Transforminal Lumbar Interbody Fusion (TLIF) versus Extensive Transforminal Lumbar Decompression Fusion (ETLDF) technique in treatment of Adult Lumbar Spondylolisthesis

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Abstract:

Background:
The best decompression – correction – fusion techniques are still a matter of controversy existing a relative merits and challenge in treatment of Adult Lumbar Spondylolisthesis (ALS). Listhesis reduction, adequate neuroforminal decompression and correction of segmental kyphoscoliotic imbalance are the main goals in treatment of ALS.

Study design and purpose:
The purpose of this study was retrospective comparative analysis of prospectively randomized collected data of patients with ALS operated either by TLIF or ETLDF techniques.

Patient samples and Methods:
Between 2011 and 2013, fifty five patients with ALS ± segmental coronal\sagittal profile imbalance were randomly divided into 2 groups according to surgical technique then followed up. Clinical and functional outcomes data involved Visual Analogue Scale (VAS) for back and leg pain, Japanese Orthopedic Association (JOA) and Oswestery disability index (ODI) for quality of life; Neurological assessment using American Spinal Injury Association (ASIA) motor index was performed; The radiographs were reviewed for percentage of listhesis reduction, deformity correction, cage position\subsidence, Lumbar Lordosis (LL) and fusion. Perioperative outcomes data included operative time, hospital stay, blood loss and complications were exhibited in each group.

Results:
The mean follow up period was 34±3.5 months. At finial follow up, clinical and radiological outcomes were significantly improved in both groups *(P<0.001)*. No major complications were reported in our series. Two patients contracted superficial wound infection, two developed postoperative neurological worsening and one had contralateral radiculopathy. Solid interbody fusion was evident in 47 cases (94%). Slippage reduction and neurological recovery were significantly improved in both groups ($P < 0.05$). ETLDF showed better results than TLIF.

Conclusions:
Despite of relatively longer operative time, hospital stay and excess blood loss, ETLDF may be superior to TLIF regarding slippage reduction ± local coronal\sagittal realignment, sufficient direct bilateral neuroforminal decompression and neurological improvement.

Keywords:
Extensive Transforminal Lumbar Decompression Fusion; Transforminal Lumbar Interbody Fusion; Adult Lumbar Spondylolisthesis; Coronal \Sagittal Imbalance.

Introduction:

Adult Lumbar Spodylolisthesis (ALS) is a major disabling spinal problem in the whole world [1]; affects mainly middle and old age [2]; it may be associated with segmental coronal vertebral translation or local sagittal kyphosis and coronal wedging or sagittal narrowing of Disk Space Height (DSH) disturbing the whole lumbar profile [3] ; it occurs due to neglected traumatic fracture pars with progressive mechanical instability not responding to conservative treatment, degeneration, isthmic lysis, scoliosis and iatrogenic mechanical instability after extensive laminectomy disrupting pars intra-articularis at the operated level [4-6].

All of previous mentioned points are the source of mechanical persistent low back pain and radicular\neurogenic claudication pain which attributed to pinching of nerve roots by slipped vertebra, facet arthropathy and central or forminal stenosis [7-9].

Transforminal Lumbar Interbody Fusion (TLIF) technique is well-known popular surgery

permitting unilateral direct and contralateral indirect neuroforminal decompression by unilateral subtotal or total facetectomy and contralateral distraction of DSH by cage respectively but postoperative contralateral neurological deficit or radiculopathy was reported [10,11].

The purpose of this study was to evaluate and compare both techniques (TLIF or ETLDF) in surgical management of ALS ± segmental coronal and sagittal profile imbalance.

Patients and methods:

Fifty five adult patients with ALS were underwent either TLIF **(group I)** or ETLDF **(group II)** surgery between January 2011 and December 2013, but 50 patients with their complete medical data were retrospectively reviewed and compared and the remaining five cases were excluded as they dropped during follow up. The patients were 26 (52%) male and 24 (48%) female with age ranging from 25-60 years.

Written informed consent was obtained following the rules of institutional medical ethical committee.

