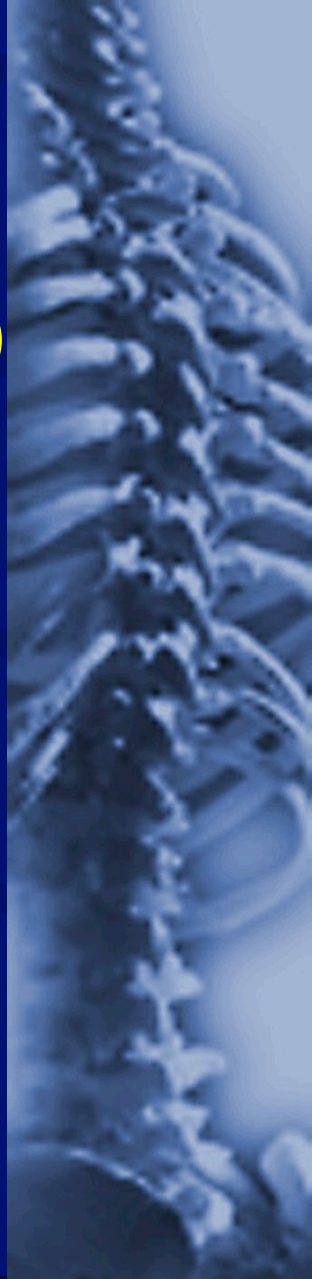


MIS FUSION FOR SYMPTOMATIC DDD

Richard G. Fessler, MD, PhD



Rush University Medical Center, Chicago IL



What is “BETTER”?

- Neurologic improvement?
- Improved VAS, Oswestry, SF-36?
- Less destruction of normal tissue?
- Less operative pain?
- Faster/easier procedure?
- Less EBL?
- Less physiologic stress?
- Shorter ICU and LOS?
- Faster RTW?
- Fewer complications?
- Lower infection rate?
- Less expensive?



Minimally Invasive Transforaminal Lumbar Interbody Fusion: A Perspective on Current Evidence and Clinical Knowledge

Ali Habib, Zachary A. Smith, Cort D. Lawton, and Richard G. Fessler

Department of Neurological Surgery, Northwestern University, Suite 2210, 676 N. St. Clair Street, Chicago, IL, 60611, USA

Minimally Invasive Surgery
Volume 2012, Article ID 657342, 9 pages
doi:10.1155/2012/657342

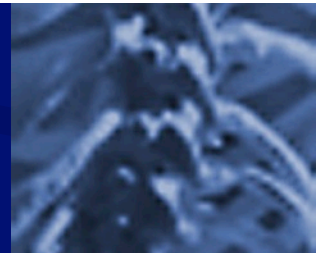
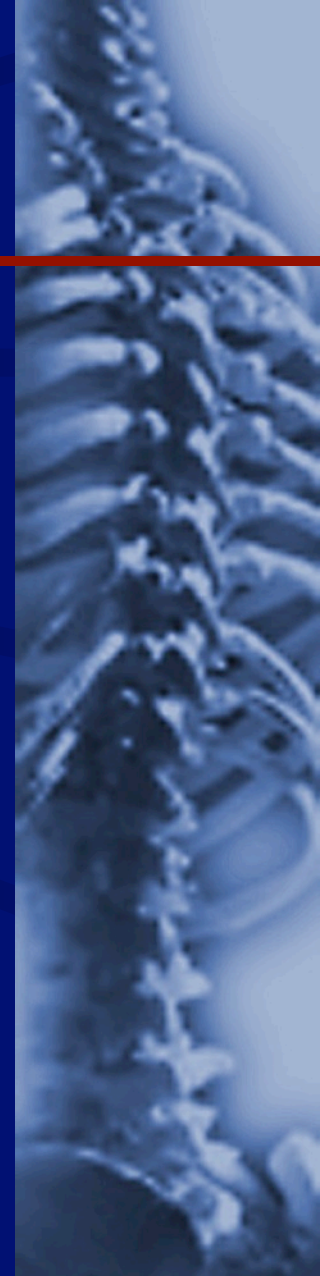


TABLE 2: Comparative studies basic data.

Author	Mean duration of surgery MIS	Mean duration of surgery open	MIS blood loss	Open blood loss	Length of stay MIS	Length of stay open
Villavicencio et al.	222.5	214.9	163 mL	366.8	3	4.2
Shunwu et al.	159.2	142.8	399.8	517	9.3	12.5
Wang et al.	156 (X-ray 84)	145 (37)	264	673	10.6	14.6
Peng et al.	216.4 (fluoro 105.5 s)	170 (35.2)	150	681	4	6.7
Schizas et al.	348 (X-ray 2.7 cGy/cm ²)	312 (1.8)	456	961	6.1	8.2
Dhall et al.	199	237	194	505	3	5.5
Isaacs et al.	300	276	226	1147	3.4	5.1

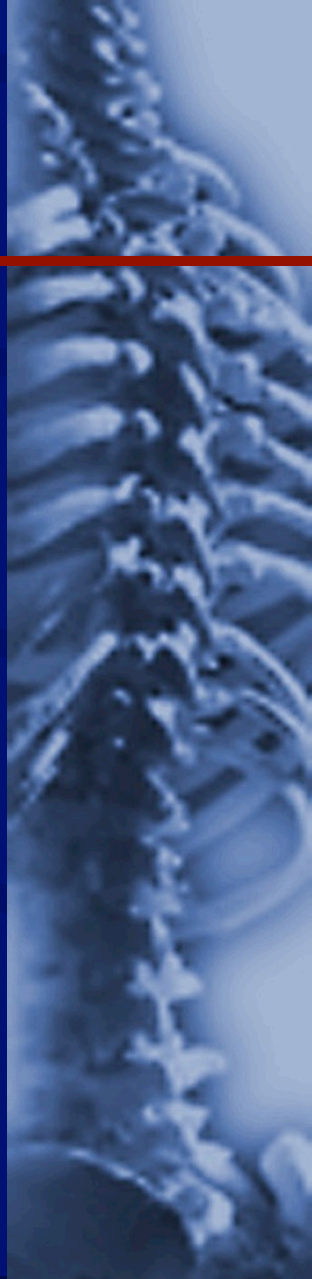
TABLE 4: Complication rate by TLIF approach.

Complications	MI	Open
Infection	6.9%	23.5%
UTI	3.4%	11.8%
Neurologic deficits	20.7%	11.8%
Screw/Cage complications	44.8%	11.8%
CSF leak	10.3%	5.9%
Blood transfusion/coagulation	3.4%	11.8%
Other	10.5%	23.4%

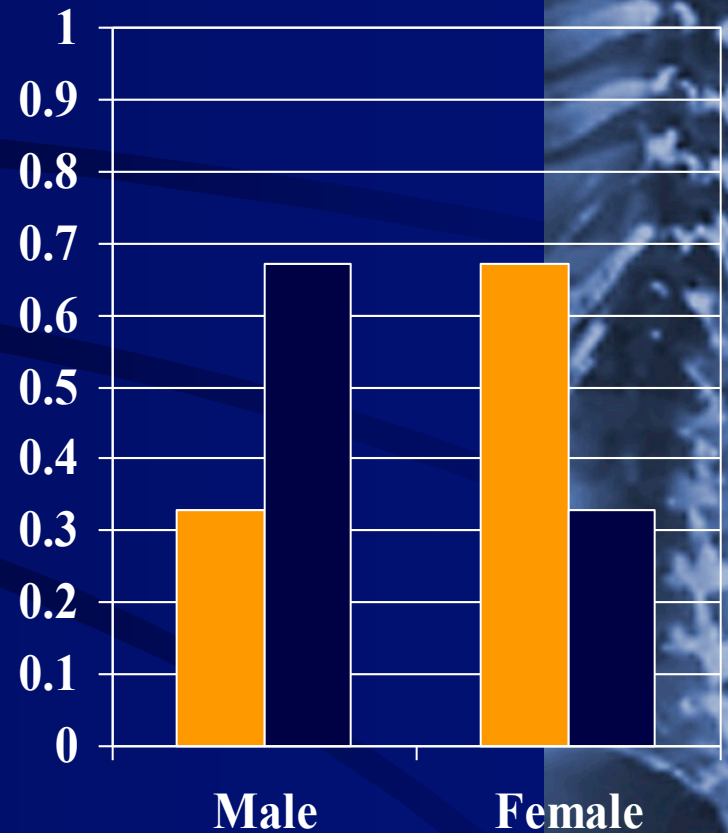
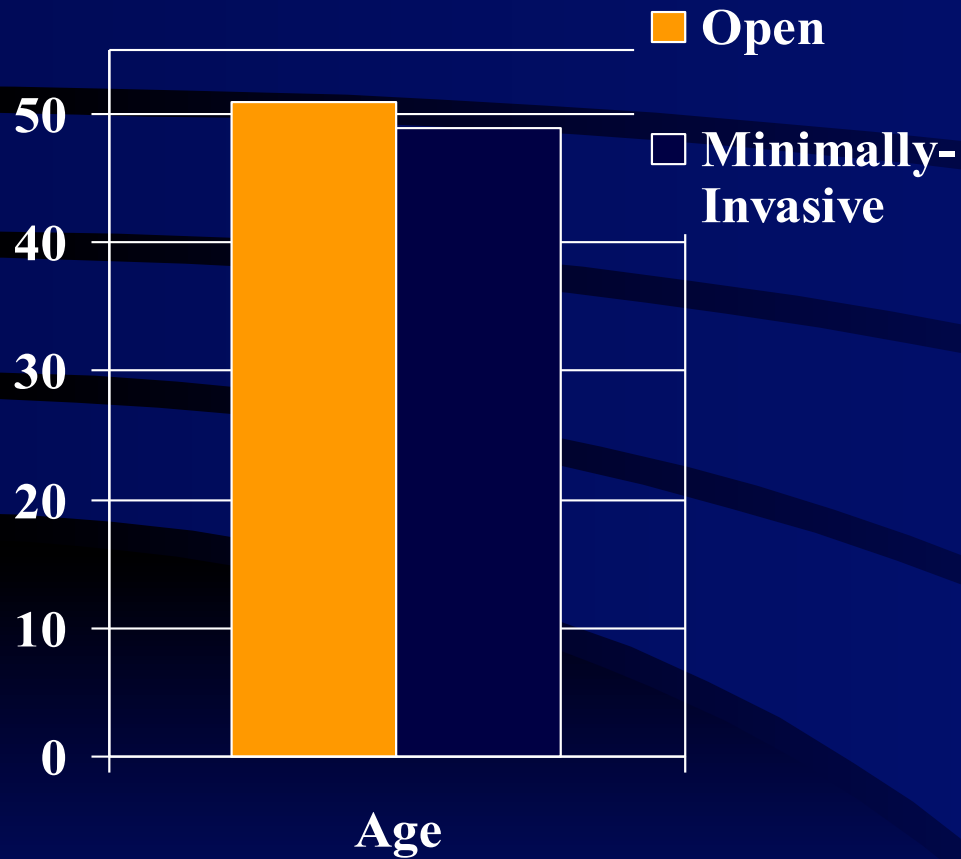


Endoscopic TLIF and Percutaneous Pedicle Screw Instrumentation

Khoo,L.T., Palmer,S., Laich,D.T., Fessler,R.G.: Minimally Invasive Percutaneous Posterior Lumbar Interbody Fusion. Neurosurgery 51(5, Supplement), 166-181, 2002.



