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Radiological outcomes of Lateral Lumbar Interbody Fusion (LIF) in Adult Spinal Deformity – A Systematic Review

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ABSTRACT

Background Data: Adult spinal deformity (ASD) needing surgical treatment is often seen in the aging population. Radiological goals for ASD surgery have been standardized to achieve a good functional outcome. Lesser complication rates and blood loss have made MIS surgeries more popular in the current day. Trans-psoas / Pre-psoas Lateral Lumbar Interbody Fusion (LIF) has been the cornerstone of MIS surgeries for ASD. The corrective potential of conventional MIS surgeries was limited, owing to which various modifications have been described. Despite the demonstration of good clinical outcomes by various studies employing different surgical techniques, cumulative analysis of the radiological outcome of the various modifications of LIF is poorly discussed in the literature. A recommendation of an ideal MIS technique based on the type and magnitude of ASD is also lacking.

Purpose: We aim to perform a qualitative systematic review of the radiological outcomes of various modifications of LIF surgeries for ASD and to decipher a treatment algorithm based on the type and severity of ASD with existing literature.

Study design: Systematic review.

Patients and Methods: A systematic search of two electronic databases (PubMed & Google Scholar) from its inception till December 2020 was done independently by 3 different authors. Relevant keywords and MeSH terms were used to identify articles and further filtered by applying appropriate selection criteria.

Results: A total of 171 articles were selected for abstract screening, followed by full-text screening. After applying the selection criteria, 28 articles were selected for the systematic review. The methodology and radiological parameters of each study were analyzed qualitatively, and the inferences in regards to the radiological outcomes were validated.

Conclusion: Circumferential MIS (cMIS) seems to be adequate in milder forms of ASD, while hybrid surgeries may be needed in higher magnitude deformities. Addressing the L5-S1 junction using LIF and anterior column realignment (ACR) are useful tools to correct more severe deformities. (2020ESJ223)

Keywords: OLIF; LLIF; DLIF; XLIF; Minimally invasive spine surgery; Degenerative scoliosis; Degenerative kyphosis; Adult spinal deformity.

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INTRODUCTION

Adult spinal deformity (ASD) is a common cause of disability in the aging population. The deformity can be coronal in the form of degenerative scoliosis or sagittal in the form of degenerative kyphosis or a combination of both. Degenerative spinal deformities can be seen in up to 68% of people above 60 years of age[36]. Patients are often asymptomatic, although they sometimes present with mechanical or neurological symptoms[1]. Mechanical symptoms are seldom reported unless they develop significant imbalance when they might need intervention[1]. Conventionally these patients were treated with major posterior-based surgeries ranging from multi-level posterior spinal decompression & fusion, posterior interbody fusions, posterior column osteotomies (PCO) osteotomies to the most complex 3 column osteotomies [32]. These surgeries were typically performed in elderly, fragile patients associated with frequent complications like blood loss, infection, implant failures, pseudo-arthrosis, high revision rates, and even mortality[10,23,32,33].

Minimally invasive lateral interbody fusion (LIF) was developed by Ozgur et al.[29] in 2005 as a safe, effective, and reproducible technique to treat degenerative disc disease. Since then, the use of LIF was extended to more complex multi-level lumbar degenerative pathologies including ASD because of its minimally invasive nature and its benefits in the elderly population. Initially, LIF was performed through a trans-psoas window when the term extreme LIF (XLIF) was used[29]. The use of various terminologies for the same surgical procedure by various authors included Direct Lateral Interbody Fusion (DLIF), Lateral Lumbar Interbody Fusion (LLIF)[19]. Oblique lumbar interbody fusion (OLIF) was developed as a surgical technique to avoid the trans-psoas approach related lumbar plexus injuries as it is performed through the pre-psoas oblique window[26,32,41]. However, all these techniques involve similar surgical steps starting with tube placement, annulotomy, complete discectomy, endplate preparation, followed by the placement of large lordotic cages through the lateral approach. Considering the common surgical steps involved in all the above-mentioned procedures except for the approach, the term Lateral interbody fusion (LIF) has been used in this article interchangeably. LIF has evolved significantly over the recent years through various modifications of surgical technique in a quest to achieve better outcomes in deformity corrections. This systematic review aims at discussing the radiological outcome of the various modifications in the LIF technique and to decipher a treatment algorithm for treating ASD.

