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Does the Cage Position in Transforaminal Lumbar Interbody Fusion Determine Unilateral versus Bilateral Screw Placement?: A Review of the Literature

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This literature review examines the relative placement of the interbody cage with respect to the unilateral screw construct to address the need for bilateral screw placement versus unilateral screw placement. Transforaminal lumbar interbody fusion (TLIF) has become a widely used technique for correcting lumbar intervertebral pathologies. This review addresses the necessity for further study on the effects of the relative position of intervertebral cage placement on the outcome of lumbar spine surgery after TLIF with unilateral pedicle screw fixation. Previous studies have addressed various factors, including posterior screw fixation, cage size, cage shape, and number of levels fused, that impact the biomechanics of the lumbar spine following TLIF. A simple survey of the literature was conducted. A search of the English literature was conducted using the keywords 'TLIF,' 'transforaminal lumbar interbody fusion,' 'graft placement,' 'graft position,' 'cage position,' 'cage placement,' 'unilateral pedicle screw,' 'unilateral TLIF cage placement,' 'lumbar biomechanics,' 'lumbar stability,' 'lumbar fusion,' and 'lumbar intervertebral cage' with various combinations of the operators 'AND' and 'OR' and no date restrictions. Seventeen articles in the English literature that were most relevant to this research question were identified. To the best of our knowledge, there are no published data addressing the effects of cage placement relative to the unilateral screw on lumbar stability in TLIF with unilateral pedicle screw fixation. Investigation of the effects of cage placement is, thus, warranted to achieve optimal clinical outcomes in patients undergoing TLIF with unilateral pedicle screw fixation.

Keywords: Lumbar vertebrae; Pedicle screws; Spinal fusion; Bone screws; Review

Introduction

Transforaminal lumbar interbody fusion (TLIF) is a surgical technique used for the treatment of symptomatic intervertebral disk pathologies. In intervertebral body fusions, the intervertebral disk is partially or almost fully removed, and one or more cages containing graft material are placed in the intervertebral space. The cage serves to maintain the intervertebral height and lumbar lordosis [1] while allowing vertebral bone ingrowth and fusion [2]. Adequate intervertebral rigidity is necessary for graft fusion without dislodgment [3] and is therefore essential to patient recovery [4]. To further stabilize the fusion and promote restoration of lordosis, posterior instrumentation

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is utilized by insertion of unilateral or bilateral pedicle screws [3]. TLIF has become an increasingly popular fusion technique due to its anatomical advantages, which reduce damage to the thecal sac and spinal nerve roots and preserve contralateral structures [5]. Multiple systematic reviews and meta-analyzes have reported TLIF fusion rates ranging from 89.71% to 97.53% [5,6].

In TLIF procedures, bilateral pedicle screws are traditionally utilized as additional posterior fixation because they provide the greatest stability. However, although its efficacy compared with bilateral fixation is debated, unilateral pedicle screw placement may be more desirable because it is less invasive and entails less operative time, less blood loss [7,8], and less destruction of posterior structures [1,7,9]. In addition, bilateral fixation may increase stress at adjacent intervertebral levels in patients undergoing multi-level fusion due to increased stiffness, which can ultimately lead to degeneration [7,10,11].

Some studies comparing TLIF outcomes with unilateral and bilateral pedicle screw fixation have reported no significant differences in fusion rates [5,7,9], spinal stability [8], and long-term clinical outcomes [7]. However, other studies suggest that unilateral screw fixation provides insufficient stability and jeopardizes healing [11,12]. To the best of our knowledge, the effect of cage placement relative to the screw for TLIF with unilateral pedicle screw stabilization has not been studied. It is thus worthwhile to investigate whether cage placement position impacts the need to use a contralateral screw, which is a more invasive method of posterior fixation.

