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# A New, Minimally-Invasive Technique for Direct Pars Interarticularis Osteosynthesis Using Cortical Screws and Spinous-Process Modular Link

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Abstract

Study Design: Case report

Objective: To report a case of direct pars osteosynthesis using computed topography (CT) navigation, image guided cortically-placed screws with curvilinear subspinous modular link.

Summary of Background Data: Spondylolysis fracture is commonly encountered in athletes who subject their spines to repetitive hyperextension stress. Initial treatment is non-operative, consisting of rest, activity modification, physical therapy, and/or bracing. When non-operative treatment is deemed unsuccessful, surgery may be recommended.

Methods: A 17 year-old male, competitive rower, presented with 3 months of atraumatic low back pain without radicular symptoms. After a 9-month period of nonoperative management, the patient was submitted to surgery. Using navigation cortical screws were placed in the standard inferomedial to superolateral trajectory crossing the fracture lines. A rod was contoured in a curvilinear fashion and passed through the L4-5 interspinous ligament and connected to the screw tulip heads.

Results: Patient did well postoperatively and remained neurologically intact throughout his course. CT performed at 1-year demonstrated healed fracture sites without signs of fixation loosening or failure. Patient underwent removal of retained fixation approximately 16 months after surgery. Patient has returned to rowing and all sports activities with no restrictions and no reported lower back pain.

Conclusion: This technique offers a novel solution for the treatment of pars fractures through a minimally-invasive, relative muscle-sparing approach, while not compromising healing potential and preserving the native facet joint.

**Key Words:** Spondylolysis, pars interarticularis fracture, surgical technique, computed topography (CT) navigation, curvilinear subspinous modular link

**Level of Evidence:** 4

## Introduction

Several surgical techniques for repair of spondylolysis have been described, including local bone grafting[1], direct screw osteosynthesis[2], figure-of-eight wiring[3] and arthrodesis. Anatomy restoration, motion-segment preservation, and fear of adjacent segment degeneration favor direct osteosynthesis in the adolescent demographic. We present the first case report of a direct pars osteosynthesis using computed topography (CT) navigation, image-guided cortically-placed screws with a curvilinear subspinous modular link.

## Case Report

### *History and Examination*

The patient is a 17 year-old male (BMI 24.4), competitive rower, presenting with 3 months of atraumatic low back pain upon standing and extension without radicular symptoms. Physical examination demonstrated right-sided lumbar paraspinal tenderness without step-off or crepitus and normal neurologic examination. Plain radiographs (Fig. 1AB) showed spina bifida occulta, without discrete pars fracture. MRI revealed edema and suggestion of fracture in L4 pars interarticularis (PI) bilaterally (Fig. 2). CT demonstrated incomplete fractures of the PI bilaterally (Fig. 3AB). Single-photon emission computed tomography (SPECT) confirmed focal activity of the L4 PI bilaterally. Despite 9-months of multimodal nonoperative management he remained symptomatic and opted for operative treatment.

### *Operation*

Patient was positioned prone on the radiolucent table (Mizuh OSI Jackson Table, Union City, CA). A stab incision was made over the right ilium for attachment of the navigation stereotactic reference frame. CT scan of the lower lumbar spine was performed with O-arm Multi-dimensional Imaging System (Medtronic, Inc., Minneapolis, Minnesota) after fluoroscopic localization, coupled/registered with the

StealthStation Image Guidance System (Medtronic, Inc). A 2-3 cm midline incision was made at the L4 level and minimal dissection was performed to expose the lamina, spinous process (SP) and PI, taking care to avoid thermal damage to the supraspinous ligament and avoiding exposure/stripping of the facet joints at L3-4 and L4-5. Using navigation, pilot holes were drilled in the L4 PI, tapped with a 3.5 mm tap, and two 4.5 mm x 30 mm fully-threaded, non-cannulated Solera cortical screws (Medtronic, Inc) were placed in the standard inferomedial to superolateral trajectory (Fig. 4) crossing the PI fracture lines bilaterally. A titanium rod was contoured in a curvilinear/semicircular fashion and passed through the L4-5 interspinous ligament using a right-angle clamp to minimize trauma to the ligament. The rod was connected to the screw tulip heads and end caps provisionally placed. Compression was then performed between the screw head and SP prior to final tightening of the end caps (Fig. 5). Intraoperative final posteroanterior and lateral films were obtained instead of an additional CT scan. Closure was routine and total blood loss was < 15 milliliters.

