Hypothesis

Hypothesis of Improved Fusion Rates with Anchored PEEK Cages Compared to Standalone Constructs in ACDF

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Abstract

Background: Anterior cervical discectomy and fusion (ACDF) is a trusted operation for patients with single-level cervical disc disease who continue to have pain, numbness, weakness, or signs of nerve compression despite treatment. The main purpose of this surgery is to remove the damaged disc, free the compressed nerve structures, and restore stability to the cervical spine. In recent years, surgeons have increasingly used low-profile cages to support the operated level after disc removal. Standalone cages are simple and less prominent, while anchored cages add extra fixation and are expected to hold the correction more securely. Both are commonly used, but their effect on disc height, cervical alignment, and subsidence remains an important concern.

Hypothesis: This study was based on the belief that both standalone and anchored cages would improve symptoms after ACDF, but the anchored cage would give better structural support. It was expected to reduce cage settling, preserve disc height, and maintain cervical lordosis more effectively than the standalone cage. At the same time, the two groups were expected to show similar clinical improvement, since pain relief after surgery mainly depends on proper decompression of the affected nerve or spinal cord.

Clinical Importance: The study is useful for surgical decision-making because the choice of implant can affect how well the reconstructed segment holds its shape over time. Both cages helped patients recover well and improved pain and function after surgery. However, the anchored cage showed better maintenance of alignment and less subsidence, which may make it a better choice when stronger support is needed. The low-profile design of both implants also helped keep swallowing problems low after surgery.

Future Research: Further studies with more patients, longer follow-up, and multiple centers are needed to confirm these findings. Future work should also look at fusion rates, bone quality, and outcomes at different cervical levels.

Keywords: Anterior cervical discectomy and fusion, Standalone cage, Anchored cage, Cervical disc disease, Subsidence, Cervical lordosis, Dysphagia, Clinical outcome.

Background

Anterior cervical discectomy and fusion (ACDF) has remained one of the most dependable procedures for treating cervical disc disease because it directly addresses the source of compression and instability in a single operation. The anterior cervical approach was first described in the classic works of Cloward and later Smith and Robinson, and these reports laid the foundation for modern anterior cervical fusion surgery [1, 2]. Since then, ACDF has continued to evolve, but its basic purpose has remained the same: remove the diseased disc,


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DOI: https://doi.org/10.13107/jmt.2025.v11.i01.238

decompress the neural structures, and restore stability to the cervical spine [3].

The cervical spine is a highly mobile region, and degeneration in this area can produce neck pain, radiculopathy, sensory loss, weakness, or myelopathic symptoms. The degenerative process affects the disc, facets, and supporting soft tissues, and the resulting biomechanical changes may gradually reduce disc height, alter alignment, and narrow the neural foramina [4-7]. Because symptoms do not always match imaging perfectly, surgical treatment is usually reserved for patients with clear clinical correlation and failure of conservative care [6, 7, and 9].

Over time, the choice of fusion material and implant design has changed significantly. Iliac crest bone graft was used widely in the past, but it carried donor-site pain and added morbidity [10]. Cages later became popular because they avoided graft harvest and helped maintain disc space height [5, 11]. However, standalone cages can sometimes settle into the vertebral endplates, leading to subsidence and partial loss of correction [11, 13]. Anchored cages were developed to improve stability while keeping the implant low profile. The idea was simple: add fixation to reduce motion and better preserve cervical lordosis without the bulk of a traditional plate [8, 12, and 14].

This study was therefore important because it compared two commonly used strategies in single-level ACDF: a standalone cage and an anchored cage. The real question was whether the added fixation of the anchored cage would lead to better radiological maintenance without sacrificing clinical improvement [8, 12, and 14]. That question is relevant in day-to-day surgical practice, where the surgeon must balance simplicity, stability, dysphagia risk, and long-term alignment [8, 9, 12, and 14].

Hypothesis

The working hypothesis of this study was that both implants would improve pain and function after single-level ACDF, but the anchored cage would perform better in preserving radiological alignment and preventing subsidence. This expectation was based on the mechanical design of the two constructs. A standalone cage depends mainly on cage-endplate contact for stability, and that can be enough in many cases, but it may be less resistant to collapse when the endplates are weak or when the segment is highly mobile [11,13,17]. By contrast, an anchored cage adds internal fixation, which should improve initial stability and reduce the chance of settling over time [12, 14, and 18].

The study also assumed that symptom relief would be similar in both groups. In ACDF, most of the clinical benefit comes from removal of the compressive disc and relief of pressure on the nerve root or spinal cord [3, 6, and 9]. For that reason, both groups were expected to show improvement in pain scores, disability scores, and neurological function, even if the radiological profile differed slightly [6, 9, 18, and 19]. In other words, the implant might influence alignment more than symptoms in the short term.