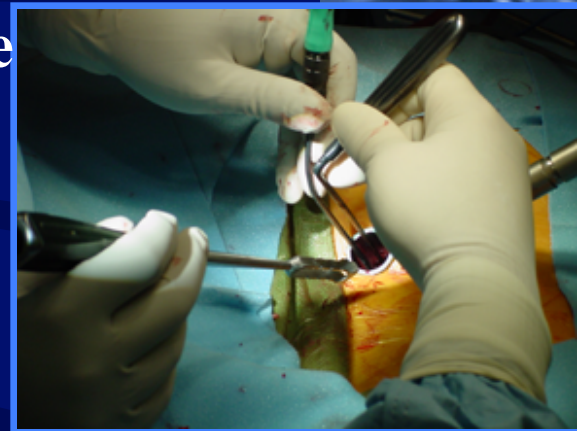
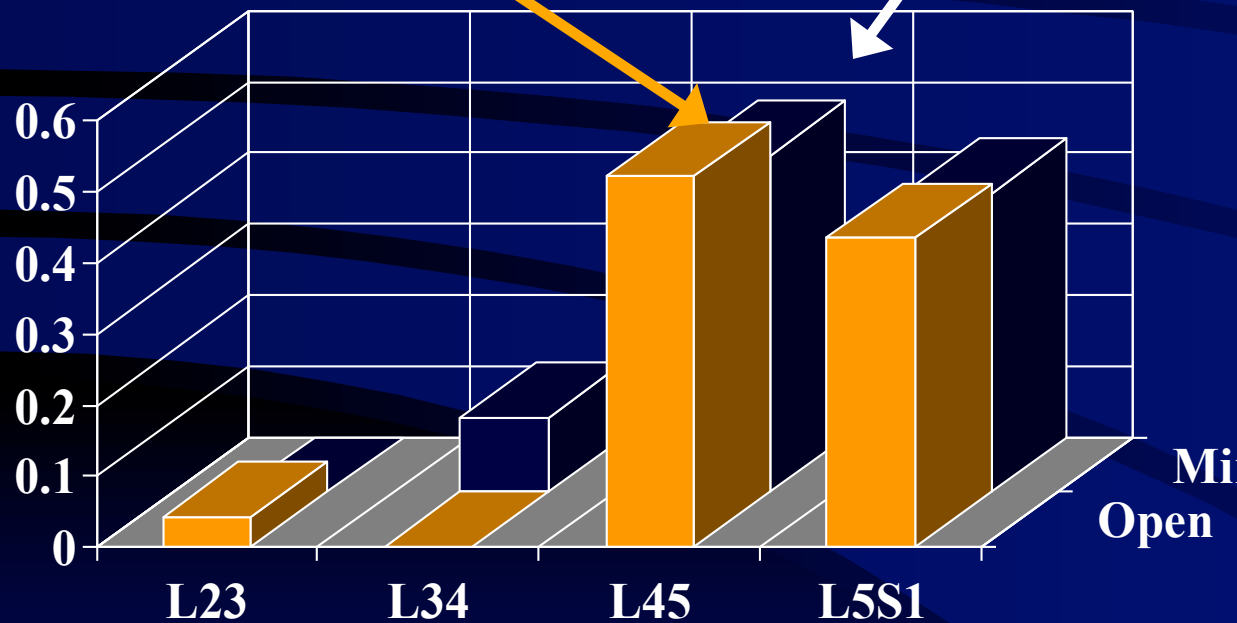
Demographics



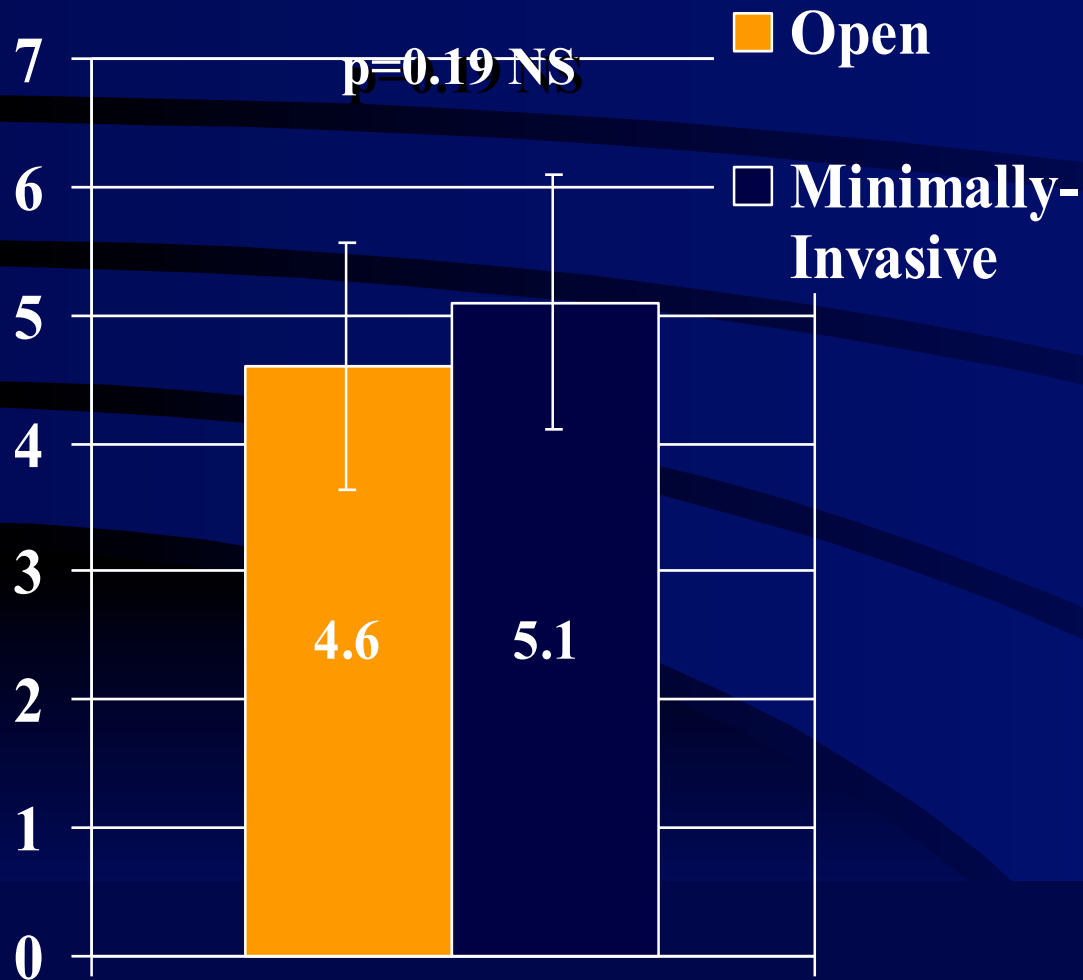
Level of Surgery

Open

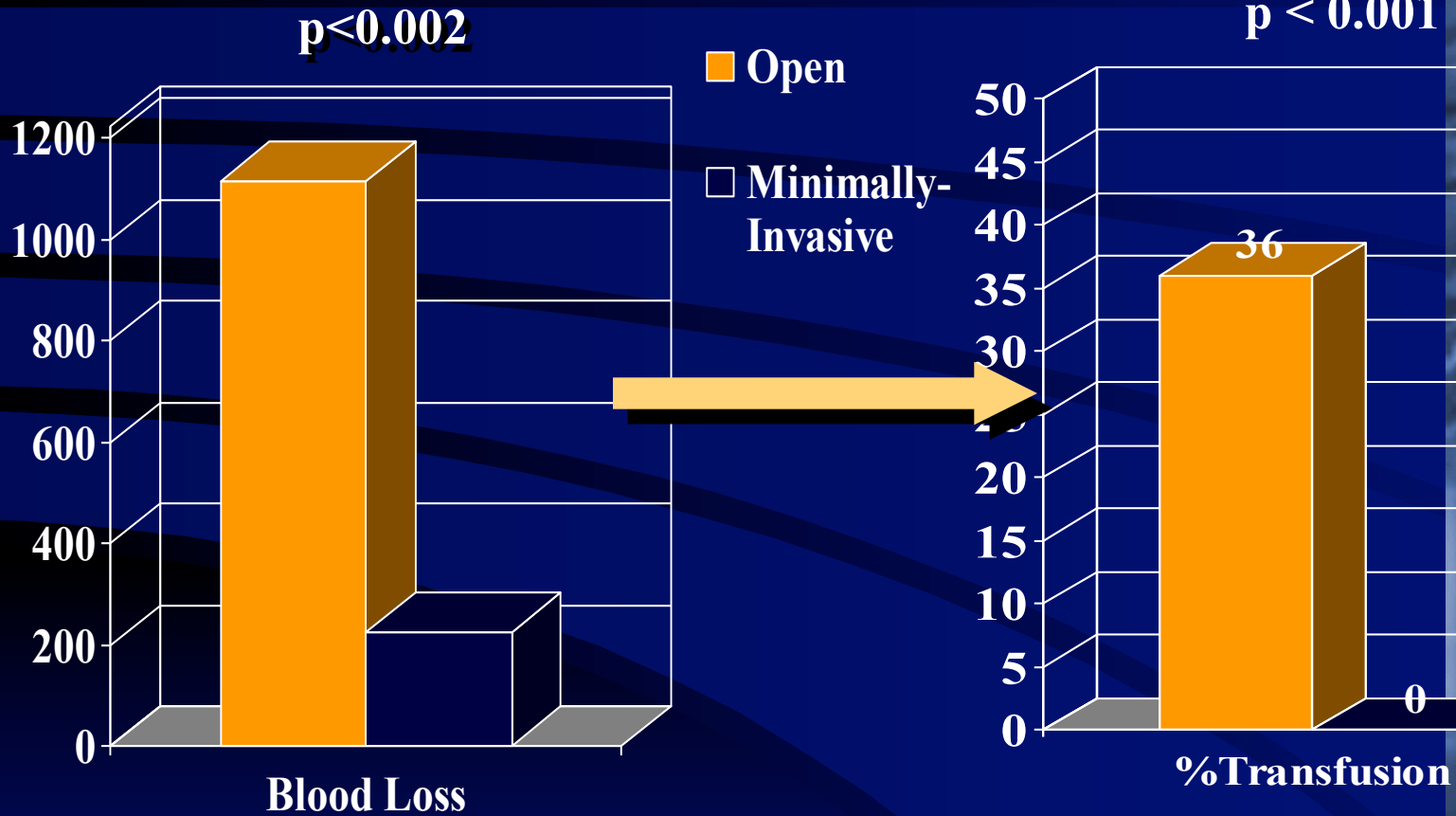
Minimally-Invasive



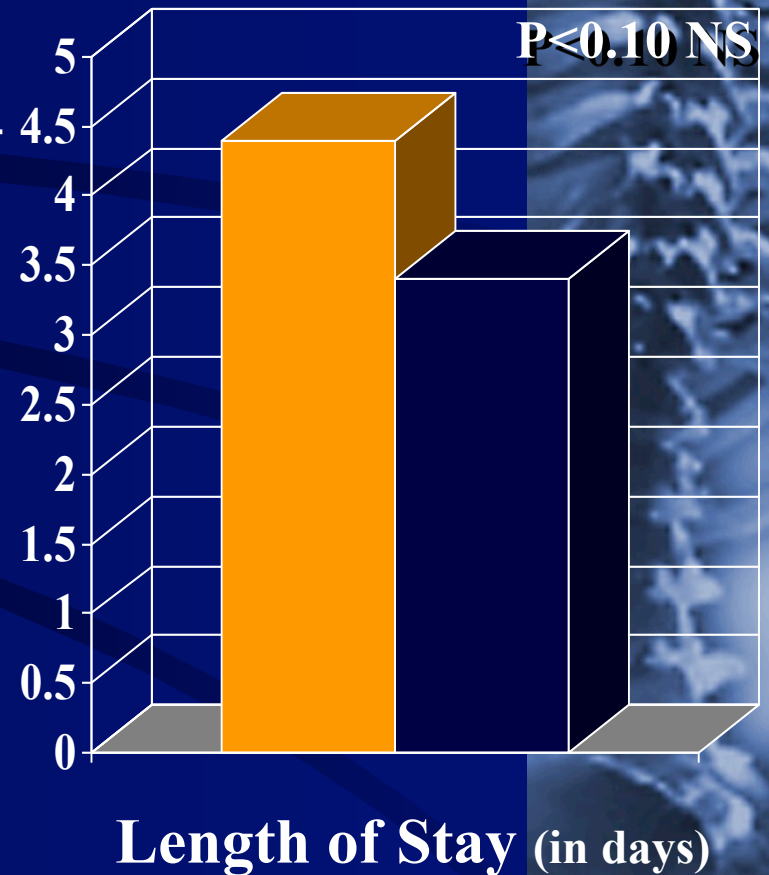
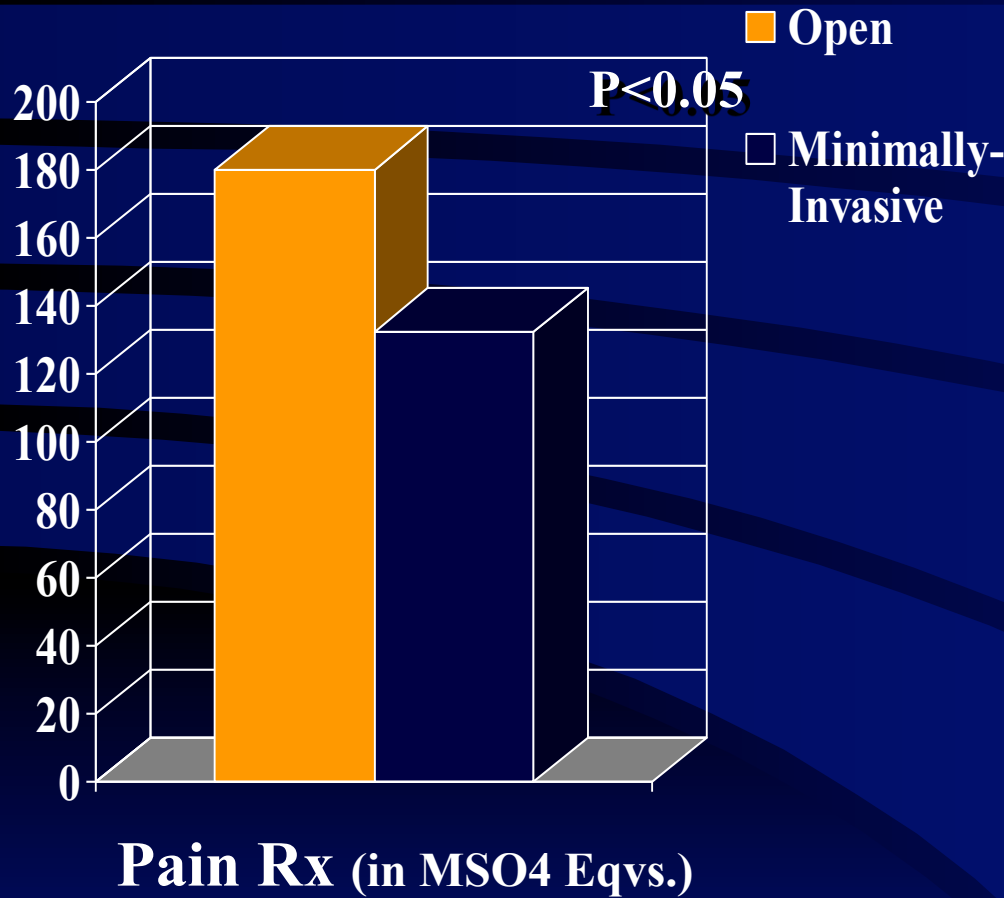
Operative Data