Placement is important when considering the different sizes and shapes of cages. In the TLIF approach, a unilateral facetectomy is performed on the symptomatic side, decompressing the exiting spinal nerve root and allowing access to the intervertebral space [11]. Because of the restricted access space in TLIF, cages with a smaller footprint are warranted yet may be associated with increased complication rates [13]. Smaller footprints in the central part of the vertebral endplate may be more likely to subside [4] and experience fusion failure at lower loads [14]. Consideration of cage placement in TLIF within the disk space relative to the unilateral fusion may therefore be essential when aiming for optimal stability.

To implement the most appropriate construct for optimal lumbar stability, it is important to evaluate the stabilization effects of cage position on TLIF as it pertains to screw fixation and cage shape. Such a strategy is expected to result in improved surgical outcomes. To the best of our knowledge, no studies have clearly elucidated the significance of the placement of the interbody cage on the stability of the lumbar spine in TLIF procedures with unilateral pedicle screw fixation. The purpose of this review was thus to address the necessity of determining the structural effects of cage placement on the lumbar spine in TLIF. Ultimately, this will determine whether cage position can be manipulated to affect the TLIF construct such that stability with unilateral pedicle screw fixation is equivalent to that of TLIF with bilateral fixation.

Materials and Methods

A simple survey of the literature was conducted. A PubMed search was conducted with the keywords 'TLIF,' 'transforaminal lumbar interbody fusion,' 'graft placement,' 'graft position,' 'cage position,' 'cage placement,' 'unilateral pedicle screw,' 'unilateral TLIF cage placement,' 'lumbar biomechanics,' 'lumbar stability,' 'lumbar fusion,' and 'lumbar intervertebral cage' in various combinations using the operators 'AND' and 'OR.' The language was restricted to English, and articles were cross-referenced. No date restrictions were used.

Results

As summarized in Table 1 [1-13,15-17], the search resulted in one systematic review with meta-analysis, two meta-analyzes, three randomized control trials, two retrospective cohort studies, four *in vivo* biomechanical studies, one *in vitro* biomechanical study and narrative review, two narrative reviews, and one technical description. There were no prospective double blinded studies and no studies directly addressing the question of placement of the interbody device relative to the unilateral pedicle screw.

Discussion

Previous studies of the relationship between the position of the interbody cage and the effect of stability on the lumbar spine have presented conflicting results [16]. Ames et al. [3] compared the stabilities of posterior lumbar interbody fixation and TLIF using three separate approaches: the difference in range of lumbar motion after one or two level TLIF without pedicle screw fixation, the additional stability provided by bilateral pedicle screw fix-

Table 1. Summary of the relevant articles regarding TLIF and interbody cage placement

