TECHNICAL NOTE

130

J Turk Spinal Surg 2026;37(3):130-133

DOI: 10.4274/jtss.galenos.2026.92485

GEOMETRY-INDEPENDENT REMOVAL OF PEDICLE SCREWS WITH DIFFERENT HEAD DESIGNS: CLINICAL APPLICATION OF THE Z-ROD TECHNIQUE

Ali Koç[1], Alperen Uysal[1], Ümit Özgür Güler[1], Mustafa Kaya[2], Fevzi Sağlam[1], Bekir Murat Çınar[1]

[1]*Sakarya University Faculty of Medicine, Department of Orthopaedics and Traumatology, Sakarya, Türkiye*

[2]*Sakarya University Faculty of Medicine, Department of Neurosurgery, Sakarya, Türkiye*

ABSTRACT

Pedicle screw removal during revision spinal surgery may become technically difficult because of stripped screw heads, incompatible drivers, or unavailable manufacturer-specific instrumentation. Existing extraction methods often depend on implant design and may increase operative time, costs, and risk of complications.

To describe the Z-rod technique, a geometry-independent pedicle screw removal method, and to evaluate its clinical feasibility, safety, and effectiveness. A retrospective, single-center study was conducted involving patients who underwent revision spinal surgery between 2020 and 2025. Patients in whom conventional screwdrivers failed to remove pedicle screws and who subsequently underwent removal using the Z-rod technique were included. The technique involves bending a standard spinal rod into a Z shape, rigidly fixing it to the tulip head with the existing set screw, and applying controlled rotational torque through a long lever arm. Demographic data, surgical indications, technical success, and complications were evaluated. A total of 83 pedicle screws in 24 patients (mean age: 42.1±16.7 years) were successfully removed using the Z-rod technique after failure of standard driver systems. Adequate mechanical stability and controlled torque transmission were achieved in all cases. No implant fractures, neurological deficits, vascular injuries, or additional bone and soft tissue injuries were observed. The technique was successfully applied across different implant manufacturers and screw-head geometries without requiring dedicated extraction systems.

The Z-rod technique is a simple, universal, and cost-effective method for pedicle screw removal that eliminates dependence on screw-head geometry and manufacturer-specific instrumentation. It may represent a practical alternative in revision spinal surgery when conventional removal methods fail.

Keywords: Spine, pedicle screws, reoperation, methods

INTRODUCTION

The pedicle screw systems are widely used to achieve segmental stabilization and to enhance fusion rates in the thoracic and lumbar spine[1]. Currently, these systems are manufactured by different companies and vary considerably in terms of internal drive-head geometry. Internal hex, Torx-like star-shaped, hexagonal, and various modified designs are commonly encountered in clinical practice.

Parallel to the increasing number of spinal fusion procedures, the number of patients requiring implant revision or removal has also steadily increased[2-6]. The pedicle screw removal may be necessary because of infection, implant failure, pseudoarthrosis, persistent pain, soft tissue irritation, or planned revision surgery[7]. Traditionally, pedicle screws are removed using manufacturer-specific screwdriver tips and instrumentation sets precisely matched to the internal geometry of the screw-head. However, in revision settings, conventional removal methods may fail because of stripped or deformed screw heads, driver incompatibility, unavailable instrumentation sets, or breakage of the screwdriver tip within the screw-head. Although dedicated extraction/removal sets may be used in such cases, these systems are not universally available as they may create additional cost, and perpetuate dependency on the implant manufacturer. Furthermore, difficulty during implant removal may prolong operative time and increase the risks of infection, blood loss, and iatrogenic soft tissue injury.

Spinal rods are one of the principal components of vertebral instrumentation systems and provide rigid segmental stability by connecting pedicle screws. In present study, we describe a geometry-independent screw removal method created by bending a standard spinal rod into a Z configuration and

Address for Correspondence: Ali Koç, Sakarya University Faculty of Medicine, Department of Orthopaedics and Traumatology, Sakarya, Türkiye
E-mail: alkoc79@gmail.com
ORCID ID: orcid.org/0000-0002-5775-102X
Received: 19.05.2026 **Accepted:** 15.06.2026 **Publication Date:** 06.07.2026
Cite this article as: Koç A, Uysal A, Güler ÜÖ, Kaya M, Sağlam F, Çınar BM. Geometry-independent removal of pedicle screws with different head designs: clinical application of the Z-rod technique. J Turk Spinal Surg. 2026;37(3):130-133

utilizing the rod-screw connection principle. The aim of this study was to evaluate the feasibility and clinical outcomes of the Z-rod technique, which functions independently of the internal drive-head geometry while using readily available spinal rod material.