Operative Data



Hospital Data



Complications

Minimally-Invasive

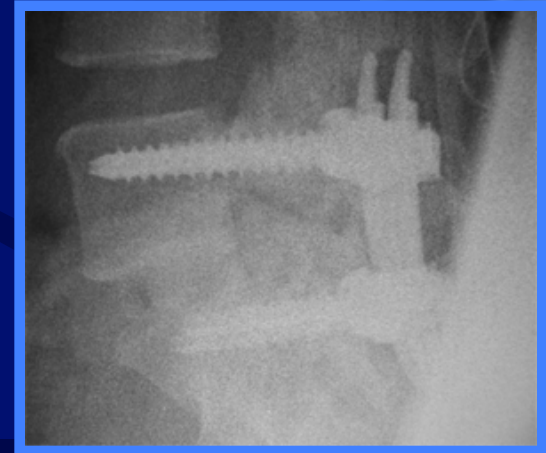
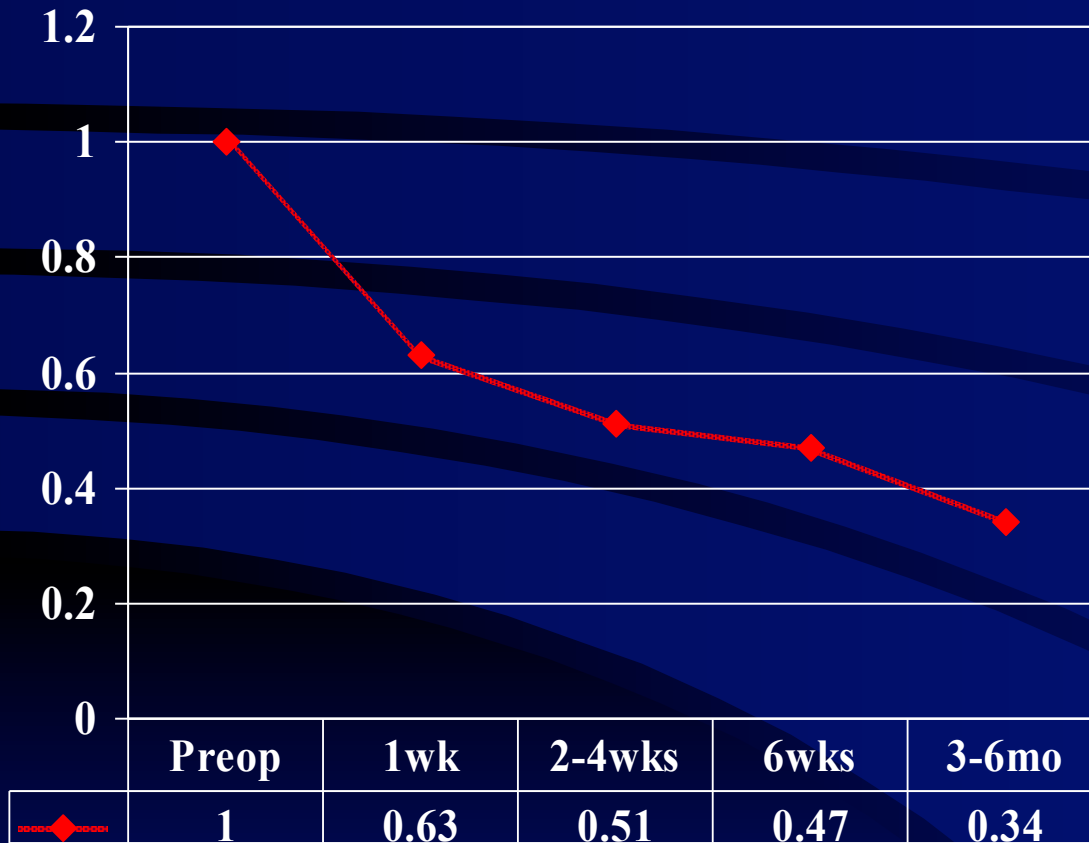
- No CSF leaks
- No infections
- No medial breaches of the pedicle
- No neurological injuries related to the procedure
- No positioning-related complications
- No hardware failures

Open PLIF

- 1 CSF leak
- No infections
- No medial breaches of the pedicle
- No neurological injuries related to the procedure
- 1 positioning-related complication
- No hardware failures

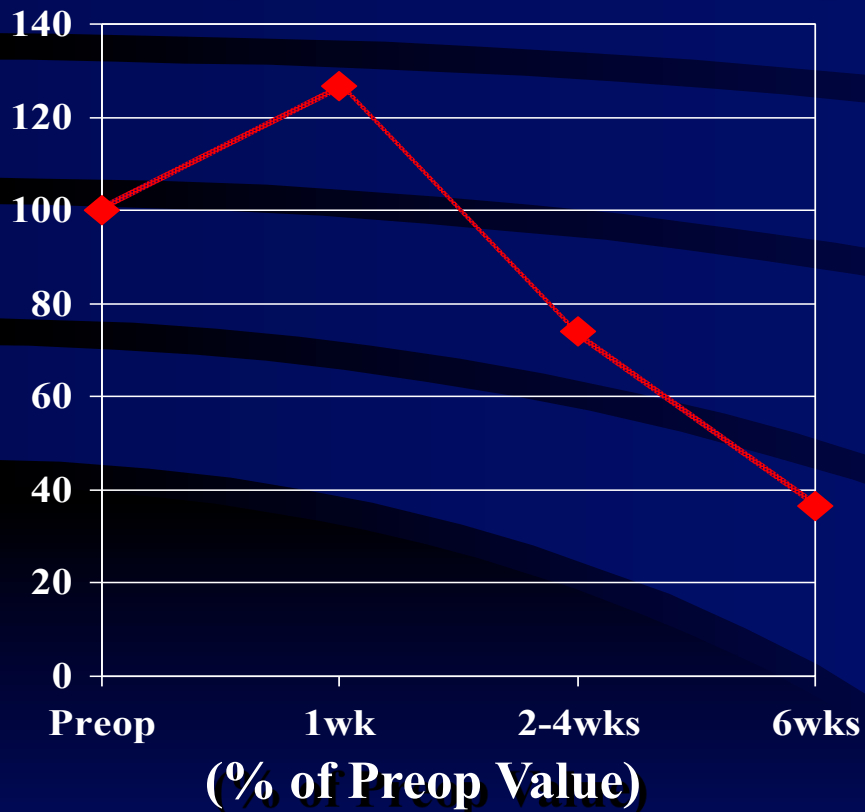


“Worst” Pain (% of Preop Value-VAS)