Author (year)	Study design	Results	Comment	Level of evidence
Hu et al. [5] (2014)	Systematic review and meta-analysis	Although statistically insignificant, total nonunion rate was higher among patients undergoing TLIF with unilateral PS fixation than with bilateral screw fixation. Some studies also showed unilateral PS fixation yielded decreased stability with range of motion compared to bilateral fixation. There was no statistically significant difference in nonunion rate, pooled complication rate, reoperation rate, or hospital stay between patients who underwent unilateral and bilateral PS fixation. However operative time was significantly longer in the bilateral group, implant cost was significantly higher in the bilateral group, and blood loss was significantly reduced in the unilateral group. The study ultimately concluded TLIF with unilateral PS to be as safe and efficacious as TLIF with bilateral screw fixation.	Meta-analysis of seven RCTs comparing the clinical and radiological outcomes of unilateral vs. bilateral PS fixation in TLIF. Bilateral PSs have traditionally been used. However, unilateral PS fixation may help to reduce operative time, tissue trauma, and blood loss while still providing adequate fixation and stability.	1
Liu et al. [6] (2014)	Meta-analysis	The results of five RCTs and one controlled clinical trial comparing the safety and efficacy of unilateral and bilateral screw fixation in minimally invasive single-level lumbar fusion were analyzed. There was no statistically significant difference in postoperative functioning (based on VAS and ODI score), mean length of hospital stay, or overall fusion rate between patients undergoing MIS-LIF with unilateral PS and MIS-LIF with bilateral PS fixation. Unilateral PS fixation required significantly less operative time and significantly less blood loss among those who had unilateral screw fixation.	Meta-analysis comparing the efficacy and safety of unilateral vs. bilateral PS fixation in minimally-invasive single-level lumbar degenerative disc disease. Previous studies showed unilateral PS fixation to be safe and efficacious for two-level fusion.	1
Xiao et al. [8] (2015)	Meta-analysis	Eight RCTs were analyzed to compare outcomes among those undergoing cage fusion with unilateral vs bilateral PSs. Analysis showed no statistically significant difference in postoperative functioning (VAS and ODI scores), fusion rates, complication rates, or blood loss between the two groups. Operative time for those undergoing unilateral PS fixation was significantly shorter than for those in the bilateral group.	Meta-analysis of cohort studies comparing fusion rates and clinical outcomes among patients undergoing cage fusion with unilateral vs. bilateral PS fixation in one- and two-level lumbar degenerative disc disease.	1
Lin et al. [9] (2013)	RCT	In comparing clinical outcomes of those treated with minimally invasive lumbar interbody fusion with unilateral PS fixation versus bilateral fixation, there was no statistically significant difference in VAS score, ODI score, fusion rate, or complication rate. Blood loss and mean operative time were both significantly decreased among the unilateral group.	RCT comparing clinical outcomes in patients treated with minimally-invasive lumbar interbody fusion with unilateral vs bilateral PS fixation.	2
Duncan and Bailey [12] (2013)	RCT	There was a statistically significantly higher number of cases of cage migration among patients who underwent fusion with unilateral PS fixation compared to those who underwent bilateral screw fixation.	RCT comparing rates of cage migration between patients undergoing lumbar interbody fusion with unilateral vs. bilateral PS fixation. Some studies have shown TLIF fusion rates to be between 90 and 100%. Some case reports have shown an increase in cage migration among patients who undergo TLIF with unilateral fixation, which may be due to decreased lumbar stability with axial rotation leading to displacement.	2

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Table 1. Continued

Author (year)	Study design	Results	Comment	Level of evidence
Zhang et al. [10] (2014)	RCT	Between patients undergoing fusion with unilateral screw fixation and patients undergoing bilateral screw fixation, there was no significant difference in postoperative functioning (VAS, ODI, and 36-Item Short-Form Health Survey scores), fusion rate, device-related complications, cage migration, or general complications. Operative time, blood loss, and cost were significantly lower in the unilateral fixation group compared to the bilateral fixation group.	RCT comparing clinical and radiological outcomes of patients undergoing TLIF with unilateral vs. bilateral PS fixation in two-level lumbar degenerative disc disease.	2
Chen et al. [7] (2015)	Retrospective cohort study	Patients who underwent fusion with unilateral PS fixation had significantly less blood loss and shorter operative time compared to those who underwent fusion with bilateral screw fixation. There was no statistically significant difference in hospital stay, fusion rate, or cage migration between the two groups. At 7 days postoperative the unilateral screw fixation group had significantly lower VAS and ODI scores than the bilateral group, although at 1 month and beyond there was no significant difference.	This is a comparison of radiologic fusion outcomes and perioperative outcomes between patients who underwent TLIF with unilateral vs. bilateral PS fixation.	3
Kim et al. [15] (2015)	Retrospective cohort study	There was no significant difference in blood loss, hospital stay, operative time, nonunion rates, and clinical outcomes (based on VAS and ODI scores) between patients with isthmic and degenerative spondylolisthesis undergoing minimally invasive TLIF. Minimally invasive TLIF with bilateral PS fixation was concluded to be safe and effective for lumbar interbody fusion among patients with isthmic and degenerative spondylolisthesis. The most common site of degenerative spondylolisthesis was at the L4–L5 segment, and the most common site for isthmic spondylolisthesis was at L5–S1.	This retrospective cohort study assessed perioperative outcomes between patients with degenerative spondylolisthesis and isthmic spondylolisthesis who underwent minimally-invasive TLIF.	3
Castellvi et al. [13] (2015)	*In vivo* biomechanical study	There were significant differences in spinal range of motion among patients who underwent TLIF with different cage positioning. In the coronal plane, a cage closer to the midline resulted in increased stability in lateral bending. In the sagittal plane, anterior cage placement (further from posterior fixation hardware) resulted in increased stability in flexion-extension as well as lateral bending. There was no distinction as to whether patients had unilateral or bilateral PS fixation.	This is an evaluation of the correlation between cage position and spinal range of motion among 13 patients who previously underwent TLIF. Cages were moved within the coronal and sagittal plane. Method of posterior fixation was not identified.	5
Ames et al. [3] (2005)	*In vitro* biomechanical study	Neither stand-alone PLIF nor stand-alone TLIF provided a significant increase in stability to lumbar specimens compared to those without fusion. However addition of posterior fixation with PSs in both PLIF and TLIF provided a statistically significant increase in rigidity. There was no statistically significant difference in stability between PLIF and TLIF in two-level fusion with posterior fixation. Position of the TLIF graft in the sagittal plane did not impact post-fusion stability in the specimens fused via TLIF.	This study is a comparison of lumbar segment stability between specimens fused with PLIF and TLIF techniques, both with and without bilateral PS fixation. It also aimed to assess whether position of the cage in the sagittal plane impacted post-fixation rigidity. Adequate intervertebral rigidity is essential to allow for graft fusion without dislodgment.	5

