

Measuring the Radiographic Efficacy of Indirect Decompression following Minimally Invasive Lumbar Interbody Fusion: A Computed Tomography (CT) Analysis Study

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INTRODUCTION:

The advancement of MIS techniques has led to increased reliance on indirect decompression. The latest generation of minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) cages are typically expandable cages that restore disc height and achieve ligamentum flavum unbuckling with associated increased central canal area. While prior studies have measured the extent of indirect decompression associated with ALIF and LLIF, the degree of decompression achieved via MIS-TLIF has not been described.

Assess the degree of indirect decompression following MIS-TLIF. Evaluate associated changes in patient reported outcome measures.

METHODS:

This was a single-center, multi-surgeon, retrospective review. Patients undergoing MIS-TLIF without direct decompression between 3/2017 and 3/2021 were included. Patients were included if they had a pre- and post-operative CT scan. Disc height, foraminal area (left and right), and central canal area were measured at the operative level(s). Sagittal alignment parameters were also measured pre- and postoperatively using lateral standing films. Post-operative CT was performed at 1-43 months based on surgeon-specific protocols. Both pre and postoperative CT measurements were performed by two observers. The most recent postoperative patient reported outcome measures (PROMs) between 6 months and 2 years were used to compare against preoperative values. PROMs were collected in a prospectively maintained database. Paired tests were used to compare changes in CT measurements and PROMs. Bivariate analysis was also done to assess correlations between the changes in CT measures and PROMs improvement.

RESULTS:

40 patients (48 operative levels) were assessed. 16 (40%) of the subjects were female and 24 (60%) were male. The average age was 56.6 ± 15.9 years. The average length of follow-up was 17.9 ± 7.9 months for PROMs and 13.5 ± 9.3 months for postoperative CT imaging. There were 32 (80%) single-level and 8 (20%) two-level cases, with 23 (47.9%) operated at L4-L5 and 25 (52.1%) at L5-S1. Disc height, foraminal area, and central canal area all increased significantly (p<0.001). Mean disc height increased 50%, from 4.2mm to 6.3mm. Right sided foraminal area increased 23%, from 144.5mm² to 177.8mm², the left increased 21.4% from 142.8mm² to 173.4mm², and the central canal increased 16.4% from 228.6mm² to 266mm². Changes in sagittal alignment measures were not statistically significant. All PROMs except for SF12-MCS (p=0.439) showed a statistically significant improvement (p<0.05). There was no correlation between each change in PROM and the increase in cross sectional canal area.

DISCUSSION AND CONCLUSION:

MIS-TLIF provides a significant degree of indirect decompression. Disc height, foraminal area, and central canal area were all increased following insertion of the interbody cage via the MIS-TLIF technique. PROMs by 2 years demonstrated statistically significant improvement.

Demographic	Value
N of subjects	40
Age (years)	56.6 ± 15.9
BMI (kg/m ²)	27.4 ± 4.77
Female Gender	16 (40%)
Race	
White	29 (72.5%)
Black	3 (7.5%)
Asian	2 (5%)
Other	2 (5%)
Declined	4 (10%)
Ethnicity	
Not hispanic	32 (80%)
Hispanic	2 (5%)
Declined	6 (15%)
Insurance Type	
Commercial/Private	28 (70%)
Medicare	10 (25%)
Workers Compensation	2 (5%)
Former Smoker	12/27 (44.4%)
Current Smoker	1/38 (2.6%)
CCI Age	2.3 ± 2.1
ASA Class	
I	5 (12.5%)
II	35 (87.5%)
CT Follow-up Duration (months)	14.6 ± 8.1
PROMs Follow-up Duration (months)	17.9 ± 7.9

Statistics are summarized as mean ± SD or N(%). SD, Standard Deviation. BMI, Body Mass Index. CCI Age, Charlson Comorbidity Index Age Adjusted. ASA, American Society of Anesthesiologists. PROMs, patient reported outcome measures.