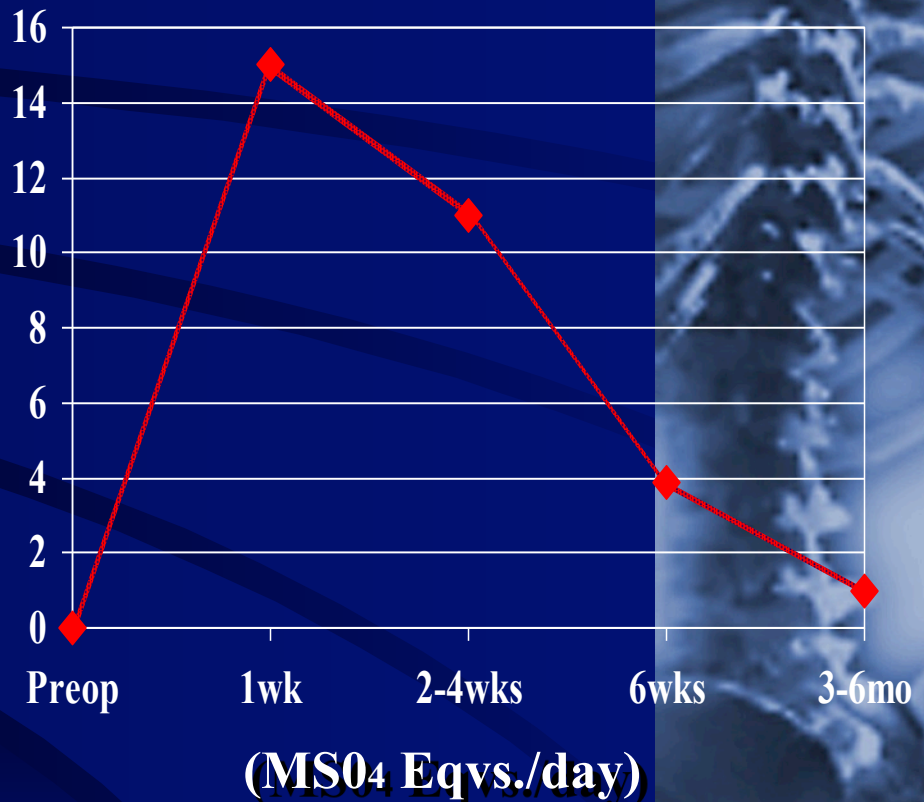


Narcotic Intake

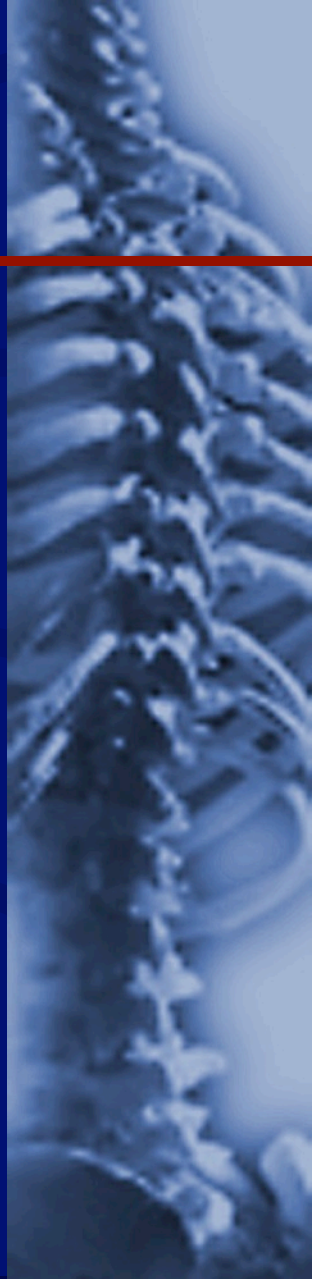
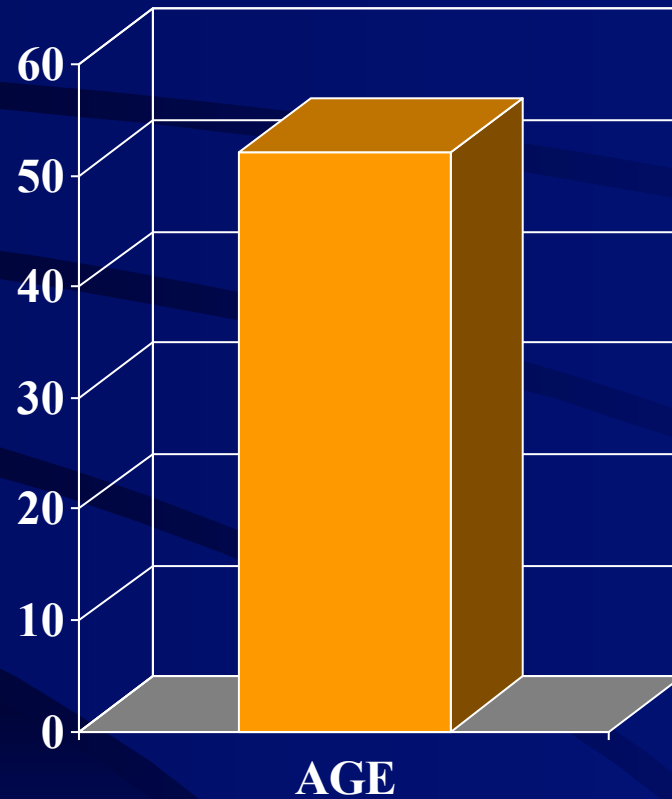
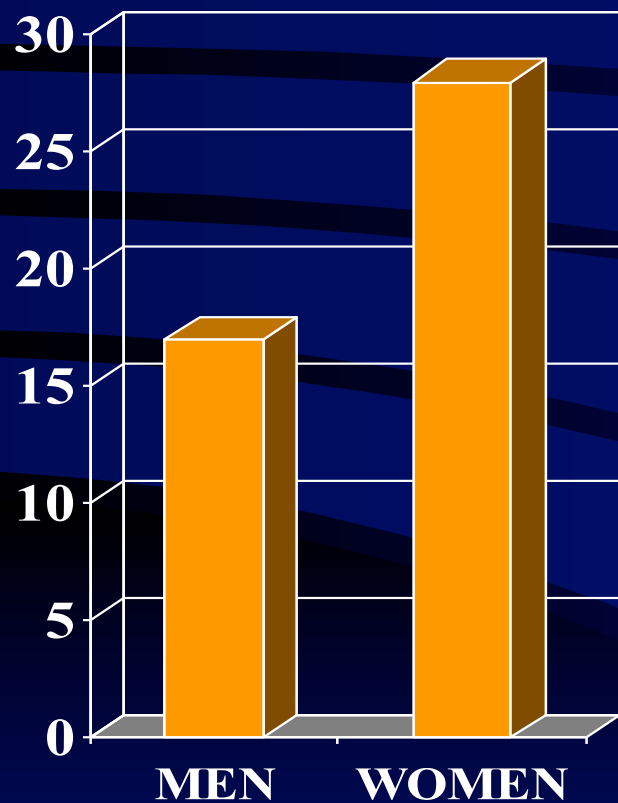
On Long-term Narcotics Preop



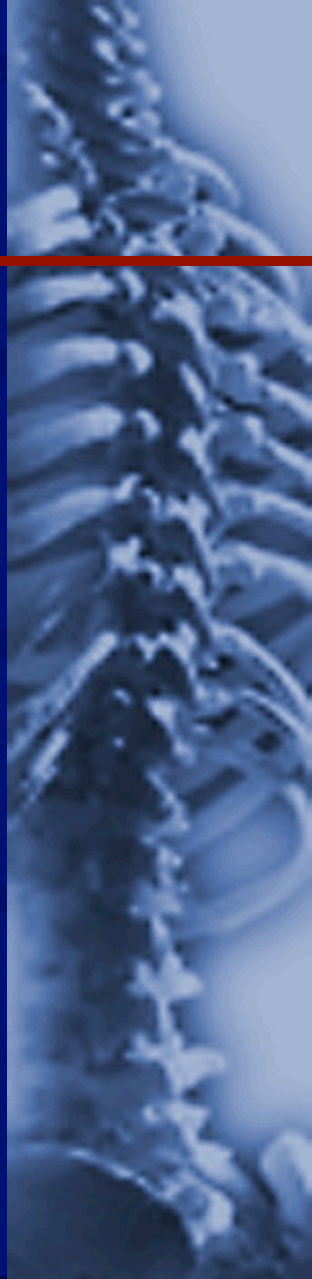
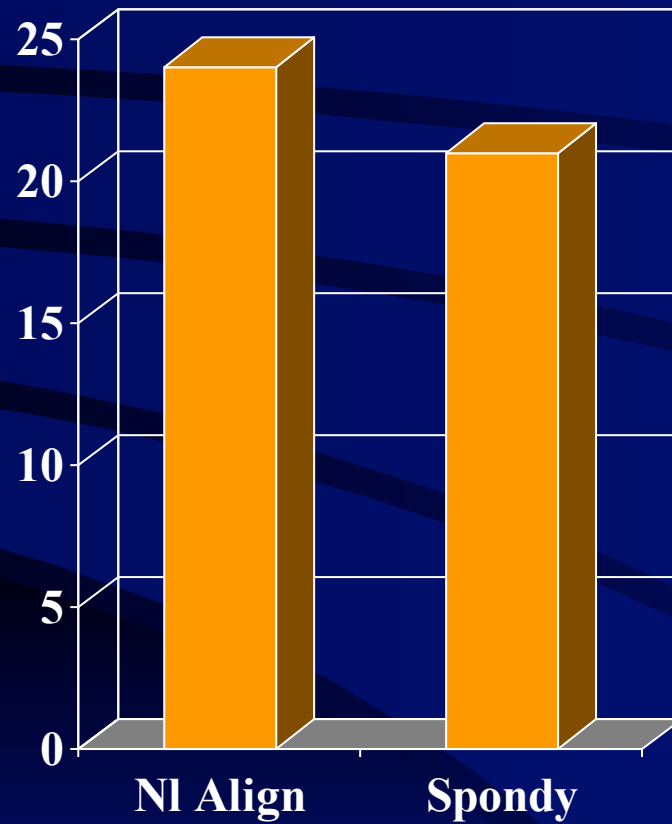
Without Narcotics Preop