The inclusion criteria were symptomatic ALS ± segmental sagittal\coronal profile imbalance (coronal wedging of DSH, coronal translation > 5mm and scoliosis\ sagittal narrowing of DSH, antero\ retrolisthesis, Local Kyphosis (LK) and loss of LL). The exclusion criteria included spondyloptosis and irregular follow up (five patients).

All patients were randomly divided into two groups; each group involved 25 cases. Twenty eight (56%) cases were presented by ALS with Segmental Coronal Imbalance (SCI) and LK while 22 (44%) cases had just alone ALS (anter\retrolisthesis).

ALS occurred due to degeneration (20 cases), traumatic fracture pars (5 cases), isthmic type (3 cases), iatrogenic (10 cases) and lysis of pars (12 cases).

Twenty three patients (46%) were smokers and the other 27 (54%) patients were nonsmoker. Two or more multi-morbid medical diseases like coronary artery disease, diabetes, hypertension, and asthma were evident in 14 cases (28%).

The diagnosis depended on clinical manifestations; back/leg pain evaluated by VAS score, neurological assessment using ASIA motor index and functional evaluation by ODI and JOA.

The radiological evaluation was performed by plain lumbar X-ray in upright positions, dynamic views and Multi Detector Computerized Tomography (MDCT) to detect coronal wedging or sagittal narrowing of DSH , slippage degree, coronal translation, elongation/defect/ neglected non united fracture (with progressive slippage) of pars interarticularis (pseudo-arthrosis), scoliotic angle, spinal canal compromise, angle of global LL, segmental LL, and LK.

While Magnetic Resonance Imaging (MRI) was indicated to detect degenerative disc changes, soft tissue stenosis, facet arthropathy changes, asymmetry of posterior vertebral element in cases of adult lumber degenerative scoliosis with spondylolisthesis due to congenital anomalies, nature of previous surgery in cases of iatrogenic ALS and neural element affection.

The mean duration of preoperative symptoms was 64.5 ± 3.5 (9–120) months.

Persistent back pain not responding to conservative methods was evident in 46 cases (92%), sciatic pain unresponsive to medical treatment in 48 cases (96%), sensory loss in 35 cases (70%), and lower-extremity muscle weakness in 23 cases (46%) which were evaluated using (ASIA) motor index.

Appearance of dense cortical bone continuing trabecular pattern across the disk space, absent motion on flexion extension views and no looser defect around pedicular screws were valuable radiological findings for conformation of soiled fusion when bone graft was used and by Sentinel sign, when a metal cage was applied [12].

MDCT scan was preferred with difficult assessment of fusion. Implant loosening and pseudo arthrosis (failure of fusion) were diagnosed by presence of radiolucent lines across disk space, stress shielding and dislocated or broken metal.

The follow up examination was carried out by patient's interview for average 4 years duration.

Operative procedure:

Patients underwent 1-stage neuro-forminal decompression either unilateral TLIF or ETLDF (TLIF + laminectomy and contralateral foraminotomy), slippage reduction, distraction-compression and grafting ± cage with posterior transpedicular fixation.

Both techniques (TLIF and ETLDF) were randomly selected in all cases. The oblique descending and traversing lumbar nerve roots were identified and protected with a small retractor with minimal medial manipulation on the thecal sac to perform diskectomy. Pseudo-arthrosis, epidural veins, adhesion and fibrosis were the major source of bleeding during surgery.

In group (I) (TILF) Figure [1]: Unilateral total or subtotal removal of facets joint, one side lamina, pars intraarticularis and osseous posterior lip of the vertebra using osteotomes or high speed burr with preservation of spinous process, contralateral lamina and opposite facet joint was

Figure (1): showing (A): plain x ray, MDCT and MRI finding of male 25 years old complained of low back pain and right lower limb pain and imaging study revealed anterolisthesis at L5-S1; (C): TLIF procedure exposing nerve root S1 after unilateral total facetectomy; (D): postoperative A\P and lateral x ray showed incomplete reduction of L5 and inadequate restoration of sagittal profile balance.