*Postoperative Course*

Patient did well postoperatively and was discharged from the hospital postoperative day 1 with oral narcotic analgesia. At 3 months and 1 year, the patient had near-complete resolution of back pain. CT performed at 1-year demonstrated healed fracture sites without signs of fixation loosening or failure (Fig. 6AB). Patient underwent instrumentation removal approximately 16 months after index surgery for mild persistent lumbar pain. Pain resolved completely within 4 months of instrumentation removal. He has returned to rowing and all athletics unrestricted, including deadlifting 400 pounds, without lumbar pain.

**Discussion**

Ulibarri et al. [4] (2006) first reported the use of a sub-SP modular link in their biomechanical/clinical study, evaluating four different repair techniques for sub-SP fixation in cadaveric

spines. In the clinical arm, patients were treated with traditional open pedicle screws and a sub-SP rod. Mohi Eldin [5] also used a sub-SP tensioned-rod, however, fluoroscopically-guided pedicle screws were placed and a cross link was added to the construct. More recently, Brennan et al. [6] described use of CT navigation for direct osteosynthesis with less-invasive exposure. A midline incision was performed and pilot hole created on the SP for k-wire placement and trajectory for screw fixation.

We sought to maximize fracture compression through direct osteosynthesis and SP loading through a minimally-invasive type approach. Cortical screws, placed in medial to lateral trajectory show equivalent toggle and axial pullout strength as traditional pedicle screws placed in lateral to medial trajectory [7] and afford a less-invasive midline approach. In our case, burring the fracture site and bone grafting were deemed unnecessary as the fracture was tension-sided, non-displaced, and metabolically active on SPECT.

To the authors' knowledge, this is the first report of a CT navigation-based direct PI repair using cortical screws placed in medial to lateral trajectory and SP-tensioned modular link. We believe this technique offers a novel solution for treatment of spondylolysis through a minimally-invasive, relatively muscle-sparing approach, while maintaining healing potential and preserving the native facet joint.