MATERIALS AND METHODS

Patients who underwent revision spinal surgery between 2020 and 2025 were retrospectively reviewed. This was a single-center study designed to evaluate the effectiveness and safety of the Z-rod technique for pedicle screw removal. Patients in whom the Z-rod technique was used because pedicle screws could not be removed with conventional screwdriver systems were included.

Inclusion Criteria

1. Patients who had previously undergone posterior spinal instrumentation in the thoracic, lumbar, or thoracolumbar region for trauma, degenerative disease, deformity, or tumor, and subsequently required revision surgery.
2. Patients aged 12-89 years.
3. Cases in which technical difficulty was encountered during screw removal with standard driver systems, necessitating use of the Z-rod technique.

Exclusion Criteria

1. Patients whose pedicle screws were loose enough to be manually removed without any driver.
2. Screws fractured at the shaft, with dissociated tulip components, or with structural deformation preventing rod fixation using the set screw.

Surgical Technique

The Z-rod technique is a mechanical extraction method. The principal steps are as follows:

1. A standard metal rod (titanium or cobalt-chromium alloy) of appropriate diameter for the pedicle screw system is bent into a Z shape using a rod bender (Figure 1).
2. The short arm of the rod, approximately 15 mm in length; is inserted into the tulip head of the pedicle screw to be removed. This arm should be kept as short as possible to minimize soft tissue injury during extraction.
3. Using the existing set screw (nut), the rod is rigidly fixed to the screw-head, thereby establishing a mechanical connection. This allows torque to be transmitted directly to the screw shaft without reliance on the internal drive-head geometry.
4. The long arm of the rod, approximately 105 mm in length, is used as a lever-arm, and controlled rotational force is applied.
5. The pedicle screw is extracted from the bone using the generated high torque (Figure 2).