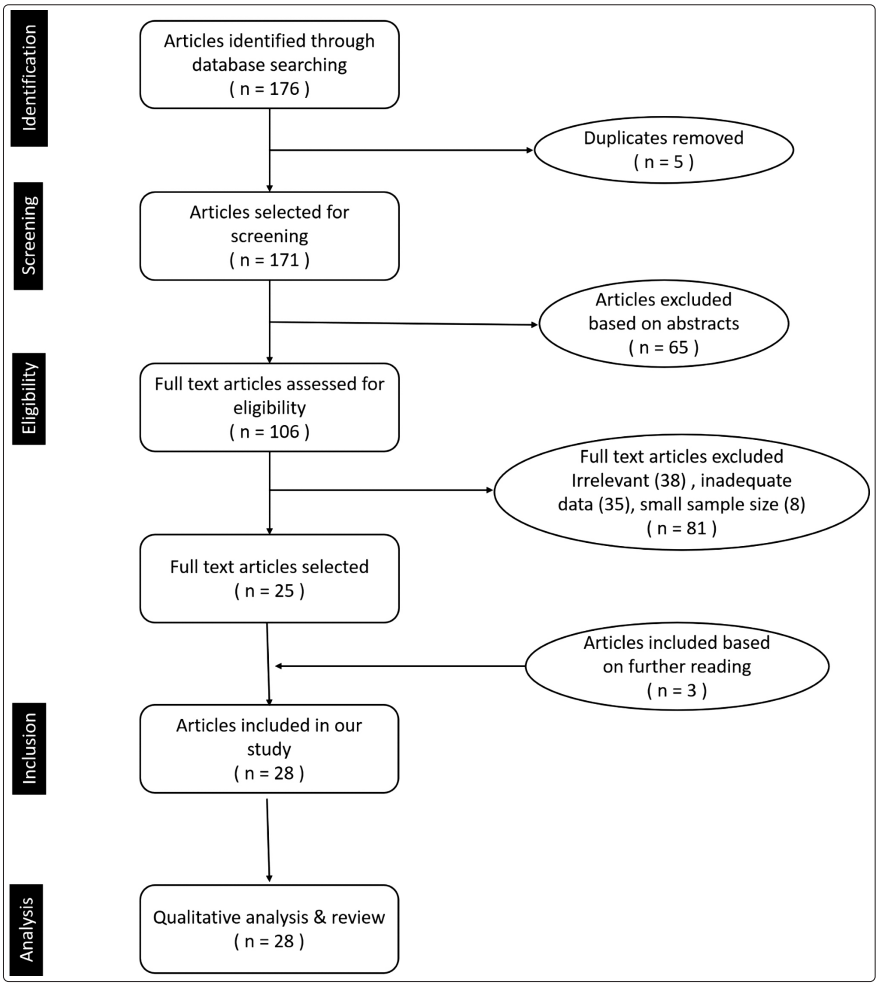
PATIENTS AND METHODS

Search strategy: An electronic search was conducted in the PubMed and Google scholar medical databases from its date of inception till December 2020. To identify all the relevant articles, we used "OLIF" OR "LLIF" OR "DLIF" OR "XLIF" OR "Oblique lumbar interbody fusion" OR "Lateral lumbar interbody fusion" OR "Direct lumbar interbody fusion" OR "Extreme lateral lumbar interbody fusion" OR "Minimally invasive spine surgery" AND "Scoliosis" OR "Degenerative scoliosis" OR "degenerative lumbar scoliosis" OR "adult spinal deformity" OR "de novo scoliosis" as keywords and exploded as MeSH headings wherever possible. The preliminary search yielded 171 articles. The abstracts of these articles were screened individually by 3 different authors, to exclude articles from languages other than English and studies with no details of the radiological outcome. A total of 106 articles (original / review) were considered for further reading. All these articles were reviewed using specific selection criteria. The inclusion criteria were; 1) Studies with the radiological outcome of ASD treated by any form of Lateral interbody fusion (LIF) or its modifications detailing regional and global spinal balance. The exclusion criteria were studies with 1) Less than 10 cases, 2) Inadequate radiological

