbar decompression and extended spinal fusion remain the surgical gold standard. The surgical technique removes all prior implants (pedicle screw and rods) and applies the new implant to previous surgical sites while extending fixation across adjacent segments with fusion; however, it leads to soft tissue trauma, massive blood loss, prolonged operative time, and an increased fixation cost. This study aimed to present the use of a domino connector for connecting the old rod and new rod for extension fixation without removing prior fixation as an alternative technique.

Methods: This study retrospectively analyzed the data of 14 patients with ASDis who underwent revision surgery with the use of a domino connector for connecting the old rod and new rod for extension fixation without the removal of prior fixation.

Results: All the patients were aged 59–85 years with a mean age of 67.2 years. The mean duration of ASDis was 4.38 years postoperatively. The patients were grouped according to the modified MacNab criteria as follows: no patient in the excellent group, 12 patients in the good group, and two patients in the fair group.

Conclusions: This surgical technique for treating failed back surgery syndrome reduces the extent of the surgery by employing rod connectors without prior instrument revision. It can serve as an alternative for the operative technique for treating patients with ASDis.

Keywords: adjacent segmental disease, adjacent segment degeneration, removing of prior fixation, revision pedicle screw fixation, domino connector

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Adjacent segment degeneration (ASDeg) defined as the radiographic change regardless of the presence of symptoms, has become a major concern after fusion surgery. Adjacent segmental disease (ASDis) represents symptomatic ASDeg causing pain or neurological deficit due to postoperative spinal instability or nerve compression at the adjacent level[1]. ASDeg and ASDis occur in 26.6% and 8.5% of cases after lumbar

spinal fusion surgery, with a prevalence of 40% and between 5.2 and 18.5%, respectively[1-3].

Revision lumbar decompression and extension of fusion remain the preferred method for treating patients with ASDis[4-6]. Currently, the surgical technique involves removing all prior implants (pedicle screw and rods), applying the new implant to the previous surgical site and extending fixation across the adjacent segments followed by decompression and posterolateral fusion (PL fusion) at the adjacent level. This technique has historically been proven as an effective treatment of ASDis. However, this method requires extensive incisions at the previous surgical site and the removal of all instruments, thereby leading to soft tissue trauma, massive blood loss, prolonged operative time, and an increased fixation cost[1,5].

This study aimed to present an alternative surgical technique that preserves the previous instruments (pedicle screw and rods), connecting them to a new rod using an end-to-end rod (domino) connector in order to attain stability, followed by decompressive laminectomy and spinal fusion with demonstrated transforaminal lumbar interbody fusion, oblique lumbar interbody fusion, or PL fusion. This study retrospectively reviewed the outcomes of patients who sustained ASDis and were treated with this method.

METHODS

This study was approved by the research ethics committee of hospital (REC-HY, protocol number HYH EC 104-64-01). Data of 678 patients who underwent lumbar spine surgery and had ASDis that required revision surgery between 2010 and 2020 were retrospectively analyzed. The exclusion criteria were as follows: underwent spinal decompression alone without pedicle fixation; required revision surgery because of traumatic spine injury, infection, or severe bone osteoporosis; and with insufficient follow-up for defining the outcomes of postoperative treatments for at least 6 months postoperatively. Of the 678 patients, 32 patients met the inclusion criteria. From the 32 patients, four patients were excluded due to severe osteoporosis and two patients due to spinal surgery without pedicle screw fixation. Of the 26 patients (3.8% of all patients who underwent lumbar spine surgery), 12 patients were excluded for having received revision surgery without the use of a domino connector. Finally, 14 patients met the overall inclusion criteria (Table 1). Clinical diagnoses were made by a surgeon. Plain radiography and magnetic resonance imaging were obtained for all the patients. This study used the modified MacNab criteria for postoperative outcomes (excellent, good, and fair).

Operative procedure

After exposure to surgical fields and identification of the adjacent level (Figure 1), the surgeon removed the locking nut on both sides of the two-proximal level of the previous pedicle screw fixation and then elevated the old rods out of the pedicle screw of the two-proximal level with a rod holder and deviated laterally with Hohmann retractors using the leverage technique; next, the pedicle screw was removed at the most proximal level (Figure 2). Subsequently, the surgeon measured the old rods from the remaining pedicle screw, which was approximately 2 cm, and cut off the rod and then applied the old rod to the previous pedicle screw. The surgeon inserted the pedicle screw and applied the new rod above the adjacent level and used the domino connector to connect the old rod to the new rod; then, the surgeon tightened the lock on the connector (Figure 3). A locking nut was applied to all pedicle screws. Finally, laminectomy and fusion (interbody fusion or PL fusion) were performed at the pathologic level.

