

A novel technique for decortication of the lumbar facet joints for posterolateral fusion with percutaneous exposure: A cadaveric feasibility study

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ARTICLE INFO

Keywords:

Interbody fusion
Percutaneous
Minimally invasive
Facet joint
Decortication

ABSTRACT

Background: Percutaneous approaches to the spine have been explored recently for various procedures, including transforaminal lumbar interbody fusion. It is known that facet decortication leads to higher rates of fusion, but effective percutaneous approaches have not been well documented. There are a set of instruments used in the cervical spine for percutaneous decortication, the CORUS™ Spinal System-X (DI# 00852776006508), which may be useful in this setting. Our aim was to investigate the feasibility of decorticating the lumbar facet joints with these instruments in cadavers to aid in minimally invasive lumbar fusion.

Methods: We performed percutaneous facet joint decortication at each facet joint in the lumbar spine in two adult cadavers. We tested varying degrees of laterality for entry points and angulation for access at each level to optimize the innovative procedure.

Results: When using the CORUS™ Spinal System-X to obtain percutaneous access for facet decortication in the lumbar spine, we successfully dissected down to the facet joint without neurovascular injury. At the L1-L2 and L2-L3 levels, access was best obtained at 4 cm from midline with an angulation of 10°. At the L3-L4 and L4-L5 level, access was best obtained at 4 cm from midline with an angulation of 20°.

Conclusions: This study demonstrates that percutaneous lumbar facet joint decortication is feasible with the CORUS™ Spinal System-X instruments, and warrants further, comparative study in the clinical setting

1. Introduction

Lumbar interbody fusion (LIF) and fixation is a mainstay in the treatment of a variety of conditions, commonly of degenerative etiology, of the lumbar spine affecting neurologic function and alignment.^{1,2} It is known that minimally invasive approaches to the spine are at least clinically equivalent versus the open approach, and even superior in terms of medical adverse events.³ Over the years in minimally invasive spine surgery, more and more procedures have been developed with approaches ranging from endoscopic, tubular, and percutaneous levels of exposure.⁴ Further, surgeons tend to agree that supplementing interbody and posterior fusion with facet fusion affords a more circumferential fusion.^{5,6}

Transforaminal lumbar interbody fusion (TLIF) has been explored with a percutaneous approach in recent years with and without endoscopy.⁷⁻⁹ A clinical trial with an investigative percutaneous delivery

system for a unique implant is underway in the cervical spine (NCT04229017). Although traditional screws have been delivered to the lumbar spine percutaneously, the use of these instruments (CORUS™ Spinal System-X; DI # 00852776006508) to supplement TLIFs with facet joint decortication has not been documented in the literature. It is well known that effective decortication of facet joints improves fusion rates,¹⁰ but promising percutaneous techniques for achieving this have not been well described. Our aim in this study was to investigate the feasibility of decorticating the lumbar facets with these instruments in cadavers to aid in minimally invasive lumbar fusion.

2. Methods

Institutional review board approval was not sought as this research involved only cadavers and was thus exempt from human subjects research. Three adult cadavers, with no obvious pathology nor surgery

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<https://doi.org/10.1016/j.wnsx.2024.100290>

Received 4 March 2023; Received in revised form 7 January 2024; Accepted 20 February 2024