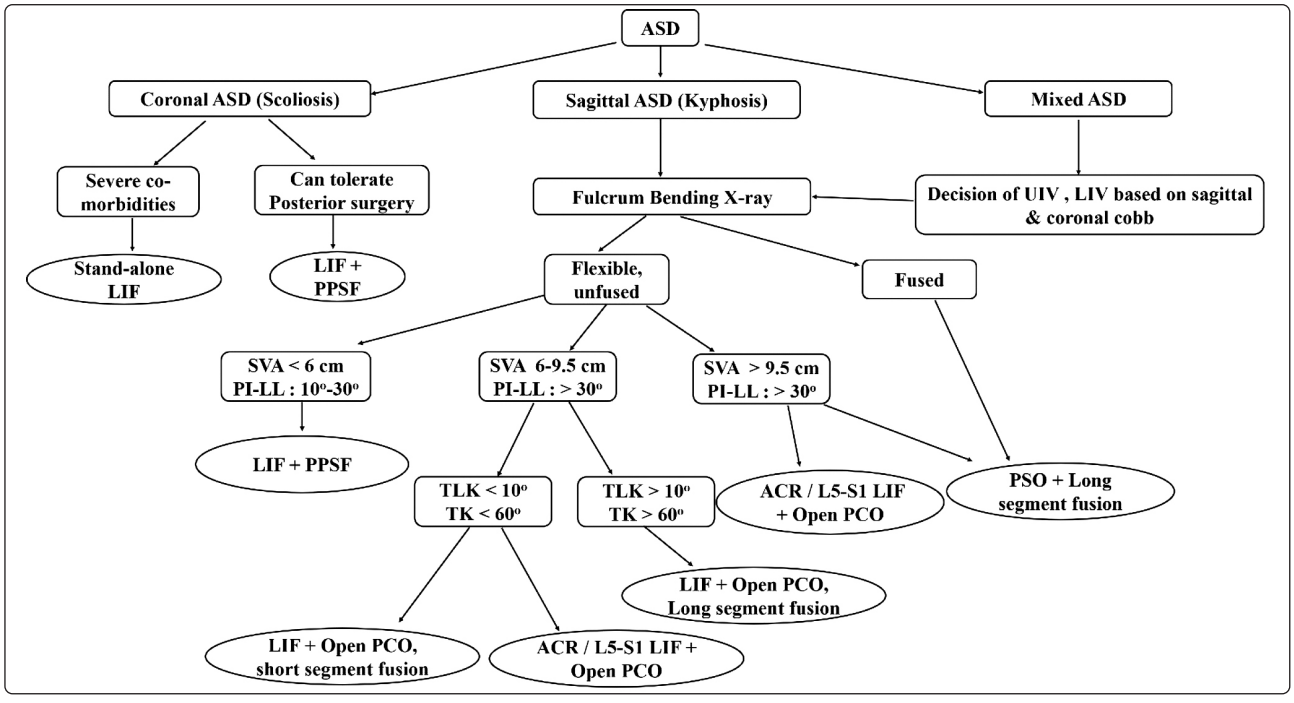
data, 3) Open LIF procedures, 4) No proper discrimination of patient population regarding the pathology or type of interbody fusion as per our area of study. We also extended our review by further reading relevant articles from the selected articles whenever necessary. Any discrepancies between the 3 reviewers were discussed and a consensus was arrived at. This finally yielded 28 articles which were included and analyzed in our systematic review. The methodology of our review is summarized below (flow chart 1).

RESULTS

We analyzed the articles in regards to the following radiological parameters: 1) Spino pelvic parameters: Pelvic incidence (PI), pelvic tilt (PT), Sacral slope (SS), Pelvic incidence – lumbar lordosis mismatch (PI-LL); 2) Regional spinal parameters: Segmental lumbar lordosis (SL – measured as the disc angle at each lumbar disc level), Regional lumbar lordosis (LL-measured as sagittal Cobb angle between L1 – S1 vertebrae), Thoracic kyphosis (TK-measured as sagittal Cobb angle between T1-T12 vertebrae), Coronal cobb angle (Cobb angle measured between upper end to lower end vertebra) and 3) Global spinal balance parameters: Sagittal vertical axis (SVA-measured as the sagittal distance between the C7 plumbline and the posterosuperior corner of the sacrum), coronal balance (measured as the distance between CSVL and C7PL). A critical analysis of each study including the methodology and their radiological results based on which their inference was built was carried out, and a qualitative systematic review was done based on the inferences of 28 studies (table 1).



