Case Series

Robotic guidance in posterior transdiscal fixation for high-grade spondylolisthesis: a case series

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Background: Spondylolisthesis affects a considerable portion of the population, yet high-grade spondylolisthesis (HGS) is relatively uncommon and is associated with substantial anatomical distortion, instability, and neurologic risk that complicate surgical management. Posterior transdiscal (PTD) fixation has emerged as a minimally invasive, biomechanically robust strategy that enables circumferential stabilization across the lumbosacral junction while minimizing soft-tissue disruption. The integration of robotic guidance in spine surgery may further enhance pedicle and transdiscal screw placement accuracy, streamline workflow, and improve patient safety by reducing reliance on fluoroscopy and minimizing trajectory deviations.

Case Description: We conducted a retrospective case series of five consecutive patients with symptomatic HGS who underwent robotic-assisted PTD fixation at a single tertiary center. Demographic characteristics, operative variables, and perioperative events were recorded. Standardized radiographic metrics (including slip percentage and segmental alignment) and clinical outcomes were collected preoperatively and at routine postoperative intervals. Patient-reported outcomes included visual analog scale (VAS) pain scores and Oswestry Disability Index (ODI). All cases achieved successful screw placement as planned by the robotic workflow without intraoperative revisions. Statistically significant improvements were observed in VAS pain and ODI from baseline to final follow-up. Radiographs demonstrated maintenance of construct integrity and improved alignment parameters. No perioperative complications, neurologic deficits, returns to the operating room (OR), or implant-related adverse events were observed during the study period.

Conclusions: Robotic guidance in PTD fixation for HGS appears to enhance procedural accuracy and safety, facilitating reliable instrumentation in challenging anatomy while potentially reducing operative risk, radiation exposure, and complications. In this preliminary series, patients experienced meaningful reductions in pain and disability with stable radiographic outcomes and an absence of perioperative adverse events. Larger comparative studies with longer follow-up are warranted to confirm durability, quantify radiation and efficiency benefits, and define patient selection criteria for maximal benefit.

Keywords: Robotics; spinal surgery; transdiscal screws; spondylolisthesis; case series

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Introduction

Spondylolisthesis is a common cause of low back pain and neurologic symptoms, defined by anterior displacement of one vertebra relative to the next. Its apparent prevalence has increased with wider use of advanced imaging. Population studies report overall prevalence up to 20%, and radiographic surveys of asymptomatic individuals identify pars interarticularis defects in approximately 9–11% (1-4).

Degenerative spondylolisthesis most often involves L4–L5, whereas nondegenerative forms more commonly affect L5–S1 due to congenital or acquired defects (5). High-grade spondylolisthesis (HGS), typically Meyerding grade III or higher, accounts for roughly 19% of cases, with isthmic spondylolysis as a leading etiology. Severe slips can disturb global sagittal balance, contributing to gait and postural abnormalities. Although surgery is generally indicated for HGS, the optimal strategy remains debated given its relative rarity (5,6). Core surgical objectives include neural decompression and durable stabilization, with or without slip reduction (6-9).

A range of techniques is described, including posterolateral fusion (with or without interbody support), anterior approaches, and vertebrectomy. Posterolateral fusion alone at L5–S1 has been associated with higher pseudoarthrosis rates. Posterior transdiscal (PTD) screw fixation, first described by Abdu *et al.* (10), provides robust three-column purchase through a posterior approach. However, transdiscal screw placement is technically demanding. Contemporary technologies such as three-dimensional (3D) navigation and robotic guidance may enhance trajectory accuracy and streamline workflow, potentially improving the safety of complex constructs (9,11). Here, we report our early experience with robotic-assisted transdiscal fixation for HGS. We present this article in accordance with the AME Case Series reporting checklist (available at https://jss.amegroups.com/article/view/10.21037/jss-25-122/rc).

Highlight box

Key findings

- This case series of high-grade spondylolisthesis patients (Meyerding III–IV) demonstrates how robotic-guided posterior transdiscal (PTD) fixation was a feasible and safe procedure, with no perioperative complications.
- Patients demonstrated statistically significant improvements in pain and disability at a mean 12-month follow-up, with operative times of 60–75 minutes. Robotic assistance supported accurate screw placement for posterior fixation procedure, including transdiscal trajectories.

