# Radiographic Lucency around Pedicle Screws with Cobalt Chromium Rod Constructs in the Setting of Lumbar Fusion

## Abstract

**Background Context:** Hybrid spinal implants that combine cobalt-chrome rods with titanium screws have been introduced with the goal of reducing the profile of implants used for lumbar fusion. 4.5mm and 4.75mm cobalt-chrome rods have been reported by the manufacturers as having similar results in biomechanical testing to conventional 5.5mm titanium rods, however little is known about the long-term clinical performance of these implants. This report discusses an interesting radiographic finding routinely encountered in our practice following use of these implants.

**Purpose:** To describe the occurrence of radiographic lucency surrounding pedicle screws following the use of low-profile hybrid spinal implants for instrumented posterior lumbar fusion.

**Study Design:** Case report.

**Methods**: This is an observational case series of 14 patients undergoing lumbar fusion instrumented with hybrid cobalt/chrome – titanium implants. All cases involved instrumented posterior lumbar fusion for the treatment of degenerative spondylolisthesis. Patients were followed for one year with radiographic evaluation of both screw lucency and bony fusion as well as subjective outcomes including visual analog scale (VAS) pain score and Oswestry disability index (ODI).

**Results:** At one year post-operative, all 14 patients had radiographic lucency around at least two pedicle screws in the construct despite radiographic bony fusion. All patients reported subjective improvement in VAS score and ODI, and all patients returned to work within 3 months post-operative.

**Conclusion:** We note a 100% rate of pedicle screw lucency in our series of patients undergoing posterior spinal fusion instrumented with hybrid low-profile cobalt-chrome implants. Lucency around pedicle screws has been previously associated in the literature with screw loosening, micro motion, and pseudo arthrosis. Despite this observation, the patients in our series subjectively report favorable outcomes. The significance and cause of lucency around pedicle screws with these low-profile implants is unknown, but may be due to decreased construct stiffness related to smaller rod diameter. Long-term experience with these implants is lacking and further studies are warranted.

**Keywords:** Lumbar fusion; Instrumentation; Cobalt-chrome rods; Corrosion; Aseptic loosening; Pedicle screw lucency; Case series

Case Report

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**Abbreviations:** CoCr: Cobalt-Chrome; Ti: Titanium; ODI: Oswestry Disability Index; VAS: Visual Analogue Scale

## Key Points

a. The use of hybrid implants, which combine low-profile cobalt-chrome rods with titanium screws, has been increasing in the setting of lumbar fusion.

b. 4.5 and 4.75mm cobalt-chrome rods have been marketed as having similar biomechanical performance to 5.5mm titanium rods, allowing for the use of lower-profile instrumentation.

c. We have routinely encountered lucency around pedicle screws on post-operative imaging when using these implants – a finding we have not seen with conventional implants.

d. The mechanism and clinical significance of this finding is unknown and may suggest that low-profile hybrid implants differ from conventional implants in their clinical performance in ways that are not captured by static biomechanical testing.

## Introduction

Hybrid spinal implants that combine cobalt-chrome (CoCr) rods and screw heads with titanium (Ti) screws have been introduced with the goal of reducing the profile of implants used for lumbar fusion. Owing to the higher modulus of elasticity of CoCr (218 GPa) relative to titanium (116 GPa), 4.5mm and 4.75mm cobalt-chrome rods have been marketed by manufacturers as having similar results in biomechanical testing to conventional 5.5mm titanium rods [1]. These claims, however, have not been independently verified and little is known about

the long-term clinical performance of these implants. We present here a series of 14 patients who underwent posterior lumbar fusion instrumented with low-profile CoCr rods. All 14 patients developed an interesting radiographic finding on routine post-operative imaging: lucency surrounding multiple pedicle screws, despite successful bony fusion and excellent clinical outcome.

Radiographic lucency surrounding pedicle screws is well described in the literature as associated with screw loosening, micro motion, and pseudo arthrosis [2,3]. The development of lucency surrounding pedicle screws in all patients in our series is a concerning radiographic finding which may indicate that hybrid implants differ in clinical performance from conventional implants in ways that are not captured by the manufacturers' reported biomechanical testing.

## Materials and Methods

14 patients are presented with similar clinical and radiographic outcomes following posterior lumbar fusion. All of the procedures were performed by the senior author (M. M.) for the diagnosis of degenerative spondylolisthesis with associated lower extremity radiculopathy. Ten cases involved single-level fusion and four involved two-level fusions. 12 cases were instrumented with 4.75mm CoCr rods using the Medtronic Solera System (Medtronic, Minneapolis, MN) and 2 with 4.5mm CoCr rods using the Stryker Xia Vitallium System (Stryker Spine, Kalamazoo, MI).