Available online 25 February 2024

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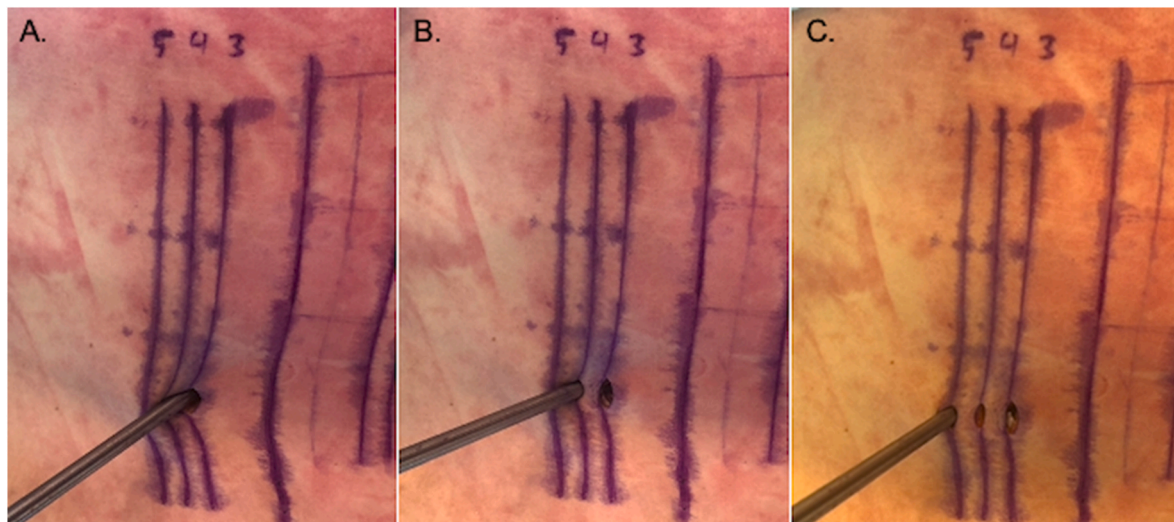


Fig. 1. Markings for percutaneous access to the lumbar spine
 Stab incisions with initial percutaneous access with chisel at (A) 3 cm (B) 4 cm, and (C) 5 cm. This figure is original to this submission, so no credit or license is required nor requested.

Table 1
 Operative variables for percutaneous access.

Level	Angulation ^a	Laterality
L1-L2	10°	4 cm
L2-L3	10°	4 cm
L3-L4	20°	4 cm
L4-L5	20°	4 cm
L5-S1	20°/35°	4 cm

^a Lateral/inferior.

of the area studied were utilized. In the prone position, each cadaver’s lumbar spine was localized and marked, and a ruler was used to mark gradations of a centimeter from 3 to 5 cm from midline (Fig. 1). Intra-operative fluoroscopy and a spinal needle were used to confirm the L5-S1 level. Percutaneous exposure was achieved with a stab incision at the 3 cm line. Having accessed the facet joint with a percutaneous chisel, we inserted a guide tube to distract the facet joint for further articular decortication. To obtain a precise angle of the corridor, we aligned the percutaneous instrumentation with the fluoroscopic guidance. In this channel we then used the rasp then rotary decorticator to complete articular decortication. This was repeated at the 4 and 5 cm lines, and this process was extended sequentially up each lumbar facet joint superiorly until L1-L2 at varying degrees of angulation and laterality (Table 1).

3. Results

At the L3-L4 and L4-L5 level, we obtained access at 4 cm from midline and an angulation of 20° (Fig. 2), whereas at the L2-L3 and L1-L2 level, we obtained access at 4 cm from midline and an angulation of 10° (Fig. 3). Most importantly, at the L5-S1 level, we obtained successful access at 4 cm from midline, but in addition to using 20° of angulation laterally, like the L3-L5 segment, we additionally needed an inferior angulation of 35° (Fig. 4). The access chisel provided adequate dissection through the lumbar paraspinal musculature, fascia, and articular capsule without obvious neurovascular injury. The guide tube created an appropriately sized channel, and the rasp and rotary decorticators adequately decorticated the articular surface of the lumbar facet joints. Further, all instruments were of appropriate length to access the lumbar spine without difficulty.

4. Discussion

Lumbar interbody fusion (LIF) is one of the most common surgeries performed on the spine, with tremendous advances in minimally invasive techniques over the last few decades.^{11,12} Specifically, the percutaneous method of access has expanded over the years to cover decompression,^{8,13} fixation,¹⁴⁻¹⁶ and recently, fusion.^{7,17} One of the longstanding criticisms of percutaneous access for LIF are the increased rates of pseudoarthrosis likely secondary to the restricted access