In group (II) (ETLDF) Figure [2]: complete excision of unilateral facets with butterfly loose laminae conjoined with spinous process and Posterior Ligamentous Complex (PLC) helped in sufficient direct bilateral circumferential neuro-forminal decompression; anterior release of disk by complete diskectomy to reach Anterior Longitudinal Ligament (ALL).

The slipped kyphoscoliotic vertebrae became more mobile and easily manipulated after combined release of posterior tension surface and complete anterior diskectomy to achieve nearly anatomical listhesis reduction, correction of segmental kyphoscoliosis and restoration of LL. Cross link plate may be applied in some cases to overcome rotational instability and help in correction of coronal translation.

In cases with segmental scoliotic deformity due to congenital anomalies, facetal asymmetry was prominent and appeared by small rudimentary and large\hypertrophied facet joint on concave and convex side respectively.

Epidural veins were overdeveloped over the convex than concave side; correction of scoliosis was easily performed on the concave than convex side after posterior tension surface release, anterior release and diagonal insertion of cage from the concave side to open DSH and correct Coronal Wedging Disk Angle (CWDA), scoliotic deformity and translation. Elongation of pars was an essential step to create wider space which facilitates interbody graft ±cage insertion with direct unilateral and indirect contralateral forminal canal decompression by facetectomy and distraction of DSH using fibrocarbon or mesh cage\ strut graft respectively.

an obstacle factor in reduction of isthmic spondylolisthesis which needed to extensive procedure to assist in slippage reduction.

In cases with LK and segmental coronal imbalance at specific segment, correction of both deformity was obtained by combined extensive removal of posterior tension surface, anterior release by complete diskectomy until reaching ALL of kyphoscoliolisthetic vertebra and adjacent levels, anterior cage insertion, and lordilization of pedicular screws was to aid in opening of anterior margins of DSH, to restore LL and maintain sagittal\coronal profile balance.

Spondylolisthesis reduction screws were the keystone of reduction of slippage and correction of segmental kyphoscoliotic deformity. Reduction and standard pedicular screws must stand at the level of transverse process of listhetic vertebra and non-listhetic vertebra respectively. The head of standard screws in non listhetic vertebra was higher than the level of reduction screws in listhetic vertebra in cases of high grade anterolisthesis and the reverse in retrolisthesis.

First the lordotic rod was putted in listhetic and non-listhetic vertebrae on one side of fixation to perform gentle distraction between two affected vertebrae; Then it should be tightened first in non-listhetic vertebra then in the listhetic vertebra to achieve the anatomical reduction by appearance of almost leveling of both transverse processes of listhetic and non-listhetic vertebrae in operative field and confirmed by C-arm fluoroscopy. Another lordotic rod was applied to contralateral side.

Figure (2): showing (A and B): plain x ray and MRI finding of female 55 years old complained of low back pain and bilateral lower limb pain. Imaging study revealed anterolisthesis at L5-S1; (C): butterfly excision of loose tension deforming force of lamina L5 after ETLDF

procedure; (D): postoperative lateral x ray showed complete reduction of L5 and restoration of sagittal profile balance.

Because of using single central cage in fusion, empty space was found around the impacted cage. So additional excised laminectomy and facetectomy bone with auto bone grafting from iliac crest were applied press fit to fill this space to achieve healing. Disk space or anterior column defect was measured and reconstructed with titanium coated PEEK or mesh cage' filled with impacted morsellized autograft. An intra-wound application of vancomycin powder after wound irrigation was beneficial to diminish the chance of infection [13].

Postoperative regimen:

Postoperative plain X ray (2 views) was done to assess SCI and LK {CWDA<5°, scoliotic angle, Lateral Coronal Translation (LCT < 5mm), LL, segmental LL, angle of LK, slippage degree and DSH in pre, postoperative and final status} and implant or graft/cage placement. Also MDCT was needed to confirm fusion and accuracy of pedicular screws position in some cases.

All patients were given parenteral antibiotics (3rd generation cephalosporin) till drain removal (3-5 day after operation or drain contained less than 50cc) and permitted to walk supported by a LumboSacral Orthosis (LSO) 2 days after operation; this support orthosis was maintained for three months. One or two weeks after surgery, patients were permitted to sit on the bed. Passive and active movements of the trunk and lower limb muscles were individualized for every case and supervised by a physiotherapist.