RESULTS

Overall, 14 patients (3 men and 11 women) met the overall inclusion criteria for this study. Their mean age was 67.2 years (range: 51–85 years) with a 4.38-year mean duration of ASDis postoperatively. Fourteen patients were treated by a single surgeon with a domino connector for connecting the old rod and new rod for extension fixation without the removal of prior fixation. Decompressive laminectomy and fusion (interbody fusion and PL fusion) were performed at the

pathologic level after inserting the pedicle screw in all levels. Five patients underwent multiple revision surgery. According to the postoperative functional modified MacNab criteria outcome, no patients belonged in the excellent group, 85.71% (12/14) patients were in the good group, and 14.29% (2/14) patients belonged in the fair group (Table 2).

Table 1 Patient profile of the adjacent segment disease after lumbar spine surgery.

Case	Sex	Age at surgery (years)	Level of previous fixation	ASDis level	Duration (year)	Symptoms	Treatment (Level of fixation)	Outcome	Blood loss (ml)
1	F	71	L2–5	L1–2	3	Back and leg pain	T11–L1 connected to L3–5	Good	700
2	F	85	L1–5	T12	5	Back and leg pain	T9–11 connected to L2–5	Good	500
3	F	65	L2–5	L1–2	7	Back and leg pain	T11–L1 connected to L3–5	Good	600
4	F	63	T11–L2	L2–3	7	Back and leg pain	T11–L5	Good	600
	3rd operation		T11–L5	T10–11	4	Back and leg pain	T9–T12 connected to T10–L5		500
5	M	65	L4–S1	L3–4	5	Back and leg pain	L2–S1	Good	800
	3rd operation		L2–S1	L1–2	2	Back and leg pain	T12–L1 connected to L3–S1		700
6	F	77	L1–S1	T12–L1	3	Back and leg pain	T8–T11 connected to L2–S1	Good	600
	2nd operation		T8–S1	T7–8	1	Back and leg pain	T4–T7 connected to T9–S1		600
7	F	62	L3–S1	L2–3	9	Back and leg pain	T12–L2 connected to L4–S1	Good	800
8	F	61	L2–S1	L2–3	2	Back and leg pain	T9–L1 connected to L3–S1	Fair	1,100
	3rd operation		T9–L1 c L2–S1	T8	1	Back and leg pain	T5–T8 connected to T11–S1		600
9	F	74	L2–S1	L2	7	Back and leg pain	T8–L1 connected to L3–S1	Good	800
10	M	64	L2–5	L1–2	6	Back and leg pain	T9–T12 connected to L3–5	Good	700
11	M	60	L3–5	L2–3	4	Back and leg pain	L1–5	Fair	1,200
	3rd operation		L1–S1	T12–L1	2	Back and leg pain	T7–T12 connected to L3–S1		800
	4th operation		T7–S1	T7–8	1	Back and leg pain	T3–T6 connected to T8–S1		900
12	F	59	L3–4	L1–2	10	Back and leg pain	T9–T12 connected to L2–L4	Good	800
13	F	72	T11–L5	T10–T11	2	Back and leg pain	T5–T10 connected to T12–L5	Good	600
14	F	63	L3–5	T10–11	7	Back and leg pain	T11–L2 connected to L4–5	Good	700

ASDis: Adjacent segmental disease, L: Lumbar level, T: Thoracic level

Fig. 1. The previous fixation and adjacent level were identified. The locking nut was removed from the two-proximal level of the previous pedicle screw fixation.

Fig. 2. Hohmann retractors and a rod holder were used to elevate the old rods beyond the pedicle screw and deviate them to the lateral side using the leverage technique.