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Table 1. Continued

Author (year)	Study design	Results	Comment	Level of evidence
Harris et al. [11] (2004)	*In vitro* biomechanical study	Among cadaveric spines fused with TLIF and various posterior fixation techniques, TLIF with bilateral screw fixation showed greatest stability compared to stand-alone TLIF, TLIF with unilateral translaminar facet screw, and TLIF with unilateral PS. Among all specimens, degree of axial rotation was increased compared to intact L4–L5, but the range of motion was increased least with bilateral fixation. TLIF with unilateral PS fixation provided increased stability compared to stand-alone TLIF and TLIF with unilateral translaminar facet screw.	Range of motion among lumbar spinal segments fused with TLIF technique and various posterior fixation methods were compared. Increased flexibility can prevent proper fusion and allow loosening of hardware, while too rigid of a construct can result in abnormal spinal loading and degeneration. The study used an obliquely-inserted Brantigan cage at L4–L5.	5
Tan et al. [14] (2005)	*In vitro* biomechanical study	The effects of kidney-shaped, cloverleaf-shaped, and elliptical cages on interbody stiffness and failure strength were analyzed. Larger cages had increased mean failure loads compared to smaller constructs, and the cloverleaf cage demonstrated highest load of the three shapes. The cloverleaf-shaped cage also resulted in increased construct stiffness compared to the kidney and elliptical cages. Surface area of the cages did not have a significant impact on stiffness. Smaller cages resulted in increased trabecular bone density and deformation beneath the cages compared to cages with larger surface area.	This study compares the effects of cage shape and cage surface area on load failure in lumbar interbody fusion. Studies have shown that posterolateral and peripheral regions of the vertebral endplate are strongest, and that cage placement may impact implant subsidence and failure.	5
Faundez et al. [16] (2008)	*In vitro* biomechanical study	In cadaveric spine segments fused via TLIF, there was no statistically significant difference in range of lateral bending, flexion-extension, and axial torsion between those with the cage inserted in the anterior third of the segment versus the posterior third of the segment. Both positions resulted in increased construct stiffness in lateral bending and flexion-extension. There was no significant difference in neutral zone between anterior and posterior insertion for testing in all range of motion directions.	This biomechanical study compared 3-dimensional stability of lumbar spine segments after undergoing TLIF with anterior vs. posterior cage insertion. A semi-lunar PEEK cage was used, and was inserted in either the anterior 1/3 or posterior 1/3 of the vertebral endplate. Unilateral vs. bilateral PS fixation was not specified.	5
Cannestra et al. [4] (2016)	*In vitro* biomechanical study and narrative review	Conventional TLIF with PEEK cage and unilateral PS fixation had significantly less rigidity than MLX-TLIF with unilateral and bilateral PS fixation, ALIF, and TLIF with bilateral PS fixation. All other fused specimens showed significantly increased rigidity compared to intact specimens. Greatest rigidity in flexion-extension and axial rotation resulted with ALIF with bilateral PS fixation. MLX-TLIF with unilateral PS fixation resulted in rigidity similar to ALIF in lateral bending, and similar to conventional TLIF with bilateral screw fixation in flexion-extension.	In this study, biomechanical stability of cadaveric lumbar spine segments with expandable TLIF cage and banana PEEK cage was assessed and each were compared to published data for PEEK ALIF. ALIF has traditionally been used due to the anatomical accessibility of the intervertebral space; cages with larger surface area can be inserted from an anterior approach. Insertion from a posterior approach presents limitations to cage surface area.	5