**References**

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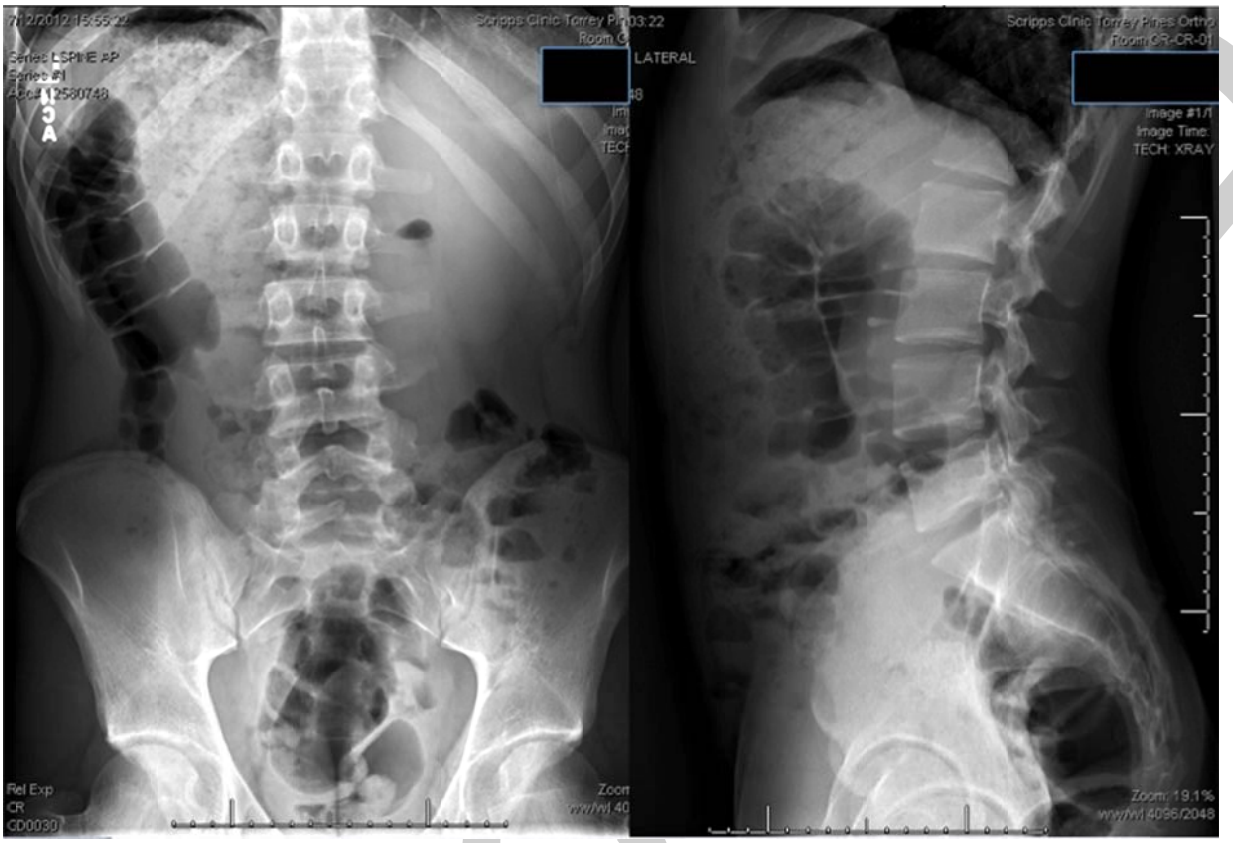
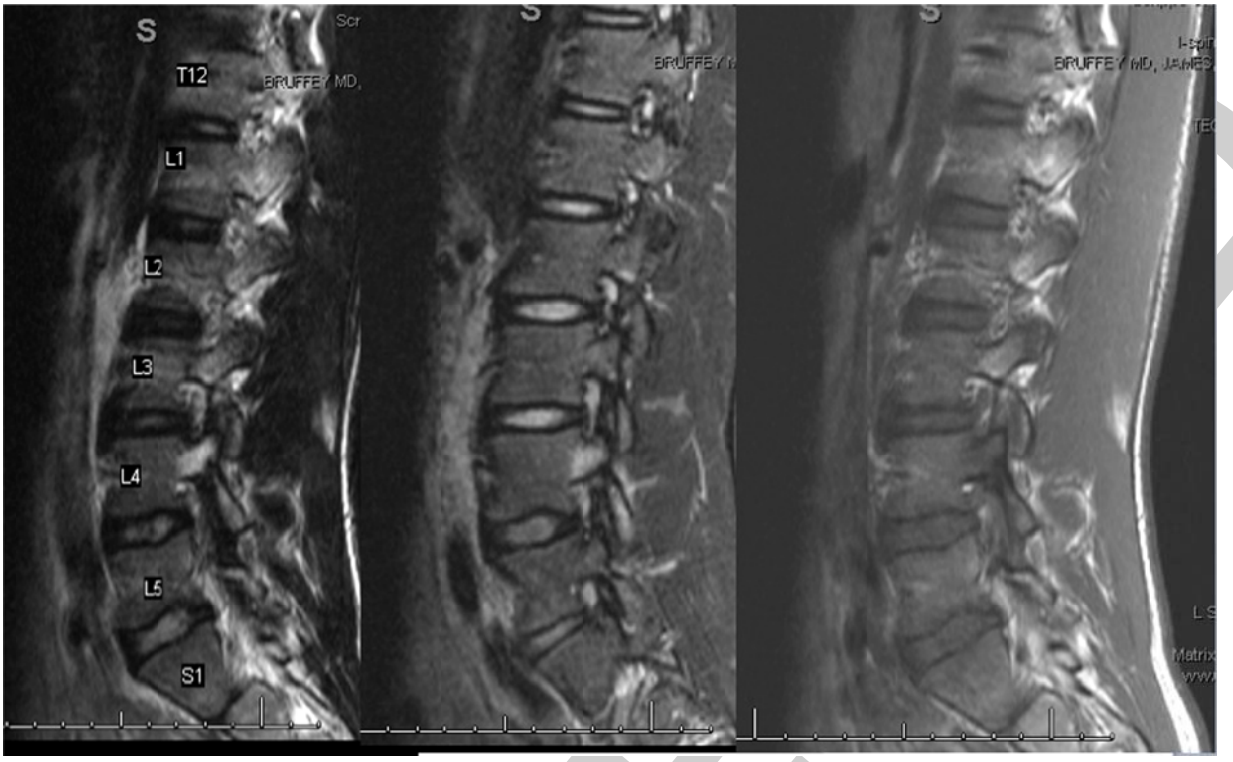
**Figure Legend**:

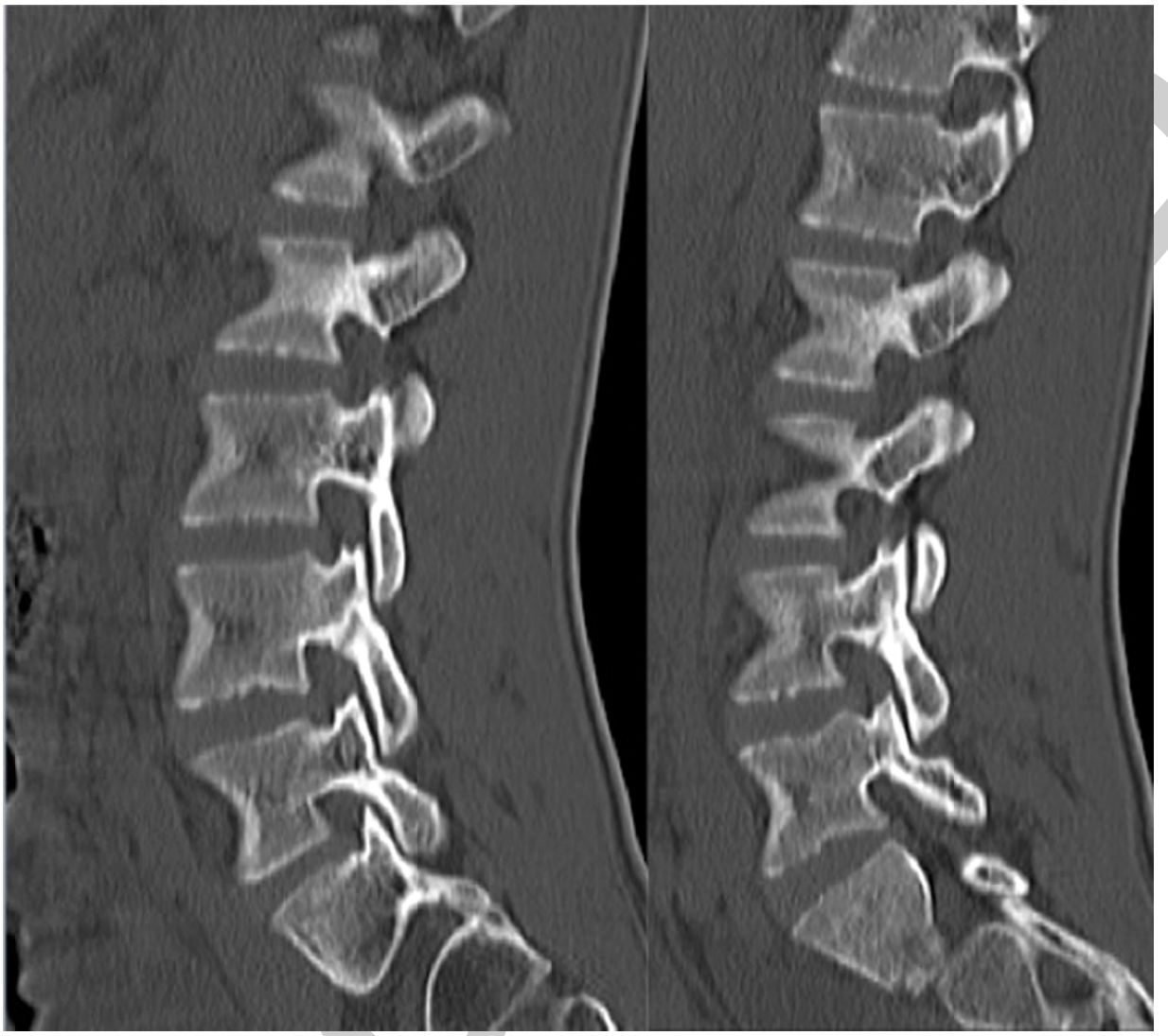
1. Preoperative radiographs revealing spina bifida occulta but without discrete evidence of pars fractures: a. Anteroposterior and lateral; b. Oblique images.