Flow chart 1. Methodology of search, inclusion of studies and analysis in our systematic review.



Flow chart 2. Algorithm to approach and treat adult spinal deformity based on our systematic review.

Table 1. Summary of studies done on radiological outcome of LIF in ASD which were included in our systematic review.

Serial number	Name of author (year)	Type of study	Level of evidence	Number of patients	Type of LIF	Posterior procedure	Inference
Stand-alone LIF							
1	Johnson et al[16] (2012)	R	4	15	LLIF	--	Stand-alone LLIF did not significantly improve pelvic parameters and sagittal balance
2	Castro et al[8] (2014)	R	4	35	LLIF	--	Good outcomes in mild scoliotic deformities, 29% subsidence with stand-alone LLIF, can be avoided by posterior stabilization
3	Ahmadian et al[2] (2015)	R	4	18	LLIF	--	30% subsidence rate in stand-alone LLIF, not advisable in severe sagittal deformities, osteopenia, instability where supplementation with a posterior procedure to be considered.
4	Hiyama et al[14] (2019)	R	4	38	LLIF	--	Stand-alone LLIF can achieve a maximum of 10-degree lower lumbar correction. More correction requires additional posterior procedures.
Circumferential MIS (cMIS)							
5	Uribe et al[45] (2017)	R	4	82	LLIF	PPSF	cMIS surgery with a short fusion construct has equivalent radiological outcome as long fusion surgeries

Serial number	Name of author (year)	Type of study	Level of evidence	Number of patients	Type of LIF	Posterior procedure	Inference
6	Anand et al[4] (2019)	R	4	60	OLIF	PPSF	Multi-level OLIF especially at L5-S1 is the major corrective force in cMIS surgery, further improved by PPSF
Hybrid LIF (LIF + Open PSF)							
7	Phillips et al[34] (2013)	P	3	107	LLIF	PPSF / Open PSF	Sagittal balance is an important predictor of quality of life. Combining posterior fusion gives better correction comparing stand-alone LLIF with a higher magnitude of correction seen with PCOs.
8	Scheer et al[35] (2015)	R	4	34	LLIF	PPSF / Open PSF	Surgery from the concave or convex side results in similar correction of deformity, with the concave side procedures, is associated with more neurological complications.
9	Park et al[31] (2015)	R	4	105	LLIF	PPSF / Open PSF	Hybrid procedures help in a higher magnitude of correction of regional and global sagittal parameters comparing cMIS with no statistical difference
10	Strom et al[42] (2016)	R	4	32	LLIF	Open PSF	Hybrid surgery is appropriate for patients with moderate ASD. Interspinous ligaments release, posterior column osteotomies enhance sagittal correction.
11	Than et al[43] (2016)	R	4	43	LLIF	PPSF / Open PSF	ASD surgeries should aim at restoring SVA < 5cm and PI-LL mismatch < 10°. PI-LL mismatch in the presence of normal SVA (compensated sagittal imbalance) can also cause disability.
12	Lee et al[22] (2016)	P	3	27	LLIF + MIS ALIF L5-S1	PPSF / Open PSF	ALIF L5-S1 achieves a more physiological restoration of SL than LLIF. Combining MIS LLIF, ALIF L5-S1 & PSF can reduce the need for PSO
13	Barone et al[6] (2017)	R	4	65	LLIF	PPSF / Open PSF	Hybrid procedures allow significantly better restoration of regional lordosis by the placement of large lordotic cages comparing cMIS
14	Park et al[30] (2018)	R	4	48	LLIF	Open PSF	Staged LLIF followed by posterior fusion achieves better correction of sagittal imbalance comparing posterior only procedures.
15	Attenello et al[5] (2018)	R	4	22	LLIF	PPSF / Open PSF	Better correction of all sagittal & coronal parameters seen with open PSF than with PPSF when similar cages were used.