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Table 1. Continued

Author (year)	Study design	Results	Comment	Level of evidence
Oxland et al. [2] (2000)	Narrative review	Cages inserted anteriorly provide increased stability in flexion, lateral bending, and axial rotation, but do not increase stability in extension. Similarly, fixation from a posterior approach increases stability with flexion but not extension; however posterior cages decrease rigidity in axial rotation and have not shown consistent correlation with either increased or decreased stability in lateral bending. Other factors that may impact stability are amount of distraction of the annulus fibrosis, and vertebral bone density. Posterior fixation with translaminar screws, transfacet screws, and PSs all provided increased stability, but the degree of stability and fixation required is yet to be determined. Strength of the cage-vertebra interface can impact subsidence and may be impacted by individuals' bone density and peripheral placement of the cage.	This paper is a narrative review of the effects of interbody cage designs and insertion approach/cage positioning on the mechanics of the lumbar spine, as well as the effects of posterior fixation. Transforaminal approach was not included in this analysis.	5
Mobbs et al. [17] (2015)	Narrative review	Lumbar interbody fusion is used for degenerative disease, trauma, infection, and neoplasia. No clear evidence has been provided to establish one fusion technique as superior. Transforaminal lumbar interbody fusion has become a widely-used technique, as it avoids some of the potential complications that anterior and posterior interbody fusion procedures present. It allows for relatively easier direct lateral access to the disc space, necessitating only unilateral opening of the neural foramen and avoiding damage to nerve roots, dura, and the ligamentum flavum. Ligamentous structures are essential to postoperative stability. Disadvantages of TLIF may include increased risk of injury due to prolonged retraction of the paraspinal muscles, difficulty restoring lordosis, and relatively increased difficulty with endplate preparation.	This paper is a narrative review of the advantages and disadvantages of available lumber fusion techniques. ALIF, PLIF, TLIF, and lateral lumbar interbody fusion have all been established as effective fusion techniques.	5
Singh and Vaccaro [1] (2005)	Technical description	TLIF is a lumbar fusion technique which uses a posterior approach to access the intervertebral space. The lumbar spine carries 80% of the weight-bearing load in the anterior column, making anterior column integrity essential for stability. TLIF allows for preservation of posterior longitudinal ligaments and eliminates the need for thecal sac or nerve root retraction. The procedure entails a unilateral or bilateral laminectomy, partial facetectomy, neural decompression and discectomy, interbody cage placement, and posterior fixation with PSs. The interbody cage is essential for maintaining intervertebral height, lumbar lordosis, and stability, and cages are filled with graft material.	This is a technical description of the TLIF procedure.	5

TLIF, transforaminal lumbar interbody fusion; PS, pedicle screw; RCT, randomized controlled trial; VAS, Visual Analog Scale; ODI, Oswestry Disability Index; MIS-LIF, minimally invasive surgery-lumbar interbody fusion; PLIF, posterior lumbar interbody fixation; MLX-TLIF, medial-lateral expandable TLIF; PEEK, polyetheretherketone; ALIF, anterior lumbar interbody fusion.