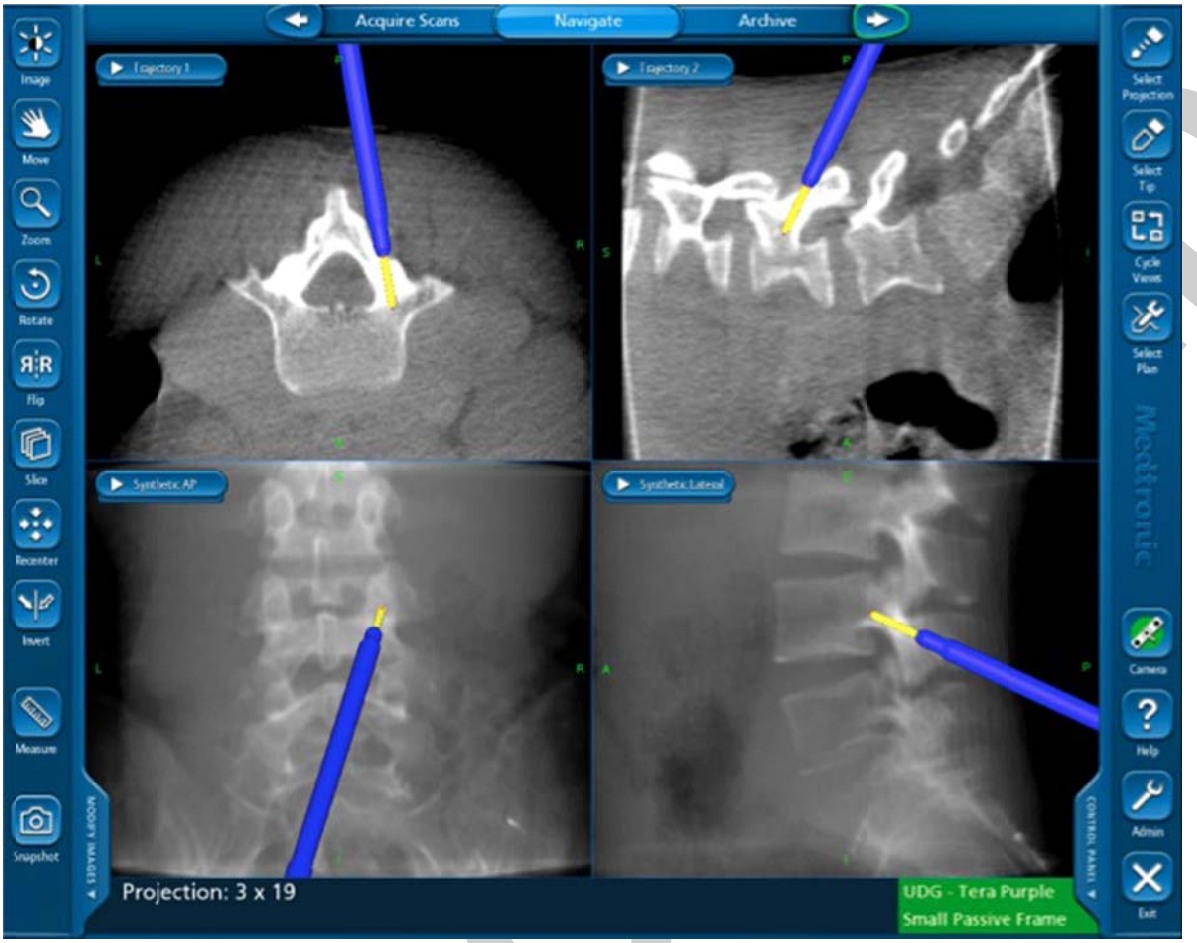
2. Sagittal preoperative MRI images revealing edema within the L4 pars bilaterally suggestive of fracture.