Follow up:

The patients were followed up clinically, radiologically and functionally at 1- month intervals in the first 3 months, at 3- months intervals in the next 9 months , at 6- months intervals in the second year and then once a year until the end of follow up.

Statistical analysis:

The collected data were coded, tabulated, and statistically analyzed using SPSS (version 20). Descriptive statistics were done for numerical data by mean, standard deviation and minimum& maximum of the range, while categorical data were described by number and percentage. The x^2 test was used for non-continuous variables, and Student's *t* test to analyze the statistical significance in each group and between two groups.

Results:

The mean follow up period was 34 ± 3.5 (20-48) months. The mean age was 42.5 ± 3.2 (25-60) years.

Surgery was performed at L4–5 in 24 cases (48%), L5–S1 in 15 cases (30%), and L3–4 in 6 cases (12%), 3 (6%) and 2 (4%) cases were operated at L2-3 and L1-2 respectively (Table 1).

ALS with LK alone was evident in 8 (16%) cases while ALS with SCI alone was noticed in 15(30%) cases. ALS with combined LK and SCI were present in 5(10%) cases. The commonest affected segments by LK and SCI separately are L4-5(10 cases = 20%) and L5-S1 (8 cases = 16%) levels respectively (Table 1).

Table (1): showing operated levels and ALS± coronal and sagittal profile imbalance among 50 patients.

No of patients\ operated level				
L4-5	**L5-S1**	**L3-4**	**L2-3**	**L1-2**
24(48%)	**15(30%)**	**6(12%)**	**3(6%)**	**2(4%)**
No of patients according to ALS±LK, SCI or combined				
ALS alone	**ALS±LK**	**ALS±SCI**	**ALS± combined (SCI+LK)**	
22(44%)	**8(16%)**	**15(30%)**	**5(10%)**	

ALS: Adult Lumbar Spondylolisthesis**; LK:** Local Kyphosis**; SCI:** Segmental Coronal Imbalance

Pain outcomes:

Significant improvement of back and leg pain was subjectively noticed in 45 (90%) and 47 (94%) patients respectively with significant difference between pre and postoperative state *(P <0.001).*

Neurological outcomes:

Sensory loss and motor deficits according to ASIA index were significantly improved in 33 (94.3%) and 21 (91.3%) patients respectively *(P <0.001)*. Two cases with motor deficits (1 grade B and 1 grade C) had not improved due to late presentation, longstanding compression or stretch (pinching) of the neural structure and previously injured dural sac or nerve root. Among all cases, only one patient in each group had transient deterioration from ASIA D to C who improved to ASIA E after one and half month. There was significant difference between preoperative and final ASIA motor index in all cases and in each group *(P<0.001)* and insignificant difference between both groups in final follow up ASIA motor index state. Percentage of neurological state improvement was better in group (II) [60%] than group (I) [24%] (Table 2) (Chart 1). At the final follow-up, the ambulatory status in all patients showed a statistically significant increase from 54 % to 96 % *(P<0.001).*

Radiological outcomes:

Radiographically, DSH, LL, Spinal Canal Compromise (SCC), angle of LK, percentage of slippage, scoliotic angle and lateral coronal translation showed significant improvement between preoperative and immediate postoperative and also between preoperative and final follow up state in each group. There is also significantly better improvement in group (II) than (I) *(P <0.001)*. Average correction of LL was about 20.17 ± (5.13) ° while mean loss of LL was about 1.36 ± 0.12°/ level. Percentage of SCC showed statistically significant improvement from 83.36 ± 6.74% preoperatively to 13 ± 5% postoperatively *(P<0.001)* in both groups. In the postoperative state, there was more spinal canal decompression in group (II) (SCC= 7.8 ± 2.03%) than group (I) (SCC = 31.55 ± 3.5%).

Percentage of spinal canal decompression was greater in group (II) [86.7%] than group (I) [51.9%] Table (3).

Table (2): pre, postoperative and final follow up state ASIA motor index.