Serial number	Name of author (year)	Type of study	Level of evidence	Number of patients	Type of LIF	Posterior procedure	Inference
16	Kanter et al[17] (2018)	R	4	63	LLIF	PPSF / Open PSF	The radiographic outcome is similar when approached from the convex or concave side with a slightly higher incidence of neurological complications when operated from the concave side.
17	Patel et al[32] (2019)	P	3	15	OLIF	Open PSF	Multi-level OLIF obviates the need for PSO and extension of fusion to the pelvis. Hybrid surgeries / ACR showed more correction comparing stand-alone multilevel OLIF.
18	Katz et al[18] (2019)	R	4	27	LLIF	PPSF / Open PSF	Patients who underwent multilevel LLIF with adjunctive posterior surgery had sustained correction with minimal cage subsidence.
19	Lee et al[23] (2020)	R	4	41	OLIF	Open PSF	The addition of open posterior column osteotomies to multi-level OLIF maximizes lordosis correction in severe sagittal deformities and comparable to results achieved by PSO.
20	Kim[21] et al (2019)	P	3	46	OLIF	Open PSF	Forced extension lateral x-rays can predict the amount of correction achievable by LIF procedure alone, and helps planning posterior surgery
21	Iwamae et al[15] (2020)	R	4	14	LLIF	Open PSF	The addition of posterior column osteotomies helps to close the posterior void improving SL comparing LLIF which only increases disc height. Fulcrum bending x-rays help predict correction by LLIF
22	Wang et al[46] (2020)	R	4	53	LLIF	PPSF / Open PSF	A significant difference in pre-operative SVA between cMIS and hybrid groups. Preferential use of hybrid surgeries for higher magnitude deformities
ACR -LIF							
23	Turner et al[44] (2015)	R	4	34	ACR-LLIF	Open PSF	Restoration of segmental lordosis by ACR around 4 times that of LLIF. Further addition of posterior column osteotomies increased the SL by 72.7%, which could substitute for a PSO
24	Leveque et al[24] (2017)	R	4	13	ACR-LLIF	Open PSF	ACR-LLIF can achieve equivalent deformity correction to PSO in patients with unfused spine and significant spinopelvic mismatch
25	Godzik et al[13] (2018)	R	4	10	ACR-LLIF	PSO + PSF	Maximum correction of SL achievable by combining PSO and ACR compared to their usage alone. It is a viable option in complex deformities and can avoid grade 4 or 5 osteotomies.

Serial number	Name of author (year)	Type of study	Level of evidence	Number of patients	Type of LIF	Posterior procedure	Inference
26	Gandhi et al[11] (2018)	R	4	73	LLIF +/- ACR	PPSF / Open PSF	Better correction of SI can be achieved with ACR + PCO. However, overcorrection of spinal alignment is a potential risk factor for PJK.
27	Xu et al[48] (2019)	P	3	53	LLIF +/- ACR	PPSF	ACR-LLIF can partially replace the posterior 3-column osteotomy. Staged surgery offers the possibility of re-assessing the patient with the advantage of decreasing levels of posterior fusion.
28	Li et al[25] (2020)	R	4	37	ACR-LLIF	PPSF / Open PSF	ACR reduces the need for open posterior osteotomies, Minimum of 3 levels of LIF is essential for good sagittal correction

Number superscripts – Reference number of the study

R – Retrospective study; P – Prospective study

LIF – Lateral inter body fusion; ASD – Adult spinal deformity; LLIF – Lateral (direct) lumbar interbody fusion; OLIF – Oblique lumbar interbody fusion; PSF – Pedicle screw fixation; PPSF – Percutaneous pedicle screw fixation; cMIS – Circumferential Minimally invasive spine surgery; ACR – Anterior column re-alignment; PCO – Posterior column osteotomies; PSO – Pedicle subtraction osteotomy; PI – Pelvic incidence; LL – Lumbar lordosis; SL – segmental lordosis; SVA – sagittal vertical axis; PJK – Proximal junctional kyphosis