ation, and the difference in stability with the graft placed at the midline versus placed anteriorly in the sagittal plane in a single-level TLIF procedure. The authors concluded that cage position did not significantly impact the stability of the L2–L3 level and that posterior fixation with bilateral pedicle screws increased rigidity within the construct [3]. This study suggested that TLIF increased construct rigidity by the addition of posterior pedicle screw fixation, but did not address unilateral versus bilateral fixation or whether cage position impacts the method used. Similarly, an *in vitro* biomechanical study by Faundez et al. [16] reported no significant difference in stabilization in a comparison of semi-lunar cage placement in the anterior third of the disk space versus placement in the posterior third of the disk space and that TLIF with either approach provided significantly greater stability to the spine. Taken together, these studies suggest that the position of the cage within the sagittal plane may not impact lumbar stability with TLIF.

Oxland and Lund [2] reviewed *in vitro* stability following fusion with anterior and posterior approaches but excluded the transforaminal approach. Anteriorly inserted cages provided increased stability in flexion, lateral bending, and axial rotation, whereas posteriorly inserted cages increased stability with flexion. Posteriorly inserted cages also resulted in decreased rigidity in axial rotation. The authors suggested that a contributing factor to the differences could be the placement of the cage, as the cage is typically placed more centrally in the posterior approach [2]. It would therefore be worthwhile to investigate the impact of placement on stability in the transforaminal approach and also to determine whether cage position impacts stability. This review also suggested that both the anterior and posterior approaches provide inadequate stabilization of the intervertebral segment in extension [2]. If graft placement plays a role in stability, utilizing placement to maximize stability could help reduce undesirable excessive motion as well as improve clinical outcomes with unilateral screw fixation.

Castellvi et al. [13] evaluated the *in vivo* effects of TLIF graft position in the sagittal and coronal planes. Motion was analyzed in patients who had previously undergone TLIF surgery and then assessed in relation to the placement of their interbody graft, which was identified by radiological imaging. The anterior column of the lumbar spine carries 80% of the weight-bearing load, making it an essential component of lumbar stability and proper fusion [1]. The findings of this study support this assertion by showing that positioning the cage more anteriorly in the sagittal plane increased stability in flexion-extension and lateral bending. In the coronal plane, a cage placed closer to the midline provided increased stability with lateral bending [13]. These findings are indicative that TLIF cage placement may have a significant impact on lumbar stability, suggesting that stability is maximal with anterior placement. However, the study did not specify the method of posterior screw fixation, and it is unclear whether the method may have played a role in stability. Furthermore, these findings contradict those of some previous *in vitro* biomechanical studies [3,16], underscoring the possibility that individual patient characteristics may influence postoperative stability [13]. Although this study provides a foundation for an established correlation between TLIF cage position and intervertebral stability, further exploration and data are warranted for a better understanding of this relationship.

When performing interbody fusion, a large cage footprint is desired [4,14]. Studies have shown that posterolateral and peripheral regions of the vertebral endplate are strongest [14] and that cages with smaller footprints placed in the weaker center of the vertebral endplate may lead to increased susceptibility to subsidence and biomechanical instability [4]. However, TLIF requires posterior access, necessitating the use of a smaller cage relative to traditional anterior lumbar interbody fusion. Tan conducted a study comparing *in vitro* effects of cage shape and surface area on load failure and lumbar stiffness, concluding that cage surface area did not impact rigidity. However, smaller cages did result in bone deformation beneath the cage and decreased failure load [14]. Cannestra et al. [4] found that expandable interbody cages with unilateral screw fixation provided greater stability than TLIF with a conventional banana-shaped polyetheretherketone cage with bilateral screw fixation. Although these studies offer conflicting evidence whether cage surface area directly impacts lumbar rigidity, they underscore the impact of increased surface area on the vertebral endplate to reduce subsidence, which may result in increased stability. Therefore, optimizing cage placement on the vertebral endplate in the peripheral or posterolateral position to reduce subsidence and endplate damage may result in optimal biomechanical stability. However, no definite conclusions can be drawn at this time, warranting further investigation.