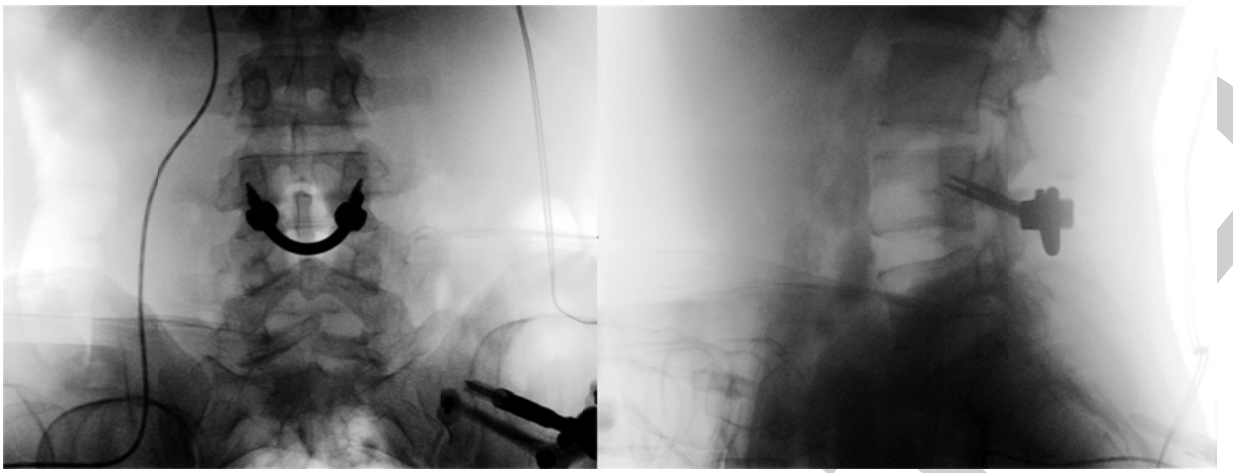
3. Preoperative CT images confirming incomplete L4 pars fractures bilaterally: a. sagittal; b. Axial.



4. Intraoperative osteosynthesis under CT navigation displaying inferomedial to superolateral trajectory of screw placement.



5. Intraoperative PA and lateral final fluoroscopy.



6. 1-year postoperative CT revealing healed pars fractures: a. Sagittal; b. Axial.