What is known and what is new?

- PTD fixation is a minimally invasive, biomechanically robust option for high-grade spondylolisthesis, but freehand accuracy is challenging due to complex lumbosacral anatomy.
- This series shows that robotic guidance can streamline transdiscal instrumentation in high-grade slips, achieving clinical improvement without perioperative complications in a real-world cohort.

What is the implication, and what should change now?

- Robotics may enhance precision, safety, and workflow efficiency in complex lumbosacral fixation, supporting its use when transdiscal trajectories are indicated. Authors should consider integrating robotic guidance for high-grade spondylolisthesis and adopt standardized outcome reporting (clinical scores, radiographic accuracy) to validate benefits in larger, comparative studies.

Case presentation

Methods

The authors present a retrospective non-comparative analysis of a small case series of 5 consecutive patients which were treated for HGS through a PTD spinal fusion with robotic guidance [robot ExcelsiusGPS® (Globus Medical, Inc., Audubon, PA, USA)] from March 2023 to December 2023 at Neurosurgical Department of Azienda Ospedaliera (AO) Papardo, University of Messina.

All procedures performed in this study were in accordance with the ethical standards of the institutional research committee (AO Papardo) and with the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from the patients for the publication of this case series and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Inclusion criteria were the following: (I) patients with a correct sagittal balance; (II) vertebral displacement greater than 50% (Meyerding grade III or IV spondylolisthesis); (III) chronic low-back pain and/or lower-extremity symptoms attributable to radiculopathy; (IV) informed consent given by the patient in the written form.

Exclusion criteria were the following: (I) active infection, neoplasm/trauma, prior fusion at the index level; (II) severe osteoporosis (T-score ≤–2.5 or very low vertebral Hounsfield units); (III) inability to tolerate prone positioning. Bone quality was assessed via dual-energy X-ray absorptiometry (DEXA) (when available) and computed tomography (CT)-derived Hounsfield units; comorbidities were recorded but did not by themselves exclude patients unless representing uncontrolled systemic disease [e.g., the American Society of Anesthesiologists (ASA) physical status classification system IV] that contraindicated surgery. Surgeon preference did not exclude otherwise-eligible patients. Patients with signs of L4–L5 instability (ligament hypertrophy, facet joint effusion, reduction in intervertebral distance) were candidates for fixation from L4 through S1. All the patients involved were older than 18 years. Preoperative radiological studies included CT and magnetic resonance imaging (MRI) in all cases. The authors compared preoperative and postoperative radiographic as well as clinical parameters: pre- and postoperative Oswestry Disability Index (ODI) scores and visual analog scale (VAS) scores for low-back pain and inferior limbs pain. An immediate postoperative X-ray (Oarm2, Medtronic, Minneapolis, MN, USA) was made to identify any screw misplacement or instrumentation failure. Intraoperative blood loss, radiation time and any other intraoperative or postoperative complications were also recorded. Statistical analysis was performed with Python (Python Software Foundation). Given the small sample size (n=5), this study is exploratory and descriptive. No a priori power calculation was feasible, and no hypothesis testing or modeling was performed. Outcomes are reported as counts and proportions for categorical variables and medians with interquartile ranges for continuous variables. No confidence intervals are provided due to the instability of estimates in such a small cohort. Normality of paired differences was assessed with Shapiro-Wilk (alpha =0.05) and quantile-quantile plot inspection. If non-normal or $n \leq 10$, Wilcoxon signed-rank was used; otherwise, paired *t*-tests were applied. For independent groups, Mann-Whitney *U* or unpaired *t*-tests were used as appropriate; variance homogeneity was checked with Levene's test. Multiple comparisons were controlled using Holm-Bonferroni within outcome families.

A two-sided significance threshold of $P \leq 0.01$ was prespecified to limit Type I error given multiple endpoints; a sensitivity analysis at $P \leq 0.05$ is provided.