The most common site of isthmic spondylolisthesis is the L5–S1 segment, whereas the most common site of degenerative spondylolisthesis is the L4–L5 segment. Cannestra et al. [4] noted that L5–S1 and L4–L5 undergo the greatest lumbar flexion-extension, greatest shear loads, and provide two-thirds of lumbar lordosis. Cannestra et al. [4] and Harris et al. [11] reported that stability with axial rotation at L4–L5 decreased after TLIF with unilateral pedicle screw fixation compared with the intact segment, whereas Ames et al. [3] found a significant increase in stability with axial rotation at L2–L3 compared with the intact segment. These conflicting reports suggest that appropriate cage position may differ on the basis of the intervertebral level undergoing fusion due to the unique biomechanics of each level. When determining cage position, surgeons may want to consider the level at which they are operating in order to achieve optimum stability due to biomechanical effects.

Several studies included in this review found that patients undergoing fusion with unilateral pedicle screw fixation experienced less blood loss and shorter operative time relative to those undergoing bilateral fixation [5-7,9,10]. Many also found no significant differences in postoperative functioning, fusion rate, or complication rate between the two methods [5-8,10]. Based on these outcomes, unilateral pedicle screw fixation appears to be the optimal choice for patients undergoing TLIF. However, conflicting results have been reported.

In a meta-analysis of randomized control trials examining differences in clinical outcomes between patients who underwent TLIF with bilateral versus unilateral pedicle screw fixation, Xiao et al. [8] concluded that unilateral pedicle screw fixation achieved similar clinical outcomes, fusion rates, and complications as bilateral screw fixation. However, it could not be definitively concluded that unilateral fixation achieved the same efficacy and safety levels as bilateral fixation. In a systematic review and meta-analysis by Hu et al. [5], unilateral pedicle screw fixation yielded decreased stability compared with bilateral fixation in some cases, although ultimately the study concluded that unilateral fixation was as efficacious and safe as bilateral fixation.

In a randomized control trial by Duncan and Bailey [12] comparing rates of cage migration between patients undergoing fusion with unilateral versus bilateral fixation, there were significantly more cases of cage migration among patients undergoing unilateral screw fixation. Similarly, Harris et al. [11] compared the stabilites of the L4–L5 lumbar segment and entire lumbar spine (T12–S1) after insertion of a single carbon fiber Brantigan cage with or without posterior pedicle screw fixation. TLIF with bilateral pedicle screw fixation resulted in greater stability than TLIF with unilateral fixation, although both techniques increased stability compared with standalone cages. The authors suggested that bilateral pedicle screw fixation provided the greatest stability and should be the standard for posterior fixation following unilateral TLIF [11]. However, these studies did not address the position of the interbody cage. If the cage can be positioned to optimally stabilize the lumbar segment, this may improve the stability of the construct such that unilateral fixation is equivalent to or more stable than bilateral fixation.

Conflicting evidence in the literature has presented challenges for determining whether unilateral pedicle screw fixation provides adequate stability to be advantageous over bilateral fixation. If cage position does have a significant effect on the stability of the fusion construct, then the cage may be inserted in a position that equalizes the stability of TLIF with unilateral screw fixation to that of TLIF with bilateral screw fixation, negating the need for a second screw and minimizing invasiveness, costs, and operative time. However, as there is insufficient evidence supporting whether cage position in the intervertebral space can impact stability such that bilateral fixation is not needed, further investigation is needed.

Conclusions

To the best of our knowledge, there have been no studies evaluating the effect of cage position relative to the unilateral pedicle screw construct on the stability of the lumbar spine in TILF with unilateral pedicle screw fixation. Because greater lumbar stability after interbody fusion results in improved fusion rates, thereby leading to better clinical outcomes, we propose that additional studies testing the placement of the interbody cage position relative to the unilateral screw construct are needed to determine if ideal cage placement can render unilateral TLIF functionally equivalent to bilateral TLIF.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Ms. Haley McKissack is the primary writer and organizer of this data. Dr. Howard Levene is the idea originator, editor, advisor, and supervisor for this work.

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