LONG TERM FOLLOW-UP

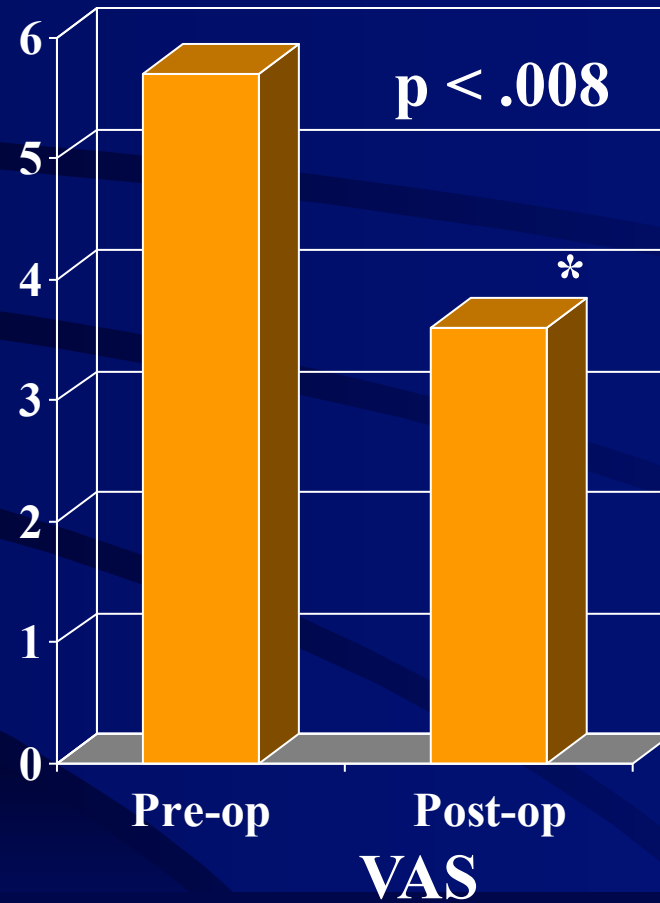


SPONDYLOLISTHESIS

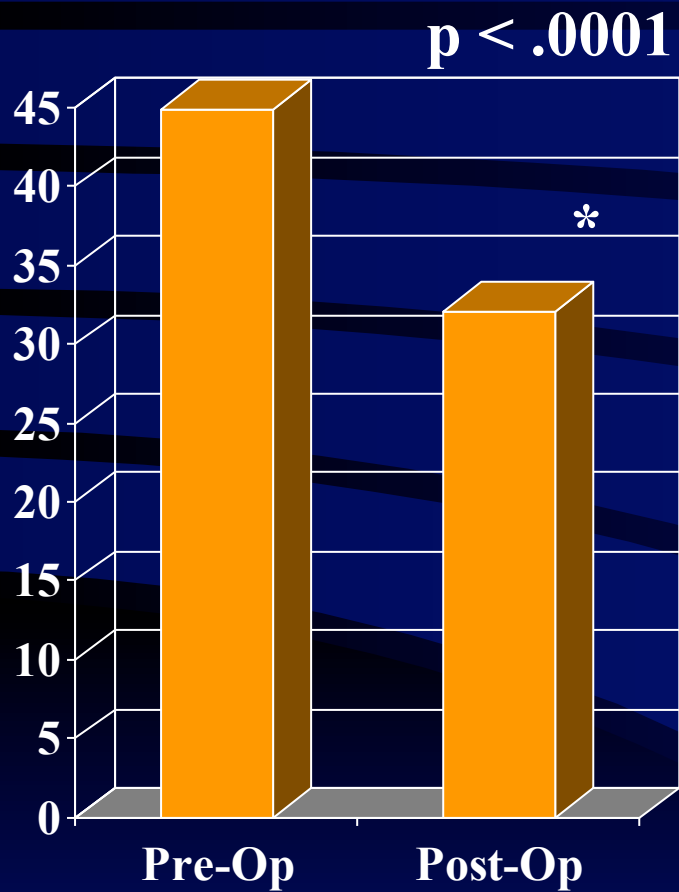


RESULTS

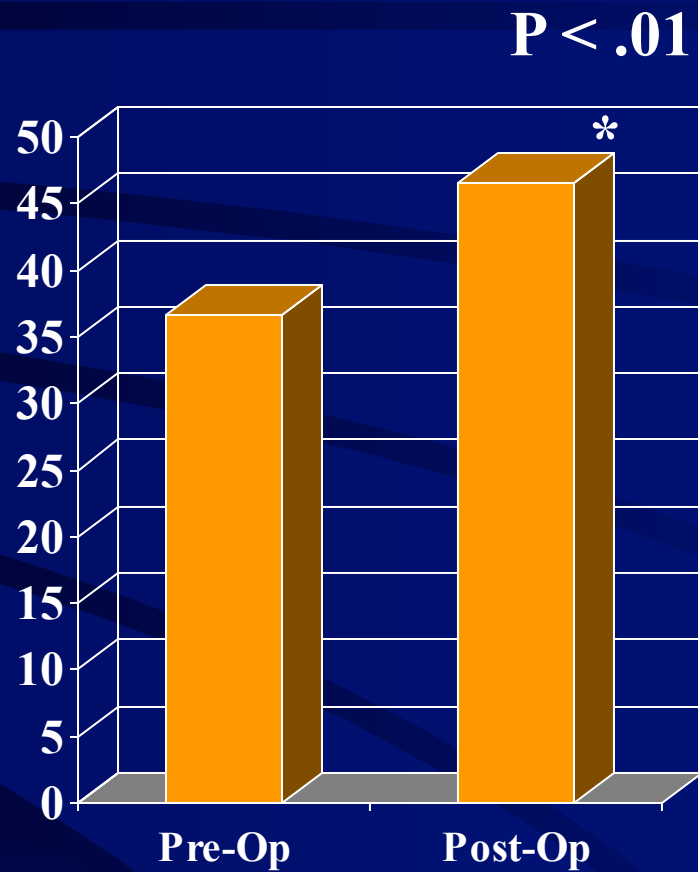
- Fusion rate: 98 %



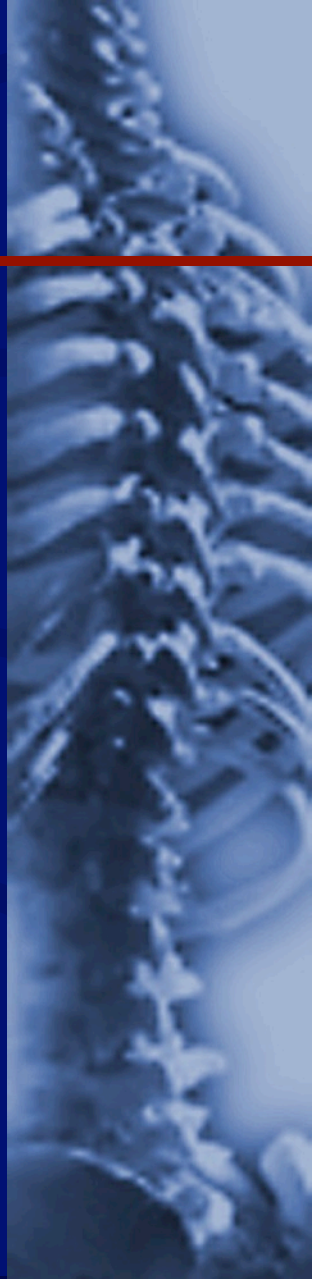
RESULTS



Oswestry

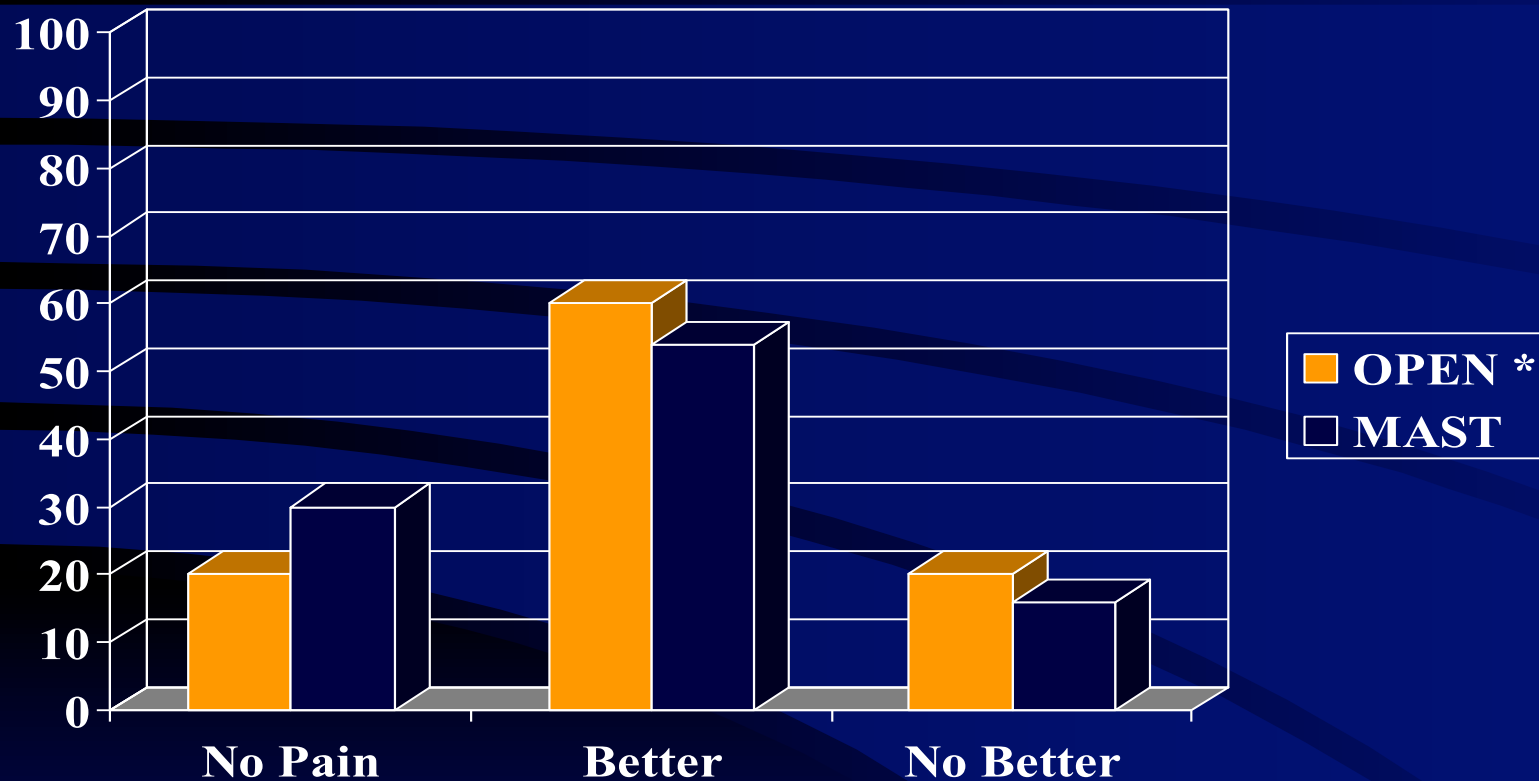
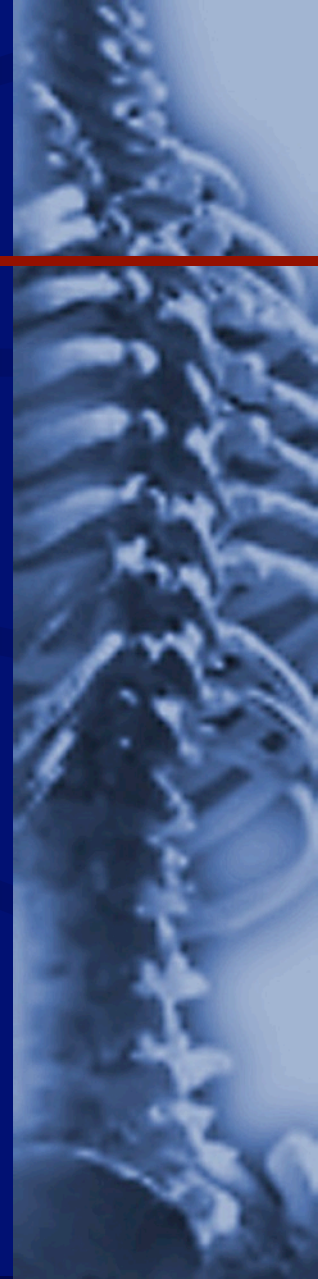


SF-36



LONG TERM RESULTS

BACK PAIN

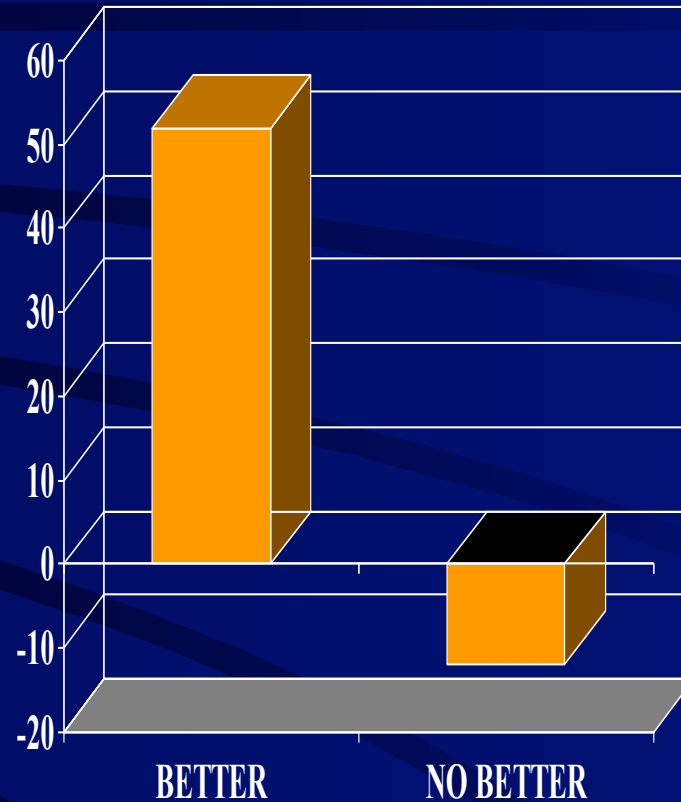
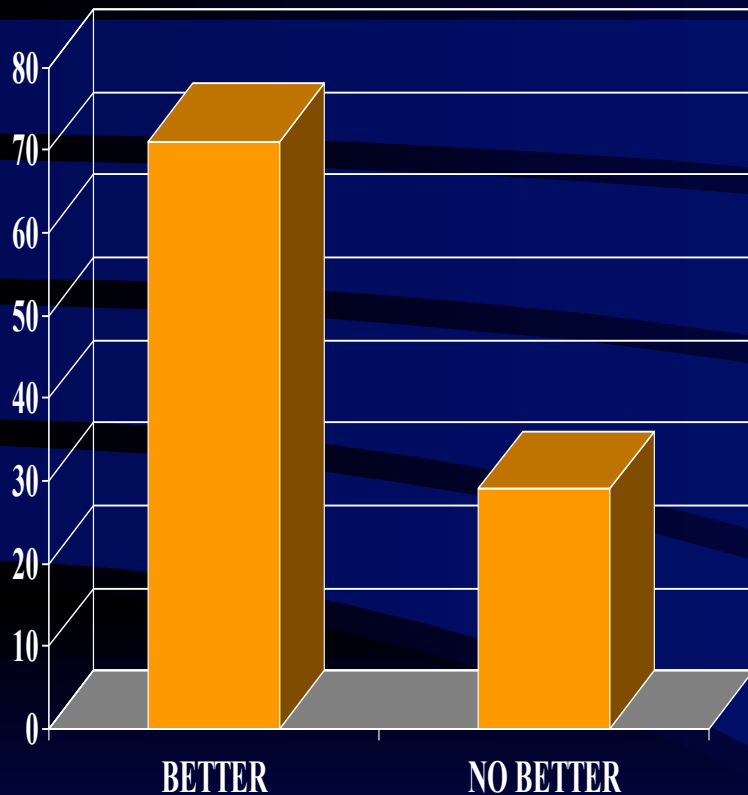


VAS

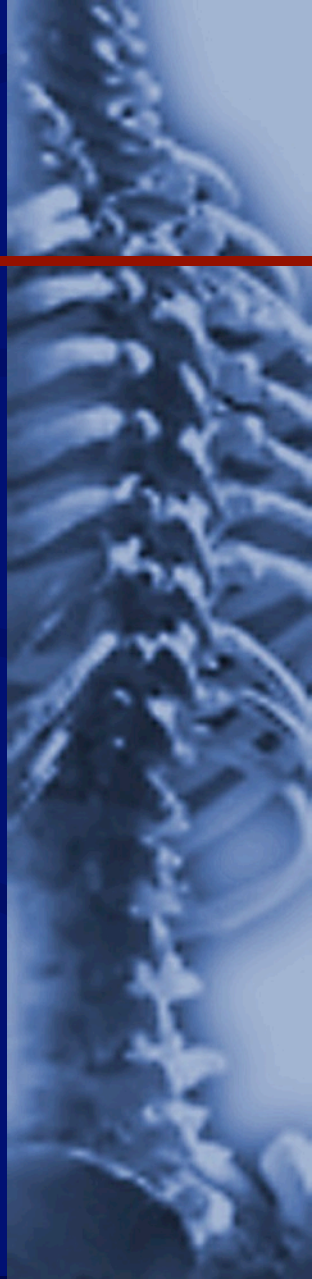
* Dickman, Fessler, MacMillan, Haid,
JNSG 1992