Surgical procedure and robotic assistance

At the time of this series, the senior surgeon had completed more than 300 robotic cases and our team (surgeon, scrub nurse, radiology technologist, and robotics specialist) had performed at least 300 total robotic procedures on the same platform. We observed a learning curve of approximately 20–35 cases for docking efficiency and workflow integration.

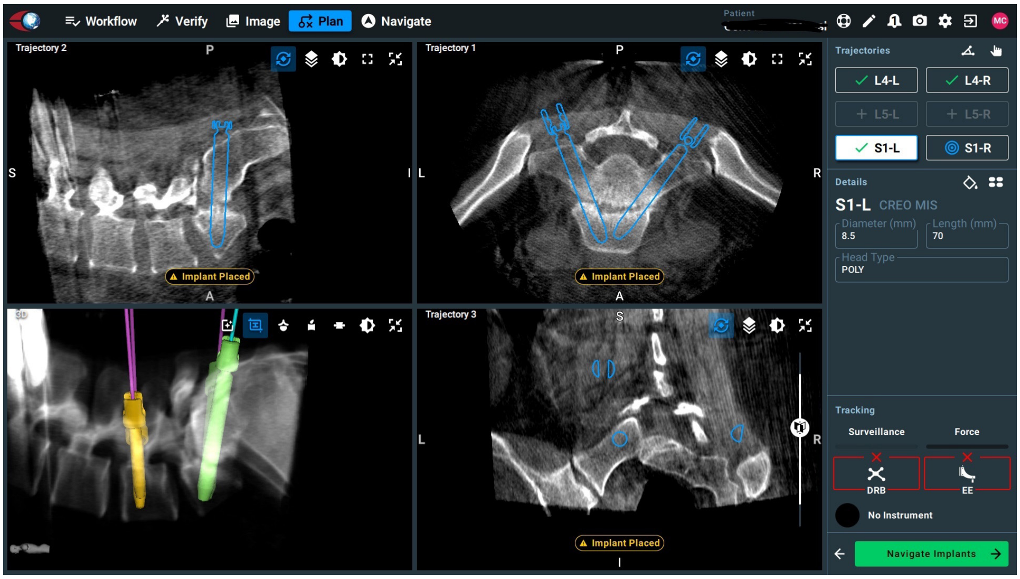
During surgery, the patient was placed under general anesthesia and lay in a prone position in the operating room (OR). An anteroposterior (AP) and a lateral fluoroscopic image were taken for the preoperative settings and then an intraoperative 3D fluoroscopy (OArm2, Medtronic) was taken and uploaded to the robotic system in order to plan the screw trajectories. To accurately track real-time position of the patient's anatomy by the robot, a dynamic reference array (DRB) was placed on the left iliac crest and a surveillance marker was placed on the right iliac crest. The navigated instruments' tracking was then validated by the robotic software, thus marking the end of registration.

In order to validate the robotic platform-Oarm2 match, before screw placement, we performed a two-point accuracy check using a navigated pointer on predefined bony landmarks (spinous process tip and facet). Any deviation >1.5 mm or >2 degrees would lead to recalibration and, if needed, re-registration. We did not report any cases of re-registration.

The preoperative screw planning consisted of positioning a bilateral transdiscal S1 through L5 screw with a length and diameter tailored to the specific slippage grade and pedicle diameter (e.g., patients 1 and 2: 8.5 mm × 70 mm, *Figures 1,2*) of the patient. The direction of the transdiscal screw followed the principle of the technique first described by Abdu *et al.* in 1994: pedicle screws are inserted obliquely through the pedicles of S1 in an anteromedial direction through the sacral promontory. The pedicle screws are then directed across the L5–S1 intervertebral disc space and into the anterior aspect of the L5 vertebral body without penetrating the anterior L5 vertebral body cortex. Two additional pedicle screws are placed in L4 and are connected either by plates or by a posterior rod system (10). In our experience, and thanks to the robotic guidance, we were able to add 2 additional pedicle screws in L5 in order to secure the system in patients with Meyerding grade 4 or in patients with a history of bone fragility. Using navigated instruments and guidance from the robotic arm, screws were placed based on the pre-planned trajectories.