Preoperative ASIA index	Postoperative ASIA index					Final ASIA index				
	A	B	C	D	E	A	B	C	D	E
A (4 cases)	2	1	1	--	--	0	1	0	--	--
B (7cases)	--	1	5	1	--	--	--	0	4	--
C (12 cases)	--	--	3	6	3	--		1	6	4
D (14cases)	--	--	1	5	8	--	--	--	13	8
E (13 cases)	-	--	--	--	13	--	--	--	--	13
Total	2	2	10	12	24	0	1	1	23	25

ASIA: American spinal injury **association.**

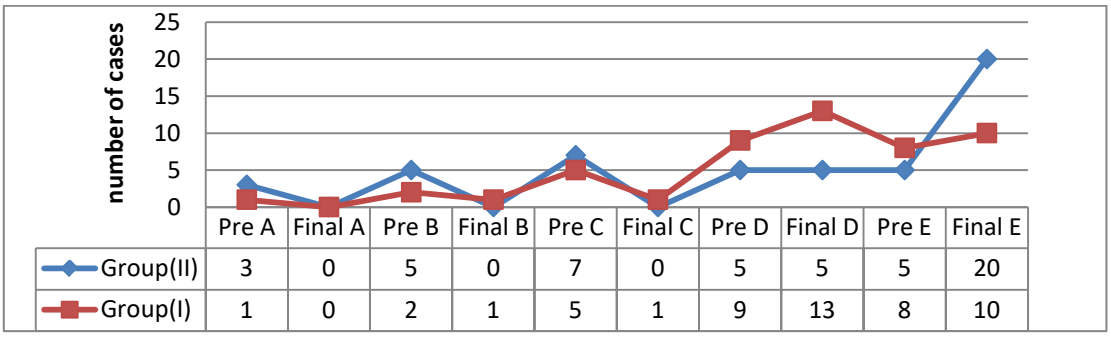

Chart (1): showing ASIA motor index in both groups.

Table (3): showing pre, immediate postoperative, final follow up state, percentage and loss of correction as Mean (M) ± Standard Deviation (SD).

	Group (I)					Group (II)				
	Pre operative	Post operative	Final	% of correction	Loss of correction	Pre operative	Post operative	Final	% of correction	Loss of correction
DSH (mm)	7.25±1.35	11.34±1.5	10.95±0.9	56.4%	0.39±0.6	7.35±1.44	12.14±1.21	11.81±1.29	65.2%	0.33±0.08
% of slippage	40.25±4.2	18.56±2.5	19.65±3.5	53.9%	1.09±1	40.12±3.45	9.68±0.47	10.92±0.91	75.9%	1.24±0.44
Global LL°	40.54±4.35	54.74±3.32	55.6±2.45	35.03%	0.86±(-0.87)	39.66±4.47	59.83±4.34	58.47±4.46	50.9%	1.36±0.12
Segmental LL°	7.5±1.2	10.8±0.5	9.8±0.1	44%	1±0.4	6±1.5	12.8±1.6	11.5±1.5	53.1%	1.3±0.1
LK°	-13.5±(-1.5)	-9.4±(-0.77)	-10±(-0.9)	30.4%	-0.6±(-0.13)	-14.8±(-2.2)	-6.8±(-0.65)	-7.5±(-0.5)	54.1%	-0.7±(-0.15)
CWDA°	8.35±0.65	5.02±0.51	5.79±0.65	39.9%	0.77±0.14	8.51±0.51	3.77±0.42	4.05±0.48	55.7%	0.98±0.06
LCT(mm)	11.55±0.39	7.67±1.66	----------	33.6%	----------	12.34±0.68	4.45±0.56	---------	63.9%	----------
SCC (%)	65.56±7.07	31.55±3.5	----------	51.9%	----------	60.36±3.08	7.8±2.03	-------	86.7%	----------

DSH: disk space height; **LL:** lumbar lordosis; **LK:** local kyphosis; **CWDA:** coronal wedging disk angle; **LCT:** lateral coronal translation; **SCC:** spinal canal compromise.

Perioperative outcomes:

Mean intraoperative Estimated Blood Loss (EBL) was 750 ± 200 mL (650–1350 mL); Mean operative time was 170±40 minutes (150–260 minutes); Mean hospital stay was 3 ± 1.5 day (2–8) days).