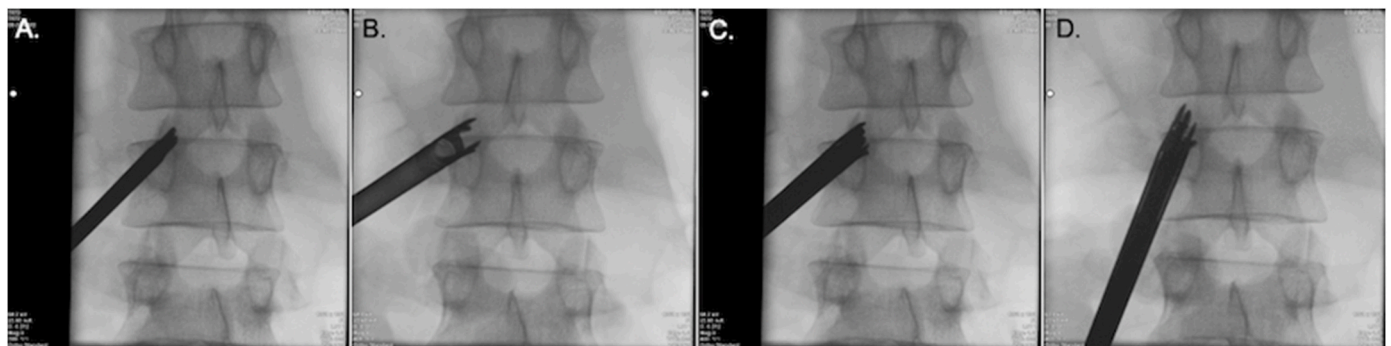


Fig. 2. Access and decortication of facet joints at upper lumbar spine (L2-L3) at 4 cm
 (A) Chisel inserted into facet joint at 10 degrees of angulation (B) Guide tube inserted into access port with (C) rasp decorticator and (D) rotary decorticator. This figure is original to this submission, so no credit or license is required nor requested.

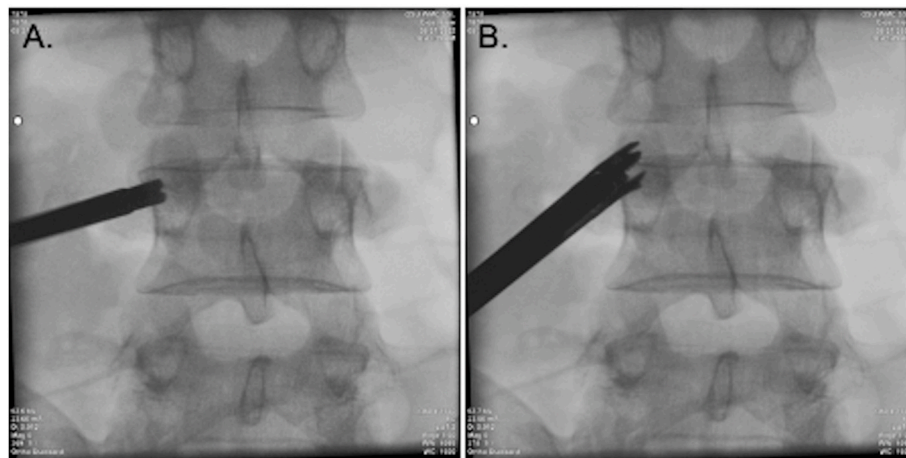


Fig. 3. Access and decortication of facet joints at lower lumbar spine (L3-L4) at 4 cm (A) Chisel inserted into facet joint at 20 degrees of angulation. Guide tube inserted into access port with (B) rotary decorticator. This figure is original to this submission, so no credit or license is required nor requested.