The patients were followed for one year post-operatively with radiographic and clinical examination at 2 week, 3 month, 6 month, and one year intervals. Clinical outcomes were assessed using the visual analogue scale (VAS) pain score and Oswestry disability index (ODI). Radiographic outcomes included assessment of lucency around pedicle screws and assessment of posterolateral fusion mass. Lucency around a screw was defined as a 1mm or greater radiolucent halo surrounding a pedicle screw. All radiographic assessments were made by the senior author.

## Results

Radiographic examination revealed that all 14 patients demonstrated posterolateral fusion mass on serial x-rays performed at 2 weeks, 3 months, 6 months, and one year. All 14 cases demonstrated radiographic lucency around at least two pedicle screws. The consistent radiographic appearance included a lucency surrounding the screw with a thin radio-opaque rim of compacted cancellous bone at the interface (Figure 1A & 1B). Although a CT scan was not obtained in all patients because of favorable clinical outcomes, similar findings were observed despite CT evidence of bridging fusion mass (Figures 2A-2C).

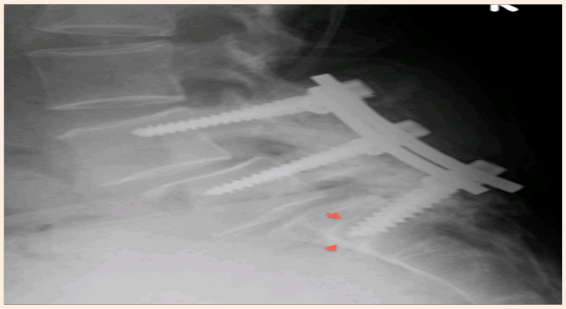

**Figure 1A:** Radiographic appearance.

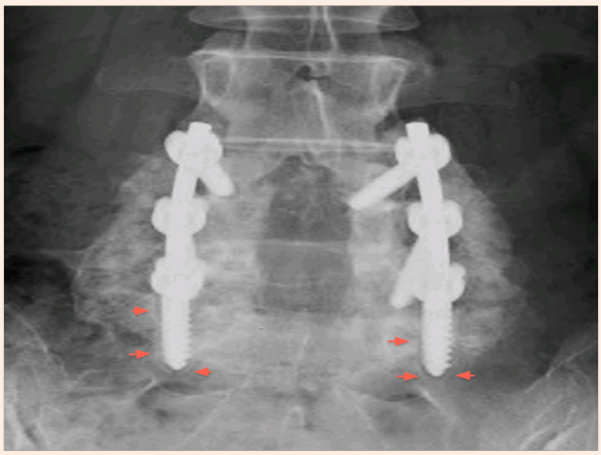

**Figure 1B:** Radiographic appearance.

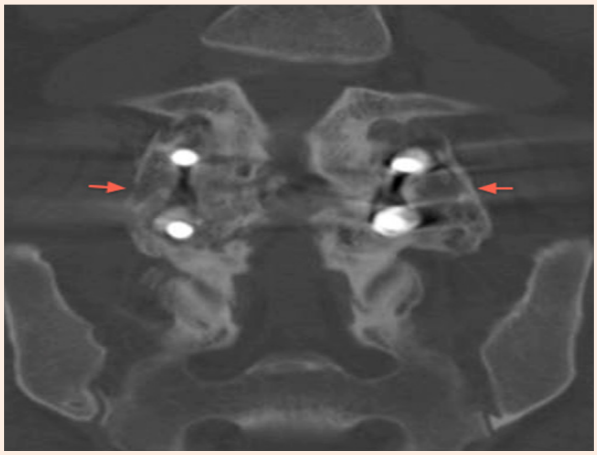

**Figure 2A:** CT evidence of bridging fusion mass.

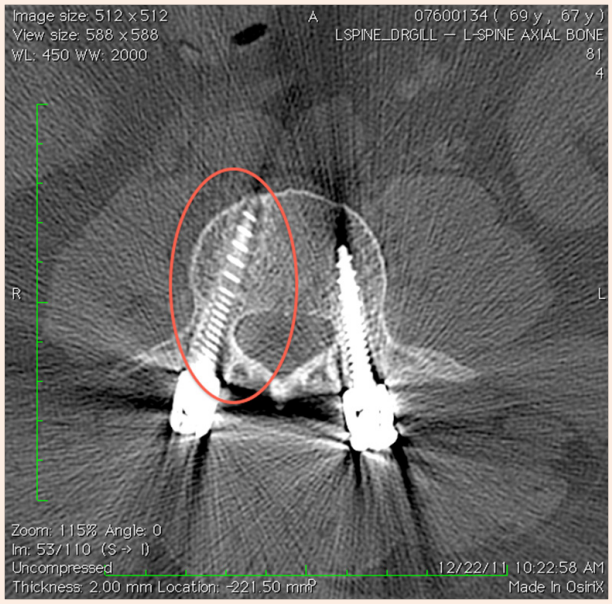


**Figure 2B:** CT evidence of bridging fusion mass.

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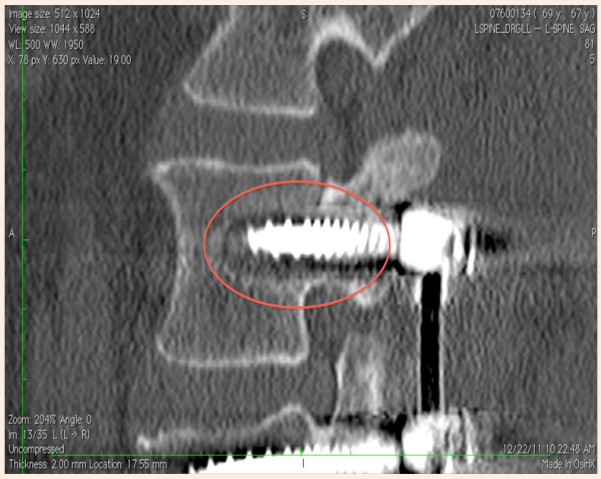


**Figure 2C:** CT evidence of bridging fusion mass.

Clinically, all 14 patients demonstrated overall improvement with average decrease in VAS scores from 8.5 to 1.5 and ODI scores from an average of 38% preoperatively to an average of 5% postoperatively. No known post-operative complications were identified in the first year.

## Discussion

We have presented a series of 14 patients who underwent lumbar fusion with low-profile CoCr rods in which all 14 patients developed lucency surrounding multiple pedicle screws. While radiographic lucency surrounding pedicle screws has been reported with conventional implants, the rates reported in the literature (18-31%) are far lower than that seen in this series [2-9]. Several previous studies have established lucency surrounding pedicle screws as a radiographic marker of screw loosening. Implant retrieval studies have shown that screws with surrounding lucency have significantly lower extraction torque than screws without surrounding lucency [3,4]. In addition, this lucency has been associated with persistent instability and pseudo arthrosis [2,6].