About the Surgeon validation: every planned trajectory was visually confirmed in axial, sagittal, and coronal CT planes by the attending surgeon before execution.

Unlike the original procedure the robotic assistance allowed us to place each screw in a percutaneous manner, with a 1 cm cut for each screw thus significantly affecting the operative time, the blood loss and the recovery time thanks to the avoidance of the subperiosteal dissection and retraction. The final construct included posterior fixation



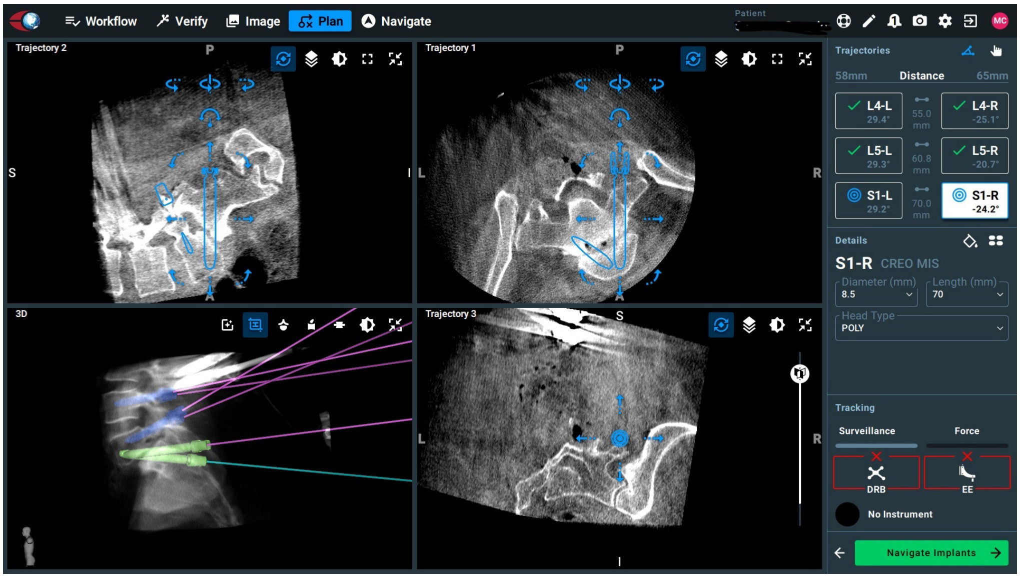
S1-L CREO MIS

Diameter (mm) 8.5

Length (mm) 70

Head Type POLY

Figure 1 Example of intraoperative planning. An L5–S1 8.5 mm × 70 mm screw was planned to reach the anterior aspect of the L5 vertebral body with an ideal Gertzbein and Robin A trajectory. Another screw was planned in a transpeduncular manner through L4 bilaterally.



58mm Distance 65mm

✓ L4-L 29.4°	55.0 mm	✓ L4-R -25.1°
✓ L5-L 29.3°	60.8 mm	✓ L5-R -20.7°
◎ S1-L 29.2°	70.0 mm	◎ S1-R -24.2°

S1-R CREO MIS

Diameter (mm) 8.5

Length (mm) 70

Head Type POLY

Figure 2 Example of intraoperative planning. An L5–S1 8.5 mm × 70 mm screw was planned to reach the anterior aspect of the L5 vertebral body with an ideal Gertzbein and Robin A trajectory. Two additional pedicle screws were planned in L5 in order to secure the system in this patient with diagnosed bone fragility. The system was secured by planning the traditional L4 screws bilaterally.

with rods affixed to the preplanned screws. After guidewire placement, we obtained a low-dose confirmatory 3D scan. In patients with radiculopathy, a hemilaminectomy and foraminotomy of the affected root were performed.