LONG TERM RESULTS

BACK PAIN

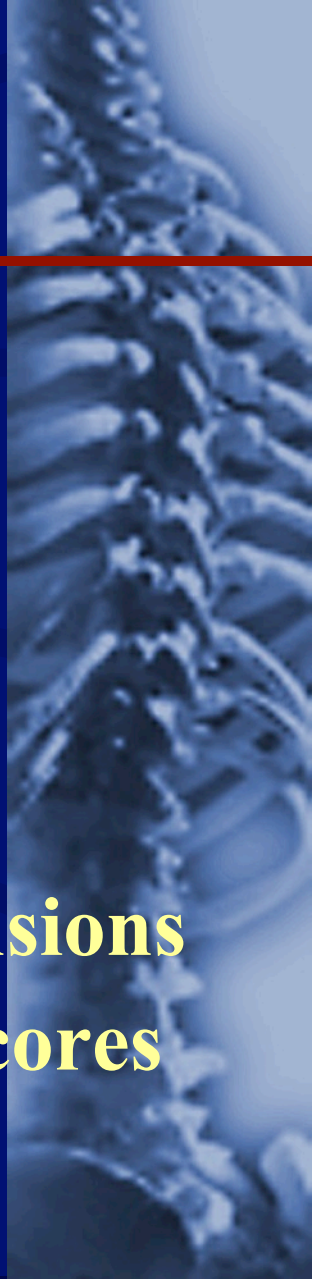


OSWESTRY



One year follow up

- **Two prospectively followed cohorts**
- **Non-randomized**
- **Two institutions**
 - **PLIF Saint John, NB, Canada**
 - **mTLIF Chicago, IL, USA**
- **Patients requiring lumbar interbody fusions**
- **All patients followed using VAS pain scores and Oswestry Disability Index**
- **Radiographic determination of fusion**



Results

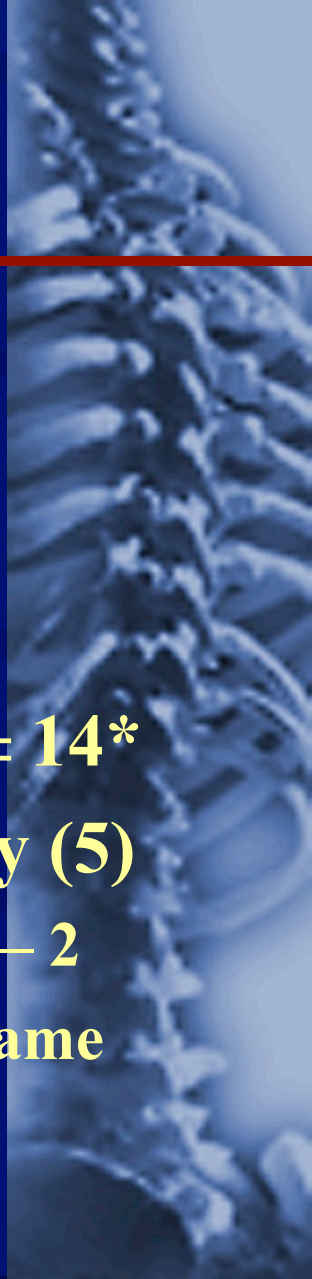
PLIF

- 31 patients
- 14 female (n.s.)
- Mean age = 42 ± 11
- Previous surgery (4)
 - Disc same level – 2
 - Adjacent anterior fusion – 1
 - Distant posterior fusion – 1

TLIF

- 29 patients
- 19 female
- Mean age = $54 \pm 14^*$
- Previous surgery (5)
 - Disc same level – 2
 - Laminectomy same level – 3

* $p < 0.05$



Results

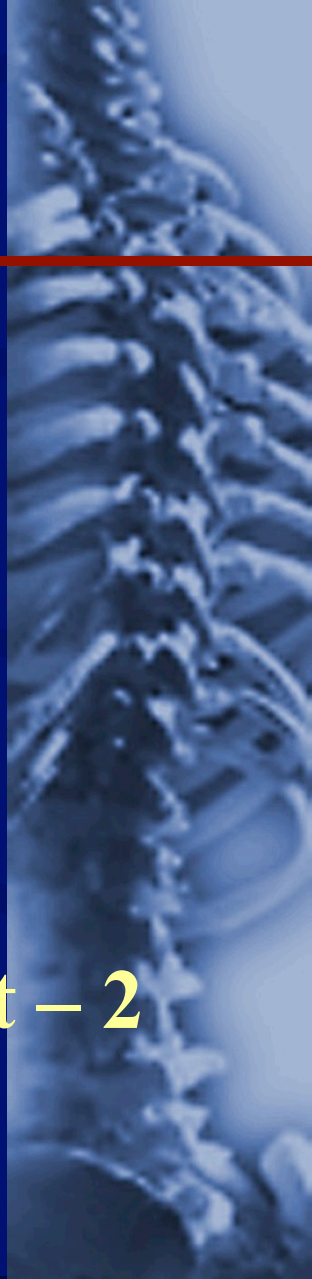
Complications

Open

- **CSF leak – 2**
- **Ileus – 3**
- **Footdrop – 2**
- **Infection – 1**

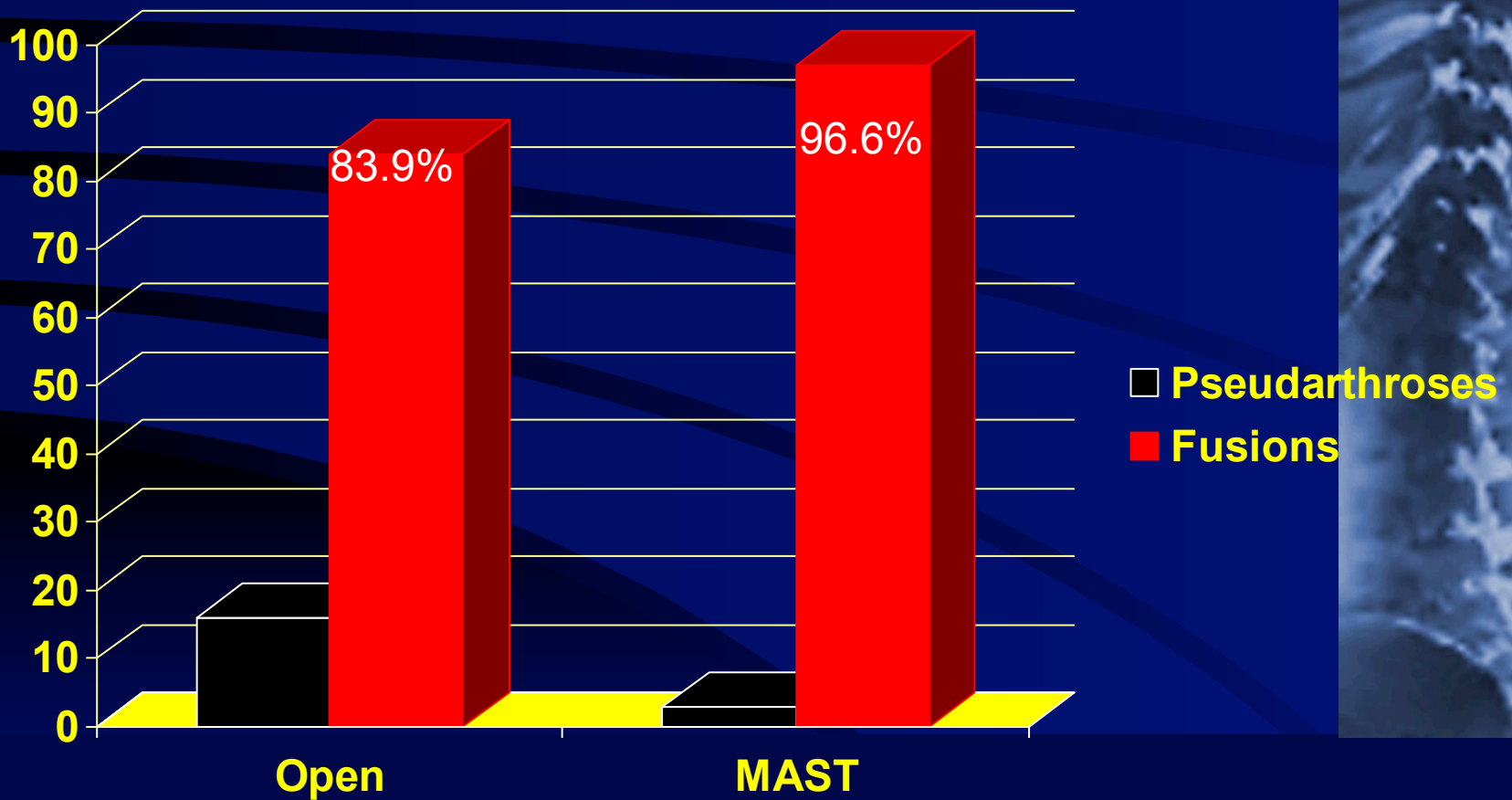
MAST

- **CSF leak – 3**
- **Migration of interbody graft – 2**
 - **Both cases Boomerang**
- **DVT – 1**