The mechanism by which the use of hybrid low-profile CoCr may contribute to radio lucency surrounding pedicle screws is uncertain. Factors that increase construct micro motion, including decreasing implant rigidity, increasing number of levels fused, delayed or incomplete fusion, poor bone quality, and absence of concomitant inter body fusion, have been associated with development of lucency around screws [2,6-8]. Smaller-diameter 4.5 and 4.75mm CoCr rods have been marketed as having similar biomechanical performance to conventional 5.5mm Ti rods, however these claims have not been independently verified. Rod stiffness is proportional to the fourth-power of diameter, and only directly proportional to modulus of material elasticity. For this reason, even small changes in diameter require dramatic increases in the modulus of elasticity to retain similar biomechanical performance. In addition, static biomechanical testing of a single rod does not capture the full complexity of a construct that contains multiple screws, rods, and the screw-bone interface [10].

Static biomechanical testing also fails to account for intraoperative contouring and notching, the fatigue from cyclic loading and the multiple axes of stress that result from clinical use [10]. Independent biomechanical studies that test cyclic loading of an entire screw-rod-bone construct with low-profile CoCr rods vs. a conventional Ti system would help to ensure that the smaller diameter of the CoCr rods does not come at a cost to biomechanical strength. In addition, there is a need for large-scale clinical studies with sufficient sample size and follow-up length to verify that the rate of loosening and pseudo arthrosis is not raised by these implants.

While all patients in our series progressed to an excellent clinical outcome, the development of lucency around pedicle screws is a concerning finding, especially given the lack of independent biomechanical and clinical studies evaluating the performance of low-profile CoCr rods. Given the increasing popularity of hybrid CoCr and Ti spinal implants, large-scale studies are needed to evaluate whether these implants increase the risk of implant loosening.

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