Five patients diagnosed with HGS underwent a robotic-guided PTD fixation from March 2023 to December 2023 with a mean duration of follow-up of 12 months (range, 6–18 months). The demographic analysis of our cohort consists of 4 females and 1 male, with a mean age of 36.8 years (range, 20–75 years). Two of the patients presented with Meyerding grade III spondylolisthesis and 3 with Meyerding grade IV. In 4 cases, an L4–S1 instrumentation was accomplished with 6 screws placed (L4–L5–S1), while in the other case, a transdiscal L4–S1 fixation was made with 4 screws placed (L4–L5–S1). The mean surgical time was 71 minutes (range, 60–75 minutes). The operation time, the estimated blood loss (EBL) and the radiological exposure were significantly lower when compared to the literature results (*Table 1*). The mean radiation time was 1.61 seconds (range, 1.43–2.3 seconds). The intraoperative CT performed at the end of the procedure showed the correct position of the instrumentation in all cases classified as A in the Gertzbein and Robbins classification, with no need for repositioning of the screws. The intraoperative EBL was 26 mL (range, 20–50 mL) (*Table 1*). There was a statistically significant improvement at 1 month and at 6 months in the mean VAS score for low-back pain (8.0 *vs.* 5.6 *vs.* 2.0), in the mean VAS score for leg pain (5.6 *vs.* 4.8 *vs.* 2.6) and the mean ODI score (57.6 *vs.* 38.2 *vs.* 18.2) (P=0.01) (*Table 2*). The calculated percentage of improvement of the clinical preoperative parameters was the following: VAS lumbar pain: 75.19%; VAS limb pain: 53.42%; ODI: 68.65% (*Table 2*). No significant difference between preoperative and postoperative spinopelvic parameters was observed (*Table 3*).

Table 1 Summary of clinical and radiological data in 5 adult patients with HGS treated with PTD

Variables	Value	Range	P value
Age, years	22.4–36.8	20.0–75.0	–
Gender (F/M)	4/1	–	–
VAS lumbar preop	0.7–8.0	7.0–9.0	<0.01
VAS inferior limb preop	0.9–5.6	5.0–7.0	<0.01
ODI preop	6.5–57.6	49.0–66.0	<0.01
Radiation exposure (s)	0.2-1.61	1.43–2.33	–
Estimated blood loss (mL)	13.4–26.0	20.0–50.0	–
Operation time (min)	6.5–71.0	60.0–75.0	–

F, female; HGS, high-grade spondylolisthesis; M, male; ODI, Oswestry Disability Index; PTD, posterior transdiscal; VAS, visual analog scale.

Outcomes are reported descriptively without comparison to non-robotic techniques; no conclusions on relative benefit can be drawn.

Discussion

The treatment of HGS is wide and varied: the main goal is to achieve the fixation of the lumbosacral mobilized segment in symptomatic patients. Many are the surgical treatments proposed through the years: instrumented and non-instrumented posterolateral fusions, anterior and posterior stabilization as described by Bohlman and Cook (11), more complex anterior approaches as the transperitoneal anterior lumbosacral interbody arthrodesis and fixation with a fibular graft reported by Jones *et al.* (12), two-staged approach as reported by Bradford and Gotfried (13). Abdu *et al.* were the first authors to propose a transdiscal fixation to treat HGS and after them many authors published their experience with this technique. Main advantages of this approach are considered the followings: (I) it is based on the concept of 3-column fixation which is achieved from a single posterior approach; (II) it has demonstrated *in vivo* implementation of superior biomechanical principles, as the triangular construct provides a superior fixation strength; (III) transdiscal screws allow for a better contact with cortical bone; (IV) the use of longer screws and greater penetration provides additional fixation (14). Many other biomechanical studies demonstrated the biomechanical superiority of the transdiscal construct, particularly addressing to the resistance against shear forces at the displaced level compared with posterolateral fusion (14,15). Moreover, PTD demonstrated a stiffness 1.6–1.8 times higher than that achieved with traditional pedicle screw fixation (14). However, L5–S1 screws could result in difficult positioning, mainly resulting from accurately reaching the L5 vertebral

Table 2 Improvement of the collected clinical parameters: lumbar VAS, inferior limbs VAS, and ODI

Variables	Preoperative	Postoperative 1 M	Postoperative 6 M	P value
VAS lumbar	8.0	5.6	2.0	<0.01
VAS inferior limb	5.6	4.8	2.6	<0.01
ODI	57.6	38.2	18.2	<0.01

M, month; ODI, Oswestry Disability Index; VAS, visual analog scale.