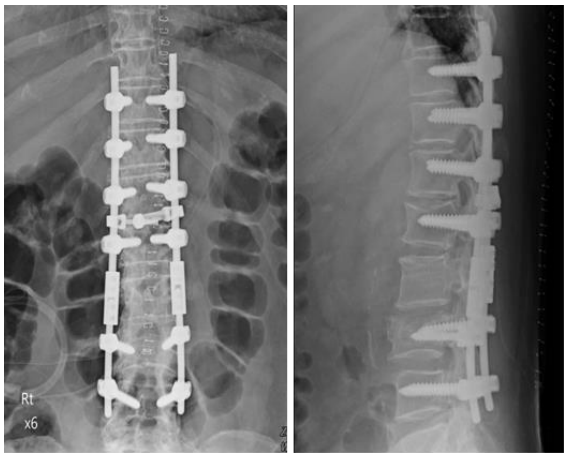

Fig. 3. After inserting the pedicle screw and applying the new rod above the adjacent level, the old rod was measured and cut. The domino connector was used to connect the old rod and new rod.

Table 2 Patient profile and modified MacNab criteria outcome data.

	Patient (N=14)	Percent
Age	67.21 ± 7.53	
Sex		
Male	3	21.45%
Female	11	8.57%
Duration of patient had ASDis (years)	4.38	
Follow up time (years)	7.33 ± 2.3	
Blood loss (ml)	730 ± 180	
Modified MacNab clinical outcome	Frequency	Percent
Excellent	0	0%
Good	12	85.71%
Fair	2	14.29%
Total	14	100%

ASDis: Adjacent segmental disease

DISCUSSION

Treating patients diagnosed with ASDis can be challenging and complicated because such patients are presented with serious problems as follows: first, a neurological deficit resulting from the compression of the neurostructure at the adjacent segment level; second, instability of the spine, leading to the patient presenting with clinical back pain and psychological problems; and last, spinal deformity, especially kyphosis deformity or spondylolisthesis[1,7,8]. Revision surgery is an inevitable treatment for patients in this group as it can provide a significant gain in health and utility[6]. However, a state-of-the-art, standard surgical treatment for ASDis has not yet been established.

Here, the rate of re-operation for ASDis was 3.8% in all the patients who underwent lumbar spine surgery. The average duration for a patient who had ASDis was 6.8 years postoperatively (the average without removing prior fixation was 4.38 years). The fixation covered the level of pathology, and all levels of severe degeneration, changing the trend to further neurological compression. Furthermore, the surgeon attempted to preserve the facet joint, especially at the most proximal and distal level of fixation, and did not have excessive distraction at the fusion level. The rate of revision surgery for treating ASDis was lower than the average rate of 8.5%.[1]

The operative technique of removing all prior implants has the advantage of strong fixation, making it easy to apply the new implant. However, this technique causes soft tissue trauma, prolonged operative time, and massive blood loss. Here, the use of a domino connector for connecting the old rod and new rod for extension fixation without removing prior fixation has been proven to have an effectiveness similar to that of the previous operative technique for treating patients with ASDis.

Nevertheless, the prevention or avoidance of ASDis is crucial for all patients. Hashimoto K et al.[1] performed a systematic review of meta-analyses, randomized controlled trials, and cohort studies. They concluded that the risk factors of ASDis at the lumbar level are age (>60 years), genetic factors, high body mass index (BMI), preexisting ASDis, laminectomy at the adjacent level of fusion, excessive distraction at the fusion level, insufficient lumbar lordosis, multilevel fixation, floating fusion, coronal wedging of L5–S1 disc, posterior tilting of the pelvis, and osteoporosis. The results are similar to those of Bagheri SR et al.[9] and Matsumoto T et al.[10], who performed a retrospective analysis. They have reported that the risk factors of ASDis are high preoperative BMI, preoperative disc degeneration, spinopelvic sagittal imbalance (decreased postoperative lumbar lordosis, PI–LL mismatch), fusion at more than four levels, and intraoperative superior facet joint violation.

This study had some limitations. First, as this was a retrospective study, some data were missing, such as preoperative parameters, and other functional scores. Second, the retrospective study design might have caused some bias. Third, this study had a small sample size. Lastly, the alternative technique used in this study was not statistically compared to the removing prior fixation operative technique. Hence, future studies are required to further compare both techniques.

CONCLUSION

This surgical technique for treating failed back surgery syndrome reduces the extent of the surgery by employing rod connectors without prior instrument revision. It can serve as an alternative for the operative technique for treating patients with ASDis.

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