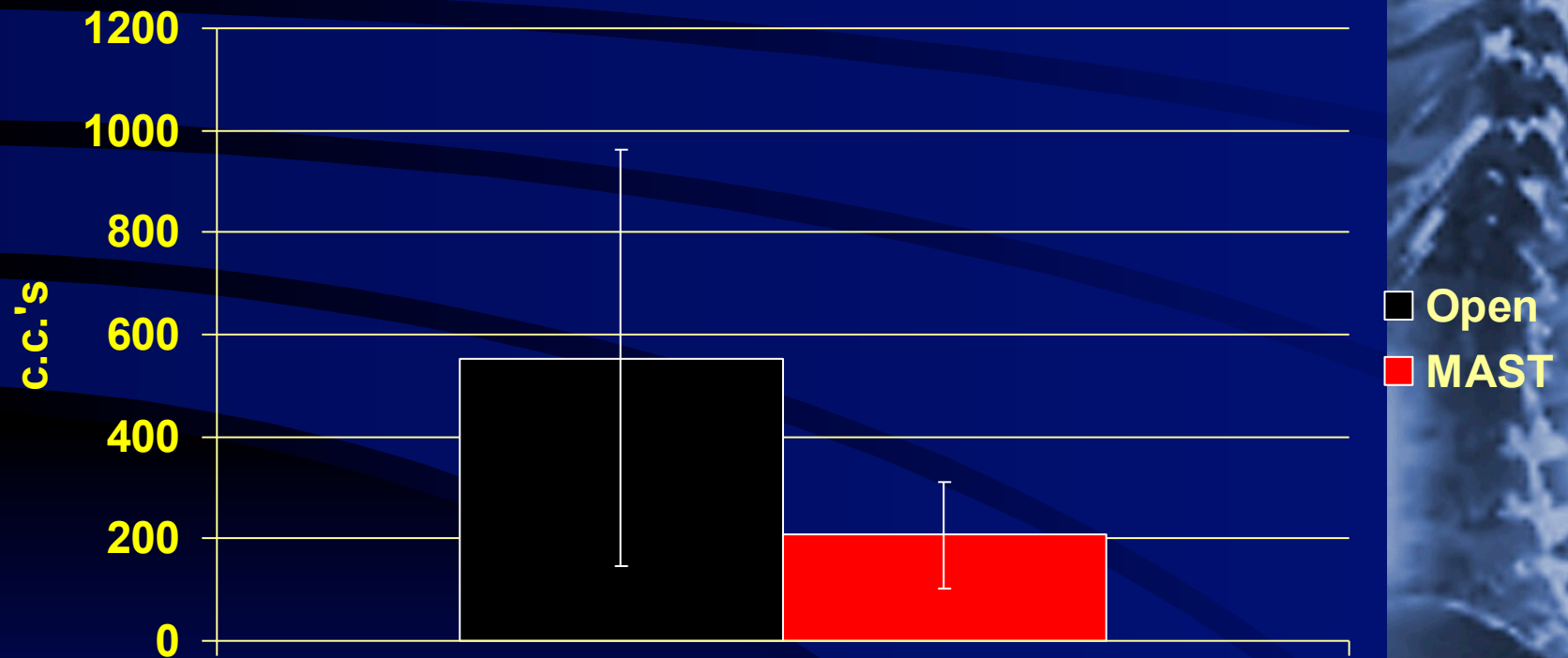
Results

$p = 0.068$



Results

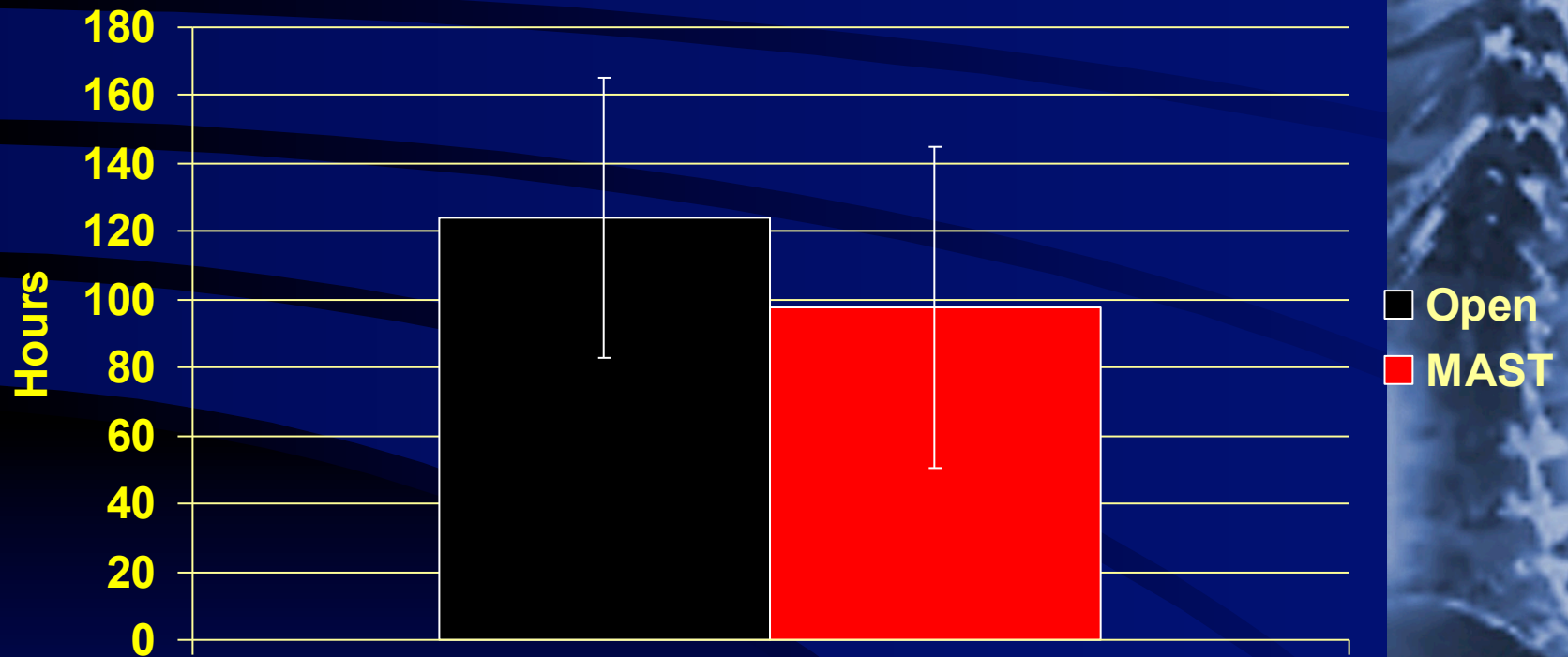
Mean Estimated Blood Loss



$p < 0.0001$

Results

Mean Hospital Stay



$p < 0.027$

The Quantitative Analysis of Tissue Injury Markers After Mini-Open Lumbar Fusion

Ki-Tack Kim, MD,* Sang-Hun Lee, MD,† Kyung-Soo Suk, MD,* and Sung-Chul Bae, MD*

STRESS RESPONSE

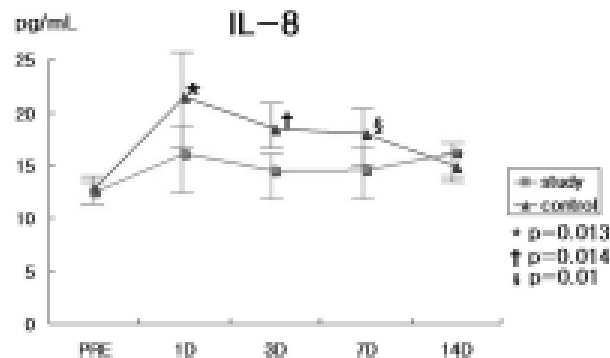


Figure 4. Serum IL-8 concentrations. The study group shows significant lower level than the control group on postoperative 1 day ($P = 0.013$), 3 days ($P = 0.014$), and 7 days ($P = 0.01$). There was no sharp increase on postoperative 1 day than other cytokines.

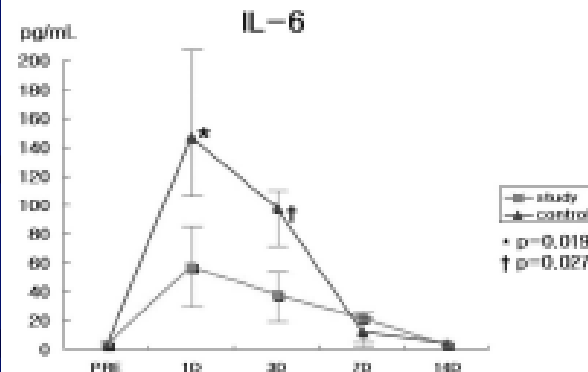


Figure 3. Serum IL-6 concentrations for the study group were significant lower than the control group on postoperative 1 day ($P = 0.019$) and 3 days ($P = 0.027$) after surgery.

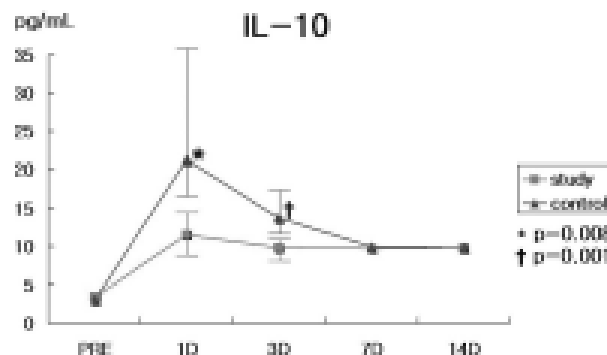


Figure 5. The mean serum IL-10 concentration for the study group was significantly lower than the control group, on postoperative 1 day ($P = 0.008$) and 3 days ($P = 0.001$).

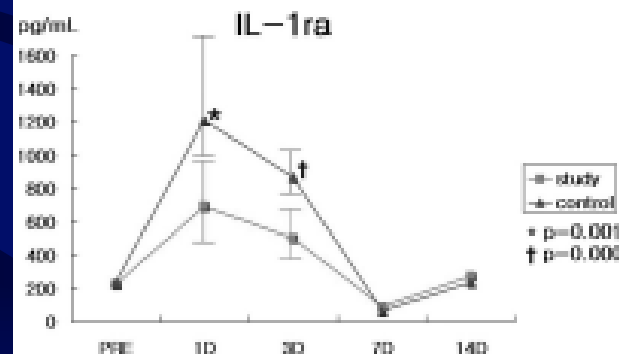


Figure 6. The mean serum IL-1ra concentration for the study group was significantly lower than the control group, on postoperative 1 day ($P = 0.001$) and 3 days ($P = 0.000$).

Comparison of Minimally Invasive and Conventional Open Posterolateral Lumbar Fusion Using Magnetic Resonance Imaging and Retraction Pressure Studies

Kathryn J. Stevens, MD, David B. Spenciner, MS,† Karen L. Griffiths, MB, BCh,*
Kee D. Kim, MD,‡ Marike Zwienenberg-Lee, MD,‡ Todd Alamin, MD,§ and
Roland Bammer, PhD**

(J Spinal Disord Tech 2006;19:77–86)

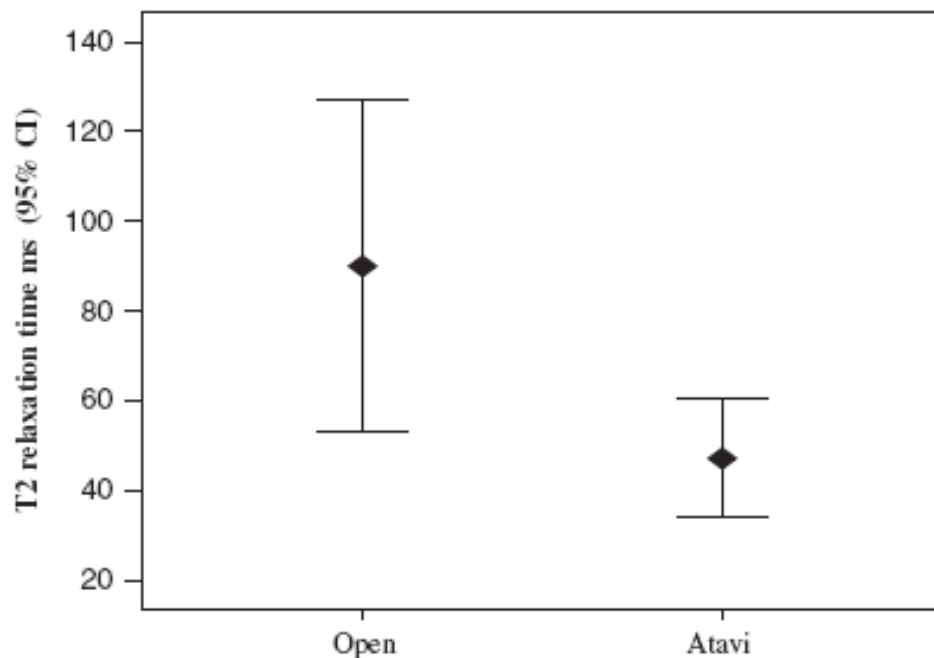


FIGURE 8. Comparison of mean T2 relaxation times at level of fusion.

■ Key Points

- The present study, which was based on the authors' initial experience of minimally invasive PLIF, could confirm the favorable results in the aspects of less blood loss, less transfusion need, less postoperative back pain, quicker recovery, and shorter hospital stay.
- It also showed the similar surgical efficacy of minimally invasive approach with that of traditional open technique.
- Minimally invasive technique for PLIF needs more surgical time and attention to lower the risk of technical complications.
- Further long-term, prospective studies involving a larger study group are needed to determine the benefits of this minimally invasive percutaneous procedure.

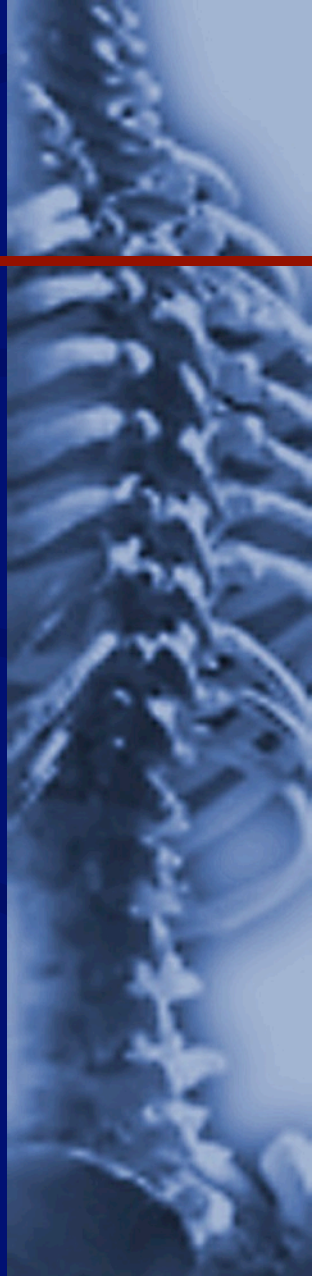


Table 2. Perioperative Parameters of the Cases

	PPF Group (N = 8)	OPF Group (N = 11)	P
Operative time (min)	260 (225–320)	258.6 (165–390)	NS
Estimated blood loss (mL)	261.3 (150–380)	769.1 (450–1300)	<0.0001
Hospital stay (days)	8 (5–14)	9.2 (7–12)	NS
Analgesic injection (no.)/day	1.8 (0.9–3.8)	1.9 (0.3–3.6)	NS

Values are mean (range) and statistical significance.
NS = not significant (Mann-Whitney U test).