Table 3 Pre- and postoperative spinopelvic parameters: PI and LL

Patient ID	Metric	Pre	Post
P1	Lumbar lordosis (deg)	38.0	52.0
	Pelvic tilt (deg)	26.0	18.0
	Sacral slope (deg)	36.0	44.0
	Sagittal vertical axis (mm)	85.0	25.0
	PI-LL mismatch (deg)	24.0	10.0
P2	Lumbar lordosis (deg)	30.0	45.0
	Pelvic tilt (deg)	24.0	16.0
	Sacral slope (deg)	39.0	39.0
	Sagittal vertical axis (mm)	72.0	25.0
	PI-LL mismatch (deg)	25.0	10.0
P3	Lumbar lordosis (deg)	42.0	58.0
	Pelvic tilt (deg)	28.0	20.0
	Sacral slope (deg)	40.0	48.0
	Sagittal vertical axis (mm)	90.0	25.0
	PI-LL mismatch (deg)	26.0	10.0
P4	Lumbar lordosis (deg)	28.0	40.0
	Pelvic tilt (deg)	23.0	15.0
	Sacral slope (deg)	41.0	35.0
	Sagittal vertical axis (mm)	65.0	25.0
	PI-LL mismatch (deg)	22.0	10.0
P5	Lumbar lordosis (deg)	46.0	62.0
	Pelvic tilt (deg)	30.0	20.0
	Sacral slope (deg)	42.0	52.0
	Sagittal vertical axis (mm)	88.0	25.0
	PI-LL mismatch (deg)	26.0	10.0

Deg, degree; LL, lumbar lordosis; PI, pelvic incidence; PI-LL, pelvic incidence minus lumbar lordosis.

body (13-15). It could require longer surgical times, elevated radiation doses and blood loss to obtain an accurate screw positioning. The literature reports a quite low rate of complications for PTD procedures with an incidence which ranges between 13% and 33%: the major reported complication is dural tear (17.8%), followed by infections (5%), hardware failure (4.5%) and malpositioning (9%) (14,15).

The advent of technology in the spine surgery adds many novelties, including intraoperative guiding tools which help the surgeon to follow the anatomy of the patient with live two-dimensional (2D) and 3D intraoperative scans during the screw positioning phase. The neuronavigation and the robotic guidance help the surgeon to reduce the operative time, blood loss and radiation time and to increase the accuracy of screw placement. In the context of prior PTD literature, our findings should be interpreted as supportive of feasibility and planning accuracy rather than definitive superiority. Non-robotic PTD series, including Delgado-Fernández *et al.* (16), have reported high accuracy (Gertzbein-Robbins A/B typically >90%) with low revision rates, comparable to our accuracy profile. Complication rates (neurologic deficit, infection, screw-related revision) in non-robotic cohorts are similarly low, and pooled estimates suggest no consistent difference in major complications between robotic and non-robotic techniques. Operative time and radiation exposure vary across studies; while robotic workflows may reduce fluoroscopy dependence, additional registration spins and setup can offset these gains, especially early in the learning curve. Long-term outcomes (ODI/VAS improvement, fusion rates) in non-robotic PTD are generally favorable, and to date, randomized evidence does not demonstrate clear clinical superiority of robotics. Accordingly, our results should be framed as showing that robotics can standardize planning and potentially enhance trajectory reproducibility in selected scenarios [e.g., dysplastic pedicles, high body mass index (BMI), revisions], while acknowledging that complication rates and long-term outcomes remain similar to well-executed non-robotic PTD in most reports.