DISCUSSION

Adult spinal deformity includes degenerative / de-novo lumbar scoliosis, Idiopathic lumbar scoliosis with degeneration, degenerative kyphosis, and flat back syndrome where long fusion surgeries might be required up-to thoracic vertebrae for coronal and sagittal balance. Achieving local and global sagittal balance is paramount to achieve an optimal clinical outcome following ASD surgeries[7,10,12,37]. The radiological goals of ASD surgeries are: 1) SVA < 50mm, 2) PI-LL mismatch < 10 degrees, 3) PT < 25 degrees, 4) C7PL – CSVL±20mm[19,38,40]. Patients with altered PI-LL and/or PT in the presence of normal SVA (compensated sagittal imbalance) can also have significant disability and can benefit from surgery[43]. Various surgical modifications of LIF techniques were developed aiming at achieving these goals with minimal complications.

Stand-alone LIF:

Stand-alone LIF involves the anterior placement of lordotic cages at multiple levels preserving the anterior longitudinal ligament (ALL), posterior muscles, ligaments, and bony structures in a stable spine. It is the least invasive procedure as it does not involve any posterior stabilization. However, its indications are limited to patients with 1) Mild degenerative scoliosis (cobb < 30 degrees) with acceptable sagittal balance, 2) Highly morbid patients unfit for long major surgeries. Castro et al.[8] showed significant improvement in coronal Cobb's angle with good post-operative balance and good fusion rates in 84% of patients. However, stand-alone LIF was not an effective tool in significantly correcting sagittal parameters[16], with a maximum lordosis correction of 10 degrees at the lower lumbar spine[14]. Moreover, a high rate of cage subsidence nearing 30% has been reported by various authors[2,8]. The presence of significant sagittal imbalance, osteopenia, pars defects, instability, significant facet arthrosis, and collapsed disc spaces are relative contra-indications where supplemental posterior procedures should be contemplated[2,8,18].

Circumferential MIS (LIF + PPSF):

Circumferential MIS (cMIS) involves multi-level LIF followed by percutaneous pedicle screw fixation (PPSF) without any posterior column osteotomies. The addition of PPSF to multi-level LIF has been advocated to prevent subsidence and maintain correction achieved by stand-alone LIF[2,8]. The sagittal correction potential of cMIS is primarily based on rod contouring and is limited by the intact posterior structures. Most of the authors have restricted the use of cMIS to milder forms of ASD (SVA < 60 mm and PI-LL < 30 degrees), preferring open posterior procedures with PCO for the higher magnitude of deformities[5,6,27,31,46].

However, Neel Anand et al.[4] performed staged cMIS surgery in 60 cases with a mean pre-op SVA of 70.8±60 mm and achieved excellent radiological correction and sagittal balance. They attributed the correction to OLIF at L5-S1 by restoring good segmental lordosis (6.9 - 16.1 degrees), which was the major corrective force. The correction achieved by multi-level OLIF was only marginally improved by PPSF.

Hybrid LIF (MIS LIF + Open Posterior column osteotomy):

Hybrid LIF involves a combination of MIS LIF followed by open posterior procedures involving Schwab grade 1 or 2 posterior column osteotomies and pedicle screw fixation (PSF)[39]. Most of the authors have recommended a staged approach for ASD surgeries, the first stage usually being the MIS LIF[4,17,20,30,42]. This helps to re-assess the sagittal parameters and to plan the posterior procedure needed based on the correction needed following LIF.

The closing of the posterior column wedge created by PCO further improves the segmental lordosis following a LIF procedure[15] thereby correcting the overall lumbar lordosis and PI-LL mismatch. This is evident in many clinical studies where the authors achieved a higher magnitude of correction comparing cMIS technique[6,22,31,32,42]. The biomechanical advantages of performing grade1 or 2 osteotomies help in correcting larger sagittal deformities (SVA > 6cm and/or PI-LL > 30 degrees) in an unfused spine[15,27]. However, the amount of correction achievable by hybrid surgeries is limited by a contracted ALL in severe ASD.

The amenability of ASD to LIF surgeries is based on the flexibility of the deformed spine. This can be assessed by fulcrum extension bending lateral x-rays pre-operatively[15,21]. This can also predict the amount of sagittal correction that can be achieved with stage 1 LIF surgery[15,21]. Addressing a minimum of 3 levels is essential to achieve optimal sagittal deformity correction by LIF[25,28,34]. LIF surgery done from the convex side or the concave side result in similar radiological outcomes. However, LIF from the concave side may be associated with a slightly higher incidence of neurological complications[17,35].