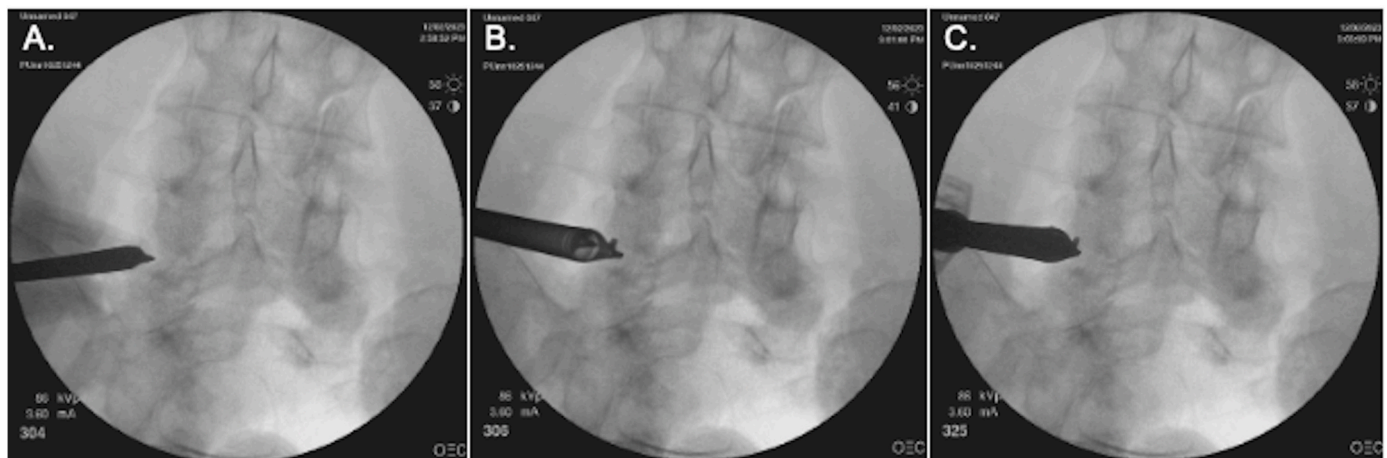


Fig. 4. Access and decortication of facet joints at lower lumbar spine (L5-S1) at 4 cm (A) Chisel inserted into facet joint at 20 degrees of angulation laterally and 35° inferiorly (B) Guide tube inserted into access port with (C) rotary decorticator. This figure is original to this submission, so no credit or license is required nor requested.

afforded to not only decorticate, but place bone graft and interbody cages, despite techniques improving over the years.^{17,18}

McCormack, et al investigated the DTRAX facet system in posterior cervical fusion with initially promising results proposing safety and efficacy in the treatment of cervical radiculopathy.¹⁹ Notwithstanding, the instrumentation in this system has potential to be used for percutaneous facet access in other areas of the spine. Interestingly, the learning curve for access to the lumbar facet joints with these instruments for surgeons familiar with the cervical procedure is smaller than expected. We found that a 4 cm access window provided enough clearance for the varying angulation of facet joints up the lumbar spine.

It is known that anterior LIFs (ALIF) supplemented by posterior fixation generate greater segmental lordosis, an improved lumbar distribution index and sustained increased disc height, in addition to moderately superior PROMs when compared to TLIFs at L5-S1.²⁰ It then follows that in addition when supplementing an ALIF with posterior fixation, which is known to be feasible percutaneously,²¹ that percutaneous facet decortication may further improve fusion rates. We found that facet decortication is feasible percutaneously at L5-S1 with an additional angulation inferiorly to account for the location's unique anatomy.

4.1. Limitations

Importantly, there are some limitations to this study. The feasibility of our technique does not necessarily imply its efficacy in achieving lower pseudoarthrosis rates using the percutaneous approach. Further, difficult diseased anatomy may limit this approach in exceptional cases of degenerative disease. However, our aim was to describe our initial experience and complement the existing literature on percutaneous access for TLIFs and supplemental posterior fixation for L5-S1 ALIFs. A small series of cases and ideally a future, high powered, prospective study is important in investigating the effects this technique has in further improving fusion rates in TLIFs and L5-S1 ALIFs using percutaneous access.

5. Conclusion

Percutaneous access to the lumbar facet joints with the CORUS™ Spinal System-X for decortication is a viable and exciting option for use in percutaneous TLIFs and to supplement L5-S1 ALIFs. Importantly, without obvious neurovascular injury, we effectively decorticated lumbar facet joints by innovating on the cervical technique. Future studies of initial clinical experience and larger prospective studies with

comparison to other approaches are warranted.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Lumbar interbody fusion (LIF).

Transforaminal lumbar interbody fusion (TLIF).

CRediT authorship contribution statement

Alexander Keister: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Olivia Duru:** Data curation, Writing – original draft. **Andrew Grossbach:** Investigation, Supervision. **David S. Xu:** Conceptualization, Investigation, Methodology, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors wish to thank no one more than those who donated their bodies to science.

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