The reported operation time for a no-neuronavigation-assisted, no-robotic guided PTD ranges from 170 to 280 minutes (17,18): our results documented that the use of the robotics could reduce the duration of this surgery up to 3 times, accordingly to the literature, thus reducing the complications, the hospital stay and the general outcome. All these features could drastically reduce the complications allowing the surgeon to perform complex surgeries without increasing the morbidity (14). Furthermore, many surgeons have less experience using the transdiscal screw trajectory inherent to the PTD compared to traditional pedicle screw placement. Robotic assistance may be a valuable tool to overcome this experience gap and support the safe and reproducible placement of transdiscal screws. A major advantage of robotic assistance is the ability to pre-plan screw trajectories based on the patient's own CT scan compared to the navigation systems. Furthermore, the robotic arm guides the surgeon in placing the screws during surgery, enabling higher screw accuracy (19). Delgado-Fernández *et al.* already demonstrated how the neuronavigation applied to transdiscal fixation was associated with improved results in this technique, including a reduction in postoperative and intraoperative complications related to screw malplacement, pseudarthrosis, and instrumentation failure (16). Our experience reports similar results in terms of clinical outcome (VAS and ODI) and adds some novelties in terms of blood loss, radiation exposure and operation time which were significantly lower than in the study of Delgado-Fernández *et al.* Our results further demonstrate that complications in such unusual procedures (particularly screw misplacement, hardware failure) could be greatly reduced with the use of robotic assistance compared with the results from previous reports.

To conclude, our data indicate that robotic guidance can facilitate preoperative planning and trajectory reproducibility; however, when compared with established non-robotic PTD series such as Delgado-Fernández *et al.*, accuracy and complication profiles are broadly similar. Any advantages in radiation or time appear workflow- and experience-dependent (16,20-22). Definitive differences in complications or long-term clinical outcomes have not been consistently demonstrated; adequately powered prospective comparisons are warranted (23,24).

This study presented several limitations. First is limited by its retrospective, single-center design and extremely small, highly selected cohort (n=5), which precludes any definitive conclusions regarding safety, efficacy, or reproducibility. Without a comparator arm and with short follow-up, causal inferences cannot be drawn and complication rates may be under- or over-estimated. Surgeon experience, case selection, and device-specific workflows further limit generalizability. Therefore, our findings should be interpreted strictly as proof-of-concept for technical feasibility and workflow integration. Larger, prospective, multi-center studies with appropriate comparators and predefined endpoints are required to evaluate clinical effectiveness, complication profiles, and reproducibility across operators and settings. Another major limitation of this study is the absence of a comparative cohort (e.g., conventional fluoroscopy-guided PTD fixation). Our findings should therefore be interpreted strictly as preliminary, hypothesis-generating observations of technical feasibility. Future studies—ideally prospective, multi-center designs with predefined endpoints—should compare robotic versus non-robotic PTD.

Conclusions

The use of PTD is considered a good surgical option for treating HGS in patients with good sagittal balance. This technique has some advantages compared with other techniques, including the stiffness and the stability of the system. The application of robotic guidance allows the surgeon to perform a complex surgery with a minimally invasive approach which could reduce the complications, the radiation exposure and the EBL and increase the accuracy of screw placement, giving the patient a good outcome in the mid-term without the morbidity of a complex spine surgery. Future multicentric studies could need to be done in order to validate our preliminary reports.

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Footnote

Reporting Checklist: The authors have completed the AME Case Series reporting checklist. Available at https://jss.amegroups.com/article/view/10.21037/jss-25-122/rc

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional research committee (AO Papardo) and with the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from the patients for the publication of this case series and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