Anterior column realignment (ACR-LIF):

Conventionally, severe ASD has been treated by 3 column osteotomies which are morbid surgeries in elderly patients. Anterior column re-alignment is a recent extension of the MIS LIF procedure where the rigid ALL which limits the correction is released followed by anterior placement of large lordotic cages[11]. It is a technically demanding procedure with a substantial risk of vascular injury, especially at L4-5[3].

Turner et al.[44] observed a four-fold better restoration of segmental lordosis with ACR when compared to traditional LIF. Further addition of posterior column osteotomies increased the SL by 72.7%, which could substitute for a PSO. Similarly, Gandhi et al.[11] showed better correction of sagittal deformity by addition of posterior column osteotomies to ACR, with a caution of increased risk of proximal junctional kyphosis (PJK) with more aggressive corrections. Leveque et al.[24] used the ACR-LIF technique in patients with a severe spinopelvic mismatch and a previously unfused spine. They showed deformity correction equivalent to the PSO technique with reduced blood loss. Similar results were shown by Xu et al.[48] who concluded that ACR-LLIF can partially obviate the need for PSO. The potential mechanical disadvantages associated with PSO like acute

angular lordosis and un-instrumented apex are avoided in multi-level ACR-LIF procedures[23,24]. However, ACR-LLIF cannot correct ankylosed spinal deformities where 3 column osteotomies are inevitable.

Godzik et al.[13] showed aggressive correction of severe, complex sagittal ASD with ankylosis by combining ACR-LLIF and PSO adjacently with good early outcomes. They reported a maximal SL restoration of 39.1 degrees compared to ACR (34.6 degrees) and PSO (26.1 degrees) alone. This helped them avoid performing grade 4 or higher osteotomies, however, the study had limitations like small sample size and follow up less than 2 years.

LIF at Lumbo-sacral junction:

The lumbosacral (LS) junction (L4-S1) contributes to 60-80% of physiological lumbar lordosis[9]. A similar lordotic profile has to be ideally achieved at the LS junction in a degenerative spine. A better correction of the sagittal balance of the spine with a long lever arm is achieved by effective lordosis correction at the base (LS junction)[22]. A major drawback of the commonly used LLIF technique is its inaccessibility to the lumbosacral junction because of the anatomical hindrance by the iliac crest and the lateral relation to the great vessels. ALIF and OLIF are very useful techniques at LS junction for restoring lumbosacral lordosis, by allowing placement of larger lordotic cages. Xi et al.[47] reported comparable segmental lordosis by using the ALIF and OLIF techniques.

Anand et al.[4] reiterated the importance of achieving maximal correction of SL at LS junction using multi-level OLIF, especially at L5-S1. This helped to achieve good sagittal balance in ASD with a pre-operative mean SVA of around 70 mm by the addition of PPSF alone without the need for open PCO. Lee et al.[22] used multi-level LLIF + mini-open ALIF L5-S1. They achieved a mean segmental angle of 17.5 degrees at L5-S1 comparing to a mean of 8.1 degrees achieved at L4-L5 using LLIF.

In addition to segmental lordosis restoration, the other indications for interbody fusion at the LS junction are: 1) L5 vertebral tilt > 15 degrees in the coronal plane, 2) Neural compression requiring decompression, 3) Lysis or listhesis, 4) Disc degeneration and 5) Long fusion constructs extending proximally above D10[25,45], where alternate techniques like trans-foraminal lumbar interbody fusion (TLIF) and axial LIF may be used.

Algorithm:

Staging of ASD surgeries helps in re-evaluating the patients after LIF surgery (first stage) for 1) Choosing an appropriate posterior procedure (PPSF vs Open PCO + PSF) based on the magnitude of correction needed after the first stage, 2) Planning the UIV of fusion construct (short vs long) based on thoracic and thoracolumbar kyphosis[48], and 3) Selection of levels needing direct decompression. The algorithm proposed based on our systematic review is summarized below (flow chart 2).