Mean EBL was more in group (II) than group (I) while hospital stay and operative time were less in group (I) than group (II). There were significance difference between two groups as regard EBL, operative time and hospital stay *(P <0.001)* (Table 4).

Table (4): showing perioperative outcomes (EBL, hospital stay and operative time) as mean (M) ± standard deviation (SD).

M±SD	Group (I)	Group(II)	P value
EBL(Ml)	700±250	950±300	<0.001*
Hospital stay(day)	3.95±1.2	6.28±2.3	0.000*
Operative time(min)	165±20	190±40	<0.001*

EBL: estimated blood loss**; *:** P value was significant <0.05**.**

Cage or iliac graft:

Anterior column was reconstructed with fibro-carbon cage augmented by morsillized bone MDCT scan was requested when radiographs were insufficient and needed for 5 patients (10%) for confirmation of fusion; 47 patients (94%) showed fusion at final follow-up and 3 cases (6%) failed to fuse; two cases in group (I) and 1 case in group (II).

Functional outcomes: There was significant difference as regard VAS, ODI and JOA score between preoperative and final follow up state in each group *(P< 0.001)* with insignificant difference between two groups in the final follow up state (Table5).

Table (5): showing VAS, ODI and JOA score in preoperative and final follow up state in two groups.

	Group (I)	Group (II)
Preoperative VAS (B)\(L)	**7.28±1.2**	**7.34±0.88**
Final VAS(B)\(L)	**1±0.57**	**1.21±0.5**
P value pre versus final	**<0.001***	**<0.001***
Preoperative ODI	**69.5 ±10.5**	**70±9.5**
Final ODI	**10±1.2**	**11±0.25**
P value pre versus final	**<0.001***	**<0.001***
Preoperative JOA	**12.6±2.6**	**11.9±3.5**
Final JOA	**23.4±3.9**	**22.5±3.6**
P value pre versus final	**<0.001***	**<0.001***

VAS: visual analogue score; **ODI:** oswestery disability index; **JOA:** Japanese orthopedic association; **B:** back pain; **L:** leg pain; ***:** P value was significant <0.05.

As regard complications:

In group (I), there was one case had superficial infection which improved after one month, one case suffered from postoperative contralateral foot drop which needed to contralateral forminal decompression and one case had cage subsidence which showed radiological loss of correction. Also one case had contralateral radiculopathy which resolved after 2 months.

In group (II), one case had neurological worsening which improved after one and half month due to late postoperative infected collecting haematoma which compromise the thecal sac, manifested by transient foot drop which gradually improved after its evacuation and radical debridement. Superficial wound infection was exhibited in one case which improved after two weeks.

Discussion:

The etiology of ALS is multifactorial and is not yet perfectly clear thus the treatment of graft in 40 (80%) cases and tricortical iliac bone graft in 10 (20%) cases. Fusion was evaluated by sentinel sign [12] and dynamic radiographs.

spondylolisthesis has become challenging amongst the treating surgeons,. The real causes, pathogenesis and development of ALS are not well discussed from the point view of knowledge in the literature [14].

Spondylolisthesis, either degenerative or isthmic type, is usually associated with radicular symptoms and back pain due to instability and compression [15, 16]. In a recent analysis of ALS, 40%were treated with corticosteroid injections, 37% were treated with physical therapy, and only 22% needed surgical intervention [17].

The surgical treatment of spondylolisthesis doesn't only depend on neuroforminal decompression and stabilization of motion segment but also reconstitution of DSH and restoration of sagittal or coronal plane (translational and rotational) alignment are essential [18].

Interbody fusion still is the crucial standard method in surgical treatment of ALS as it preserves DSH, maintains the load-bearing capacity, and reconstructs the anterior column after disk evacuation [19, 20].

TLIF usually requires unilateral exposure with less operative time and blood loss [21, 22]. But ETLDF technique can achieve circumferential spinal neuroforminal decompression stabilization fusion by a single posterior approach.