Characteristic	Value
N of Subjects	40
N of Levels	48
Number of Levels	
1-level	32 (80%)
2-level	8 (20%)
Operative Level	
L4L5	23 (47.9%)
L5S1	25 (52.1%)
Side of approach	
Right	21 (52.5%)
Left	17 (42.5%)
Bilateral	2 (5.0%)
Op time (min)	115.8 ± 73
EBL (mL)	59.5 ± 34.6
LOS (hours)	44.1 ± 24
Levels Fused	32/34 (94.1%)
Hospital Complications	5/40 (12.5%)
Urinary retention	2
Incisional edema	1
New onset pain	1
Anemia & Hyponatremia	1

Fusion assessed by Surgeon using 1-year CT. Statistics are summarized as mean ± SD or N(%). SD, Standard Deviation. Op, operative. EBL, estimated blood loss. LOS, length of stay.

Measure	Preoperative	Postoperative	p-value	Average Δ	Average % Change
Disc Area (mm ²)	238 ± 78	360 ± 81.9	<0.001	121 ± 23.0	50.9 (21.9)
Disc Height (mm)	4.2 ± 1.0	6.3 ± 1.1	<0.001	2.1 ± 0.1	48.4 (10.7)
Foraminal Area (R) (mm ²)	144.5 ± 34.3	177.8 ± 42.7	<0.001	33.3 ± 8.1	23.1 (16.0)
Foraminal Area (L) (mm ²)	142.8 ± 30.6	173.4 ± 38.1	<0.001	30.6 ± 27.7	21.4 (15.0)
Foraminal Area (operative side) (mm ²)	140.8 ± 38.1	168.8 ± 41.7	<0.001	28.0 ± 38.5	19.9 (14.1)
Foraminal Area (contralateral side) (mm ²)	146.9 ± 32.7	170.7 ± 40.3	<0.001	23.8 ± 21.4	16.2 (11.0)
Peak Incidence (°)	27.4 ± 11.1	26.8 ± 11.4	0.274	-0.6 ± 2.2	-
Latent Lordosis (°)	39.0 ± 11.0	32.0 ± 10.2	0.218	-7.0 ± 6.2	-
Inclined Lordosis (°)	20 ± 6.3	20 ± 6.2	0.589	0 ± 4.4	-
P-tilt (°)	27 ± 6.8	27 ± 6.2	0.113	-0.6 ± 4.8	-

Paired t-test. *SD. P-values reported for paired t-test comparing pre- and postoperative values. Bold values indicate statistical significance. SD, Standard Deviation. R, right; L, left; operative side, the side of the approach; contralateral side, the opposite side of the approach.

PROM	Preoperative	Postoperative	p-value	Average Δ	MCID achieved
ODI	34.5 ± 18.2	21.8 ± 16	<0.001	-12.7 ± 16.7	17/32 (53.1%)
VAS Back	4.8 ± 2.5	3.2 ± 2.5	0.007	-1.6 ± 3	16/28 (57.1%)
VAS Leg	4.1 ± 2.1	1.9 ± 2.3	<0.001	-2.3 ± 3.1	15/21 (71.4%)
SF-12 PCS	35.5 ± 11.3	40.9 ± 10.4	0.017	5.4 ± 12.4	18/33 (54.5%)
SF-12 MCS	49.9 ± 11.4	51.7 ± 10.4	0.439	1.8 ± 13.2	13/33 (39.4%)
PROMIS PF	38.4 ± 5.5	43.5 ± 7.5	0.003	5.1 ± 8.7	19/31 (61.3%)

Reported as mean ± SD. Bold values indicate statistical significance (p<0.05). MCID, Minimal Clinically Important Difference. VAS, Visual Analog Scale. SF-12 PCS, Short Form 12 Physical Component Score. SF-12 MCS, Short Form 12 Mental Component Score. PROMIS PF, Patient Reported Outcome Measurement Inventory System Physical Function.