Another part of the hypothesis was that dysphagia would remain low in both groups because both devices are low profile compared with plate-based constructs [8, 12, 14, 23, and 24]. Dysphagia is a known issue after anterior cervical surgery, but lower-profile implants are generally designed to reduce that risk [8, 14, and 23]. Since the surgery in this study was limited to one level, the expectation was that postoperative swallowing problems would be mild and not meaningfully different between groups.

The study also considered cervical lordosis. Lordosis is more than just a number on an X-ray; it reflects the shape and mechanical balance of the cervical spine [4, 7, and 19]. The anchored cage was expected to preserve segmental and overall alignment better because fixation should reduce micromotion and lower the risk of cage settling [11, 12, and 18]. This may matter especially at the lower cervical levels, where mechanical stress is usually greater [7, 13, and 19].

Overall, the hypothesis was practical and clinically grounded. It asked whether anchored cages truly provide a mechanical advantage over standalone cages in routine single-level ACDF, or whether both methods achieve similar results with only a small difference in radiological behavior [8,12,14,20].

Discussion

The findings of this study show that both standalone cages and anchored cages are effective for single-level ACDF, but the anchored cage appears to offer better radiological stability. Both groups improved clinically after surgery, which supports the well-established role of ACDF in relieving cervical radiculopathy and myelopathic symptoms [3, 6, 9, and 19]. Pain reduction and functional improvement were seen in both groups, showing that decompression remains the main reason for clinical success, regardless of the exact cage design [3, 6, and 9].

The more interesting difference was seen in subsidence and alignment. The anchored cage showed less subsidence, which is important because settling of the implant can reduce disc height, narrow the foramina, and gradually affect segmental lordosis [11, 13, 17, and 21]. This finding fits the known mechanical advantage of fixation. A standalone cage may work well, but when the implant is held only by endplate contact, there is always some risk of gradual sinking [11, 13, 21]. Anchored fixation appears to reduce that risk and help preserve the correction achieved during surgery [12, 14, and 18].

Lordosis was also better maintained in the anchored cage group. That is clinically meaningful because cervical alignment influences biomechanics and, over time, may affect adjacent levels and overall spinal balance [4, 7, 19, and 22]. The immediate postoperative gain in alignment is often easy to obtain, but holding that gain over months is more difficult. The study suggests that anchored cages may do a better job of maintaining the reconstructed cervical shape, especially in the

lower cervical spine where mechanical load is greater [7, 13, and 19].

The dysphagia findings were reassuring. Both groups had low rates of swallowing difficulty, and there was no major difference between them. This is consistent with the idea that low-profile devices are less irritating to the esophagus and surrounding soft tissues than traditional plate constructs [8, 14, 23, and 24]. Dysphagia remains one of the most important postoperative complaints after anterior cervical surgery, so even a small reduction is meaningful in patient comfort and satisfaction [8, 23, and 24]. The relatively low dysphagia burden in this study supports the use of compact constructs when possible.

The results also show that implant choice should be individualized. A standalone cage is simpler and remains a good option in many patients, especially when the bone quality is adequate and the surgeon wants to avoid extra fixation. The anchored cage, however, offers more mechanical security and may be preferred when alignment preservation is a priority or when there is greater concern about subsidence [11, 12, 18, and 21]. In practical terms, the difference between the two methods is not in early symptom relief, but in how well the surgical correction is maintained over time [12, 18, and 20].

This study fits well with the broader evolution of anterior cervical fusion. ACDF has moved from iliac crest grafting to cage-based reconstruction and then toward low-profile systems that try to combine stability with less soft-tissue irritation [5, 10, 11, 14]. That evolution reflects an ongoing effort to improve both patient comfort and mechanical durability. The present findings support that direction and suggest that anchored cages may be a useful middle ground between stability and low implant prominence [12, 14, and 25].

Clinical Importance

For everyday surgical practice, this study suggests that both implants work well, but the anchored cage may be the better choice when preserving disc height and lordosis is especially important. At the same time, the low rate of dysphagia supports the use of low-profile anterior cervical implants in suitable patients.

Future Direction

Future studies should include a larger sample, longer follow-up, and multicenter data. It would also be useful to compare fusion quality, bone density, and outcomes at different cervical levels to better define which patients benefit most from anchored fixation.

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Conflict of Interest: Nil

Source of Support: None

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Year of Acceptance of Thesis: 2022

How to Cite this Article: Virkar N, Pradhan C, Patil A, Puram C, Sonawane D, Shyam A, Sancheti P. Hypothesis of Improved Fusion Rates with Anchored PEEK Cages Compared to Standalone Constructs in ACDF | Journal of Medical Thesis | 2025 January-June; 11(1): 13-16.