TLIF technique is well known famous procedure in surgical treatment of lumbar degenerative disorders; it has a numerous advantages like minimal dural retraction and less dural tear; it allows direct unilateral and indirect contralateral neuro-foraminal decompression with minimal manipulation to minimize the risk for neurological insult [23, 24]. But some cases reported contralateral radiculopathy or neurological deterioration due to nerve root impingement by axial compression of operated level towards the cage or bone graft causing disk material protrusion to the contralateral blinded non-operated side.

While ETLDF technique creates a wider posterolateral working area through single posterior incision, allows bilateral direct circumferential neuro forminal decompression fusion and permits removal of posterior tension deforming force of loose lamina of slipped vertebra thus aiding in better and easier reduction of slipped vertebra, correction of LWDA and coronal translation in one session. However, longer operative time and excessive intraoperative blood loss are the main sequels of this procedure

which may lead to neurological affection in some cases.

Many literatures discussed TLIF procedure as Rezk et al [25] (48 cases), Xu H et al [26] (60 cases) and Yan DI et al [27] (91 cases) , their results go in line with the current results concerning pain subsidence, fusion rate, neurological improvement, radiological correction, functional recovery, operative time, blood loss, hospital stay and possible complications.

Up to our knowledge, no previous studies discussed ETLDF or compared it with TLIF technique in treatment of ALS. Both techniques (TLIF or ETLDF) in the current work were randomly performed on 50 ALS patients to avoid biased results. The results revealed that percentage of neurological state improvement was better in group (II) [60%] than group (I) [24%] which explained by thoroughness of canal decompression either central or forminal in group (II) and the radiological improvement of SCC percentage was more apparent in group (II) (86.7%) than (I) (51.9%).

Radiological correction of DSH, slippage degree, LKA, LDWA, LCT, SCC, segmental and global LL was better in group (II) than (I). The percentage of DSH restoration was greater in group (II) (65.3%) than (I) (54.3%) with minimal loss of correction in both groups. Percentage of slippage reduction was also more obvious in group (II) (75.9%) than (I) (56.9%). Angle of segmental LL was increased about 6 ° and consequently improved the angle of global LL about 10 ° in group (II). Angle of LK was reduced about 8° degrees in group (II) which is higher than angle of reduction in (I) about 3°.

The improvement of all radiological parameters in group (II) is explained by excision of posterior tension deforming surface of loose lamina, bilateral forminotomy, diskectomy, restoration of DSH and reconstruction of anterior disk defect by cage or bone graft. Fusion was evident in both groups but pseudoarthorsis was recorded in 3 cases and this may be due to inadequate grafting.

Operative time, EBL and hospital stay were significantly increased in group (II) than (I) due to extensive procedure in group (II). Percentage of pain index (VAS score) and functional (ODI and JOA scores) improvement were noticed in both groups and both encountered a complications like infection and postoperative neurological worsening.

Neurological deterioration occurred in both groups but due to different reasons.In group (I), one case encountered a contralateral partial foot drop which investigated using enhanced MRI and revealed disk protrusion compromising the opposite blinded foramen to the operated TLIF side. This case was revised in another session for contralateral forminotomy, diskectomy and nerve root decompression.

But in group (II), neurological deterioration occurred in one case 10 days later on after surgery due to infected collecting haematoma which evacuated to decompress the neural element. This patient improved after one and half month.

These points are considered limitations of the study which need future considerations. First, the study included a small number of cases Second, the spinopelvic parameters weren't evaluated like pelvic incidence, tilt and sacral slope and its correlation with lumbar lordosis especially after correction in cases with LK.

The authors recommend that both techniques should be performed over large number of cases and longer follow up period. Also both should be compared with minimal invasive transforminal and extraforminal procedures to record difference; congruence and determine if one technique will be superior to the other.

Conclusion:

In spite of multifactorial etiology, longer surgical time, excess blood loss and potential complications rate, the outcomes of ETDF technique are still superior to TLIF procedure, more over TLIF procedure is inadequate or insufficient for management of high grade ALS with or without SCI and LK. ETDF procedure has better advantages than TLIF like bilateral direct neuroforminal decompression, balanced biplane profile restoration and listhesis reduction with functional improvement.

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