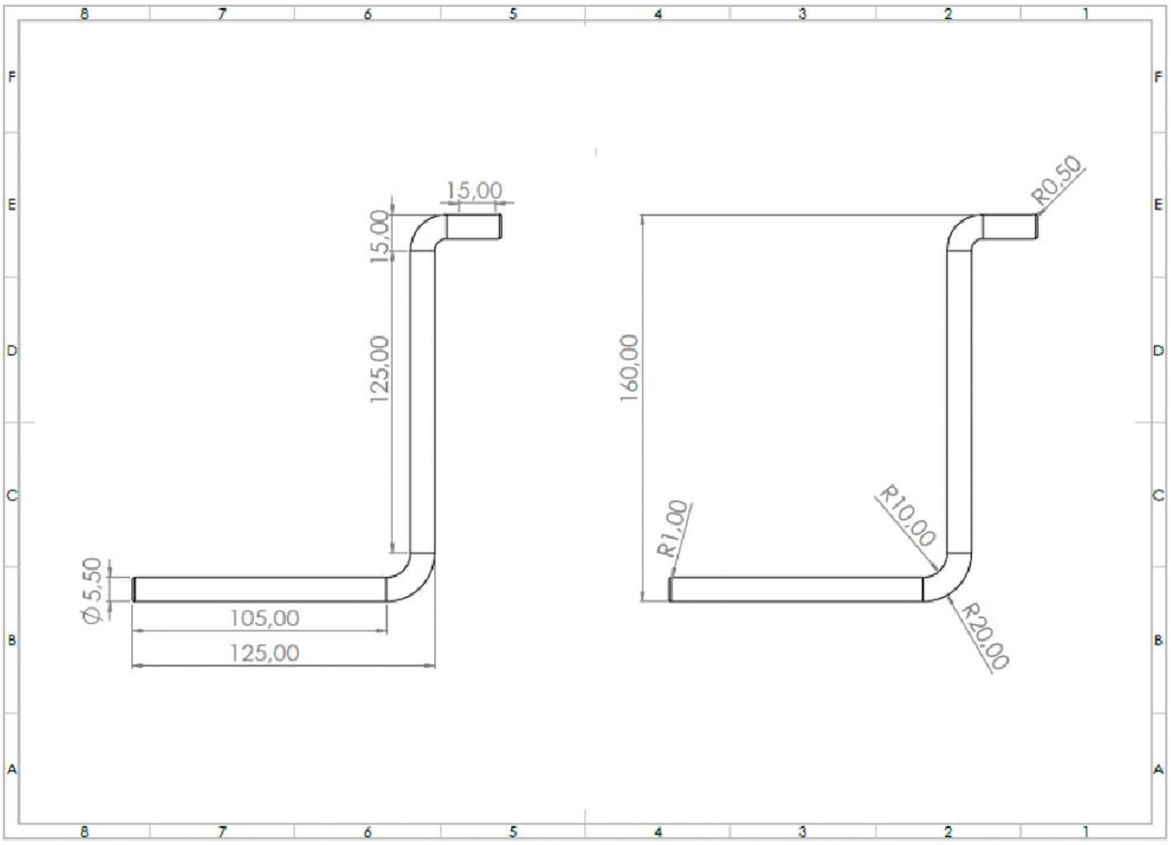

Figure 1. Technical drawing of the hand tool

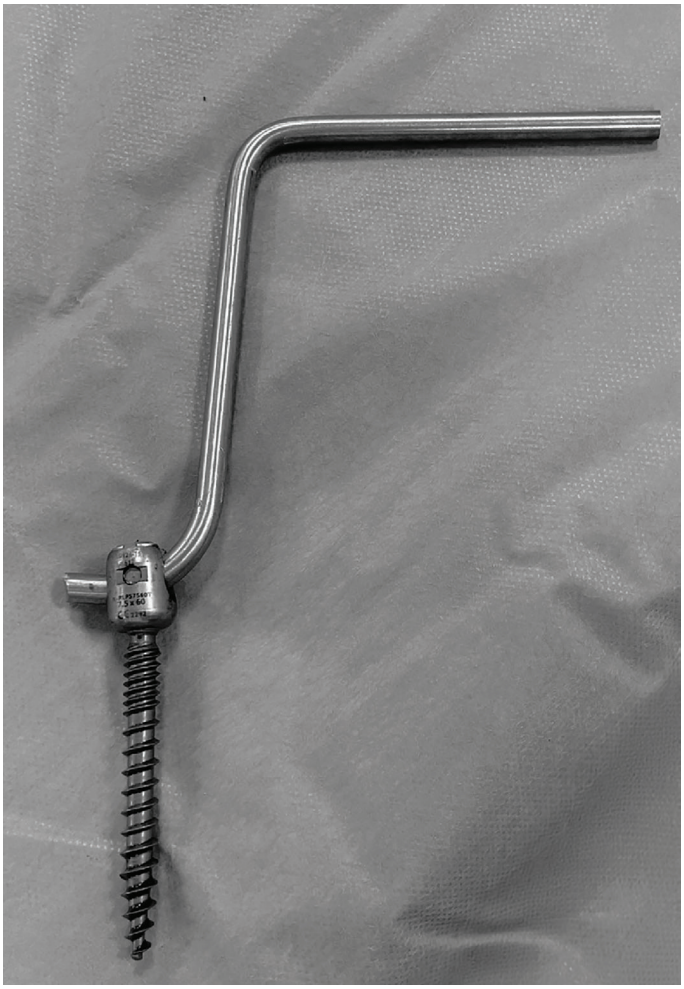

Figure 2. A screw removed via a Z-rod

RESULTS

Using this novel technique, pedicle screws that could not be removed with standard screwdriver systems were successfully extracted during a five-year period of clinical application. A total of 83 pedicle screws from 24 patients (mean age: 42.1±16.7 years) scheduled for implant removal for various indications were successfully removed using the Z-rod technique after failure of conventional driver systems due to screw-head incompatibility or inadequate torque transmission. In all cases, sufficient mechanical stability and controlled torque transfer were achieved during screw removal. No implant fracture occurred in any patient. No complications such as neurological deficit, vascular injury, or additional damage to surrounding bone or soft tissues were observed intraoperatively or during the early postoperative period. No manufacturer-specific removal/extraction sets were required during the procedures, eliminating the need for additional equipment procurement. This avoided unnecessary prolongation of surgery and prevented extra financial burden. The technique was found to be effective in pedicle screw systems from different manufacturers and with variable internal drive-head geometries, demonstrating that it can be applied independently of implant design.

DISCUSSION

Removal of pedicle screws can be technically challenging, particularly in systems using tulip-head polyaxial pedicle screws. Damage to the internal drive-head geometry, driver incompatibility, unknown implant brands, or lack of access to manufacturer-specific instrumentation may render conventional removal methods ineffective. This may prolong surgical time, requires additional bone resection, and increase the risk of complications.