References

1. Aoki Y, Takahashi H, Nakajima A, et al. Influence of Spondylolysis on Clinical Presentations in Patients With Lumbar Degenerative Disease. Cureus 2021;13:e12570.
2. Ko SB, Lee SW. Prevalence of spondylolysis and its relationship with low back pain in selected population. Clin Orthop Surg 2011;3:34-8.
3. Polly DW Jr, Haselhuhn JJ, Soriano PBO, et al. Management of High-Grade Dysplastic Spondylolisthesis. Neurosurg Clin N Am 2023;34:567-72.
4. Wiltse LL. Spondylolisthesis. West J Med 1975;122:152-3.
5. Hire JM, Jacobs JM, Bundy JV, et al. A modified Bohlman technique using a novel implant for treatment of high-grade spondylolisthesis. J Neurosurg Spine 2015;22:80-3.
6. Acosta FL Jr, Ames CP, Chou D. Operative management of adult high-grade lumbosacral spondylolisthesis. Neurosurg Clin N Am 2007;18:249-54.
7. Johnson RD, Valore A, Villaminar A, et al. Sagittal balance and pelvic parameters--a paradigm shift in spinal surgery. J Clin Neurosci 2013;20:191-6.
8. Kalra K, Kohli S, Dhar S. A modified Gaines procedure for spondyloptosis. J Bone Joint Surg Br 2010;92:1589-91.
9. Lehmer SM, Steffee AD, Gaines RW Jr. Treatment of L5-S1 spondyloptosis by staged L5 resection with reduction and fusion of L4 onto S1 (Gaines procedure). Spine (Phila Pa 1976) 1994;19:1916-25.
10. Abdu WA, Wilber RG, Emery SE. Pedicular transvertebral screw fixation of the lumbosacral spine in spondylolisthesis. A new technique for stabilization. Spine (Phila Pa 1976) 1994;19:710-5.
11. Bohlman HH, Cook SS. One-stage decompression and posterolateral and interbody fusion for lumbosacral spondyloptosis through a posterior approach. Report of two cases. J Bone Joint Surg Am 1982;64:415-8.
12. Jones AA, McAfee PC, Robinson RA, et al. Failed arthrodesis of the spine for severe spondylolisthesis. Salvage by interbody arthrodesis. J Bone Joint Surg Am 1988;70:25-30.
13. Bradford DS, Gotfried Y. Staged salvage reconstruction of grade-IV and V spondylolisthesis. J Bone Joint Surg Am 1987;69:191-202.
14. Dhar UK, Sultan H, Aghayev K, et al. Biomechanical assessment of anterior plate system, bilateral pedicle screw and transdiscal screw system for high-grade spondylolisthesis: a finite element study. Front Bioeng Biotechnol 2024;12:1491420.
15. Collados-Maestre I, Lizaur-Utrilla A, Bas-Hermida T, et al. Transdiscal screw versus pedicle screw fixation for high-grade L5-S1 isthmic spondylolisthesis in patients younger than 60 years: a case-control study. Eur Spine J

2016;25:1806-12.
16. Delgado-Fernández J, Pulido P, García-Pallero MÁ, et al. Image guidance in transdiscal fixation for high-grade spondylolisthesis in adults with correct spinal balance. Neurosurg Focus 2018;44:E9.
17. Minamide A, Akamaru T, Yoon ST, et al. Transdiscal L5-S1 screws for the fixation of isthmic spondylolisthesis: a biomechanical evaluation. J Spinal Disord Tech 2003;16:144-9.
18. Özalp H, Özkaya M, Yaman O, et al. Biomechanical comparison of transdiscal fixation and posterior fixation with and without transforaminal lumbar interbody fusion in the treatment of L5-S1 lumbosacral joint. Proc Inst Mech Eng H 2018;232:371-7.
19. Oh BK, Son DW, Lee JS, et al. A Single-Center Experience of Robotic-Assisted Spine Surgery in Korea: Analysis of Screw Accuracy, Potential Risk Factor of Screw Malposition and Learning Curve. J Korean Neurosurg Soc 2024;67:60-72.
20. Srinivasa V, Thirugnanam B, Pai Kanhangad M, et al. Flattening the learning curve - Early experience of robotic-assisted pedicle screw placement in spine surgery. J Orthop 2024;57:49-54.
21. Joaquim AF, Patel AA. Posterior L5-S1 transdiscal screws for high grade spondylolisthesis - a systematic review. Rev Assoc Med Bras (1992) 2018;64:1147-53.
22. Logroscino CA, Tamburrelli FC, Scaramuzzo L, et al. Transdiscal L5-S1 screws for the treatment of adult spondylolisthesis. Eur Spine J 2012;21 Suppl 1:S128-33.
23. Galieri G, Orlando V, Altieri R, et al. Current Trends and Future Directions in Lumbar Spine Surgery: A Review of Emerging Techniques and Evolving Management Paradigms. J Clin Med 2025;14:3390.
24. McNamee C, Kelly D, McDonnell JM, et al. The learning curve of robotic assisted pedicle screw placement: individual patient data meta-analysis. Spine J 2025. doi:10.1016/j.spinee.2025.07.007.

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