Limitations:

Our search was limited only to Medline and Google scholar databases, and articles published in languages other than English were not considered. Most of the studies included in our review were retrospectively done with small sample size. Those studies comparing cMIS vs Hybrid surgeries did not have comparable patient subgroups as deformities with larger magnitude were preferentially treated by hybrid surgeries, according to the surgeon's discret. Besides, studies lacking precise radiological data were excluded from our review, which could have contributed otherwise.

CONCLUSION

The Lateral lumbar interbody fusion (LIF) improves the radiological outcome in selected cases of adult spinal deformity. cMIS LIF technique is effective in correcting milder grades of ASD, with a sagittal vertical axis of less than 6cm while hybrid techniques are often needed for higher grades of adult spinal deformity, with a sagittal vertical axis of more than 6cm. Addressing the L5-S1 junction

substantially contributes to the corrective potential of LIF surgeries. The use of the Anterior column realignment (ACR) technique may help avoid larger 3 column osteotomies in an unfused spine. However, there is a need for further prospective randomized controlled studies with a large sample size to formulate a specific treatment algorithm in ASD, which could be a future direction for prospective research.

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الملخص العربي

النتائج الإشعاعية للانصهار الجانبي القطني (LIF) في تشوه العمود الفقري عند البالغين - مراجعة منهجية

البيانات الخلفية: غالبًا ما يُلاحظ تشوه العمود الفقري للبالغين (ASD) الذي يحتاج إلى علاج جراحي في كبار السن من السكان. تم توحيد الأهداف الإشعاعية لجراحة ASD لتحقيق نتيجة وظيفية جيدة. جعلت معدلات المضاعفات وفقدان الدم بالعمليات الأقل MIS أكثر شيوعًا في اليوم الحالي.

يعتبر Trans-psoas / Pre-psoas Lateral Lumbar Interbody Fusion (LIF) حجر الزاوية في جراحات MIS لعلاج ASD. كانت الإمكانات التصحيحية للعمليات الجراحية MIS التقليدية محدودة، بسبب وصف التعديلات المختلفة. على الرغم من إثبات النتائج السريرية الجيدة من خلال الدراسات المختلفة التي تستخدم تقنيات جراحية مختلفة، إلا أن التحليل التراكمي للنتائج الإشعاعية للتعديلات المختلفة لـ LIF تمت مناقشته بشكل سيئ في الأدبيات. لا توجد أيضًا توصية بتقنية MIS المثالية بناءً على نوع وحجم اضطراب طيف التوحد.

الغرض: نحن نهدف إلى إجراء مراجعة نوعية منهجية للنتائج الإشعاعية للتعديلات المختلفة لجراحات LIF من أجل ASD وفك تشفير خوارزمية العلاج بناءً على نوع وشدة ASD مع الأدبيات الموجودة.

تصميم الدراسة: مراجعة منهجية.

المرضى والطرق: تم إجراء بحث منهجي لقواعد بيانات إلكترونية (PubMed و Google Scholar) منذ إنشائها حتى ديسمبر 2020 بشكل مستقل بواسطة 3 مؤلفين مختلفين. تم استخدام الكلمات الرئيسية ذات الصلة ومصطلحات MeSH لتحديد المقالات وتصفيتها بشكل أكبر من خلال تطبيق معايير الاختيار المناسبة.

النتائج: تم اختيار مجموعه 171 مقالة لفحص الملخصات، يليها فحص النص الكامل. بعد تطبيق معايير الاختيار، تم اختيار 28 مقالة للمراجعة المنهجية. تم تحليل المنهجية والمعايير الإشعاعية لكل دراسة نوعياً، وتم التحقق من صحة الاستنتاجات المتعلقة بالنتائج الإشعاعية.

الخلاصة: يبدو أن MIS المحيطي (cMIS) مناسب في الأشكال الأكثر اعتدالًا من ASD، بينما قد تكون هناك حاجة إلى العمليات الجراحية الهجينة في التشوهات الكبيرة. تعتبر معالجة التقاطع L5-S1 باستخدام LIF وإعادة محاذاة العمود الأمامي (ACR) أدوات مفيدة لتصحيح التشوهات الأكثر خطورة.