Several alternative techniques have been described in the literature to address this problem. Kose et al.[8] described the U-rod technique, based on rotating a rod-screw complex counter clockwise using a rod bent into a U shape and inserted into the tulip head. Although practical since it does not require a dedicated extraction tool, the rod must be grasped and rotated using a rod holder. Unlike the Z-rod technique, this method does not incorporate a lever-arm principle and may require greater manual force for extraction. More recently, Zhang et al.[9] reported an alternative method in which a rod segment is cut to an appropriate length, reinserted into the tulip head, and tightened with the nut, thereby functionally converting the polyaxial screw into a monoaxial rod-screw construct. Although this technique may reduce operative time and intraoperative blood loss, its applicability may be limited when the screw rotates during tightening of the short rod segment or when counter-torque instruments are unavailable.

The Z-rod technique described in this study offers a mechanical solution aimed at eliminating dependency on implant-system type or screw-head geometry during removal of polyaxial pedicle screws. The technique can be performed without modifying the existing implant-system or requiring special extraction devices. The long lever-arm of the rod-screw construct enables controlled torque generation, facilitating screw extraction. The principal advantages observed with this method include:

1. Successful removal of stripped, damaged, or driver-incompatible pedicle screws.
2. Elimination of dependence on manufacturer-specific screwdrivers or extraction sets.
3. Applicability using standard instruments commonly available in most hospitals.
4. Easier extraction through generation of high and controlled torque.
5. Potential reduction in surgical time, cost, and complication risk.

Accordingly, the Z-rod technique may offer simpler applicability and greater implant-system independence compared with previously described U-rod and rod-reuse techniques.

Study Limitations

This study has several limitations. The sample size was relatively small, and no comparative control group was included. Although the primary aim was to introduce a new technique and the current results were satisfactory, larger comparative studies are required to establish stronger evidence. In addition, objective torque measurements were not performed. Future biomechanical studies are warranted to quantify the mechanical capacity of the technique. Nevertheless, the 100% clinical success rate supports its practical applicability.

CONCLUSION

The Z-rod technique is a simple, universal, and cost-effective method that eliminates dependence on internal screw-head geometry and manufacturer-specific systems during pedicle screw removal. It may serve as a practical alternative in revision surgery, particularly when pedicle screws cannot be removed using standard driver systems.

Ethics

Ethics Committee Approval: Ethics committee approval was not required for this study.
Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practises: A.K., Concept: A.U., Design: A.K., Data Collection or Processing: Ü.Ö.G., Analysis or Interpretation: M.K., Literature Search: Ü.Ö.G., F.S., Writing: A.U., B.M.Ç.
Conflict of Interest: No conflict of interest was declared by the authors.

One of the authors of this article (Ü.Ö.G.) is a member of the Editorial Board of this journal. He had no involvement in the peer-review process or editorial decision regarding this manuscript. The peer-review process and editorial decision were handled independently by another editor.
Financial Disclosure: The authors declared that this study received no financial support.

REFERENCES

1. Wood KB, Li W, Lebl DR, Ploumis A. Management of thoracolumbar spine fractures. Spine J. 2014;14:145-64.
2. Redaelli A, Pun A, Aebi M. The problems associated with revision surgery. Eur Spine J. 2020;29:2-5.
3. Simmons JW, Andersson GB, Russell GS, Hadjipavlou AG. A prospective study of 342 patients using transpedicular fixation instrumentation for lumbosacral spine arthrodesis. J Spinal Disord. 1998;11:367-74.
4. Martin BI, Mirza SK, Spina N, Spiker WR, Lawrence B, Brodke DS. Trends in lumbar fusion procedure rates and associated hospital costs for degenerative spinal diseases in the United States, 2004 to 2015. Spine (Phila Pa 1976). 2019;44:369-76.
5. Di Lorenzo N, Conti R, Romoli S. Retrieval of broken pedicle screws by "friction" technique. Technical note. J Neurosurg. 2000;92:114-6.
6. McGuire RA Jr. A method for removal of broken vertebral screws. Orthop Rev. 1992;21:775-6.
7. Sanderson PL, Ryan W, Turner PG. Complications of metalwork removal. Injury. 1992;23:29-30.
8. Kose KC, Isik C, Altinel L, Ates A, Ozdemir M. Easy retrieval of polyaxial tulip-head pedicle screws by "U" rod technique. Eur Spine J. 2010;19:144-6.
9. Zhang Y, Song J, Lu Y, Yi M, Xu X, Ding L. A practical method for the retrieval of tulip-head polyaxial pedicle screw by reusing the rod in revision and implants removal surgery: introduction of technique and evaluation of clinical outcomes. BMC Surg. 2023;23:152.