Table 5. Duration of Postoperative Oral Nonopioid Analgesic Medication

	PPF Group	OPF Group
Unnecessary	5 (62.5)	1 (9.1)
1–3 months	3 (37.5)	7 (63.6)
3–6 months	—	2 (18.2)
>12 months	—	1 (9.1)

Values in parentheses are percentages.
PPF = percutaneous pedicle screw fixation; OPF = open pedicle screw fixation.

Table 3. Outcome of the Cases

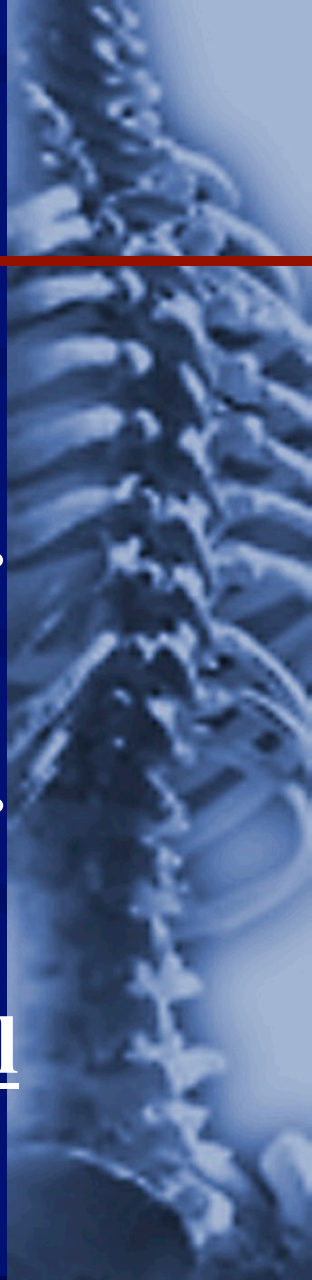
	PPF Group			OPF Group		
	Preoperative	Follow-up	P	Preoperative	Follow-up	P
VAS of LBP	6.9 (4–10)	4.3 (1–8)	0.058	8.6 (5–10)	5.0 (1–10)	0.011
VAS of leg pain	9.1 (6–10)	4.0 (1–9)	0.018	8.3 (0–10)	4.2 (0–10)	0.016
JOA score	NA	22.9 (19–28)		NA	21.7 (14–27)	

Values are mean (range) and statistical significance.

VAS = visual analog scale; LBP = low back pain; JOA = Japanese Orthopedic Association; NA = not available.

EFFECT OF RETRACTION

- **Denervation and muscle atrophy**
 - Sihvonen et al Spine 18:575-581, 1993.
 - Weiner et al Spine 24:2268-72, 1999.
 - Epstein in Youmans 2004, pp 4521-39.
- **Failed low back surgery**
 - See and Kraft Arch Phys Med Rehabil 56:80-3, 1975.



Comparison of Multifidus Muscle Atrophy and Trunk Extension Muscle Strength

Percutaneous *Versus* Open Pedicle Screw Fixation

Dong-Yun Kim, MD,* Sang-Ho Lee, MD, PhD,* Sang Ki Chung, MD,†
Ho-Yeon Lee, MD, PhD*

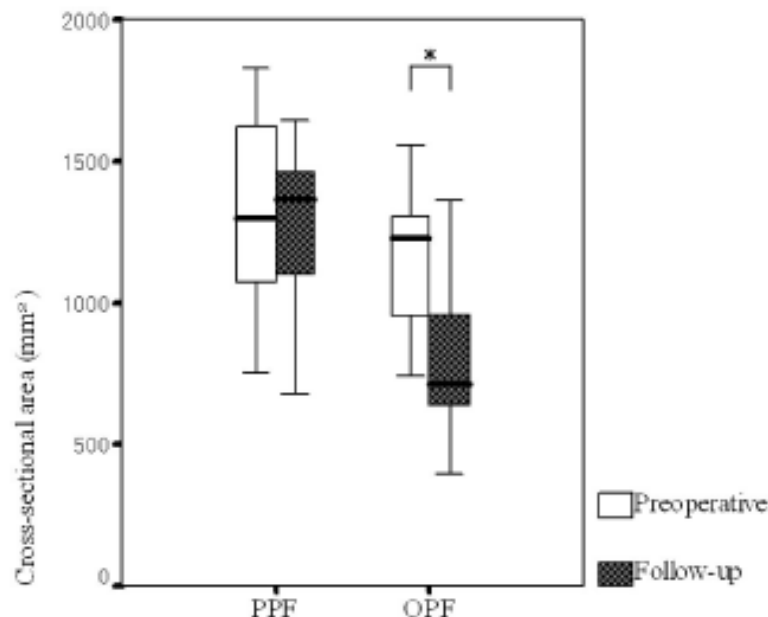


Figure 3. Box plot showing the longitudinal changes of cross-sectional area of multifidus muscle in the percutaneous and open pedicle screw fixation groups. Box plots show the median value (horizontal line in box), and interquartile range (25%–75%) is represented by the box. Whiskers encompass the 5% to 95% range. * $P < 0.05$ (Wilcoxon signed ranks test). PPF = percutaneous pedicle screw fixation; OPF = open pedicle screw fixation.

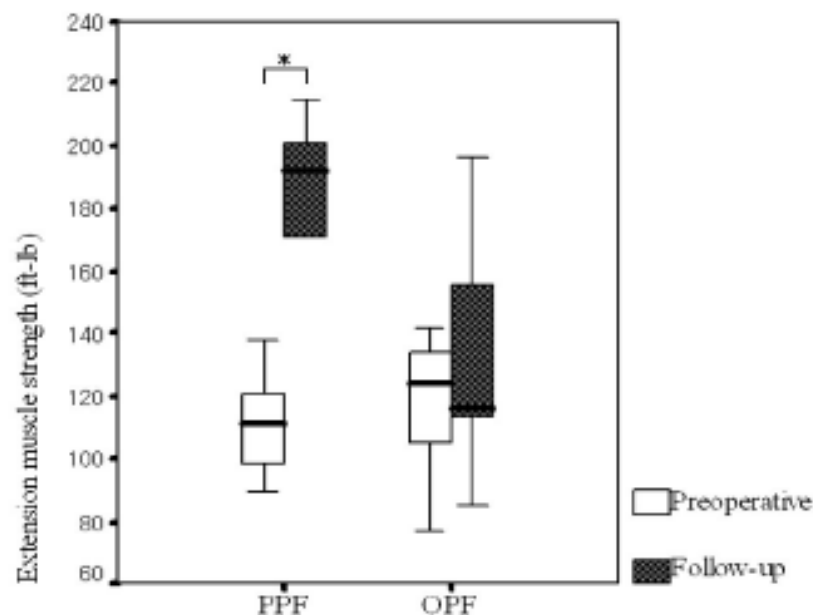
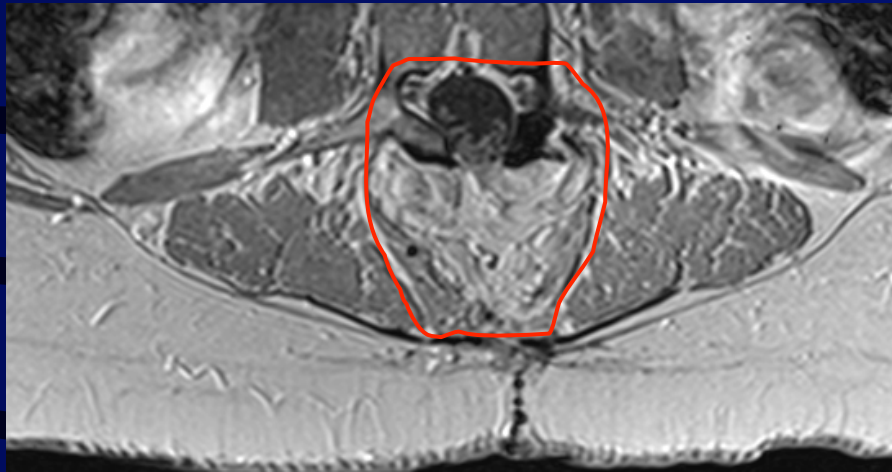


Figure 4. Box plot showing the longitudinal changes of trunk extension muscle strength in the percutaneous and open pedicle screw fixation groups. Box plots show the median value (horizontal line in box), and interquartile range (25%–75%) is represented by the box. Whiskers encompass the 5% to 95% range. * $P < 0.05$ (Wilcoxon signed ranks test). PPF = percutaneous pedicle screw fixation; OPF = open pedicle screw fixation.

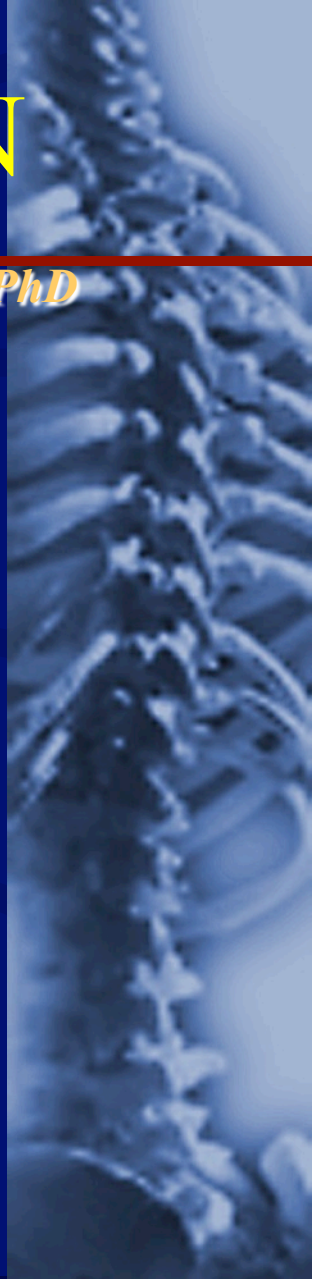
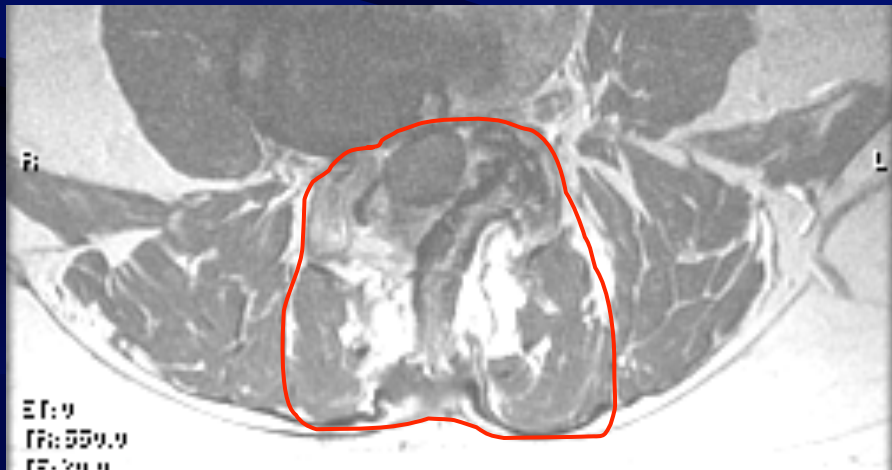
LESS TISSUE DESTRUCTION

*Lacey E. Bresnahan, PhD, R. David Fessler, BA, Richard G. Fessler, MD., PhD
ISSLS, May 1-4, 2009*

Open



MIS



PARASPINAL MUSCLE CHANGES ON MRI FOLLOWING POSTERIOR LUMBAR SURGERY

Lacey E. Bresnahan, PhD, R. David Fessler, BA, Richard G. Fessler, MD., PhD
ISSLS, May 1-4, 2009; Spine, Submitted.

- **Muscle cross-sectional area (CSA) was measured and compared for the longissimus, iliocostalis and multifidus in the pre- and post-operative scan.**
- **T 2 MRI, axial, 2mm cuts, no gap**
- **Medical imaging processing and Visualization software from NIH**

OPEN

MEAN DECREASE
LARGEST IN R LAT



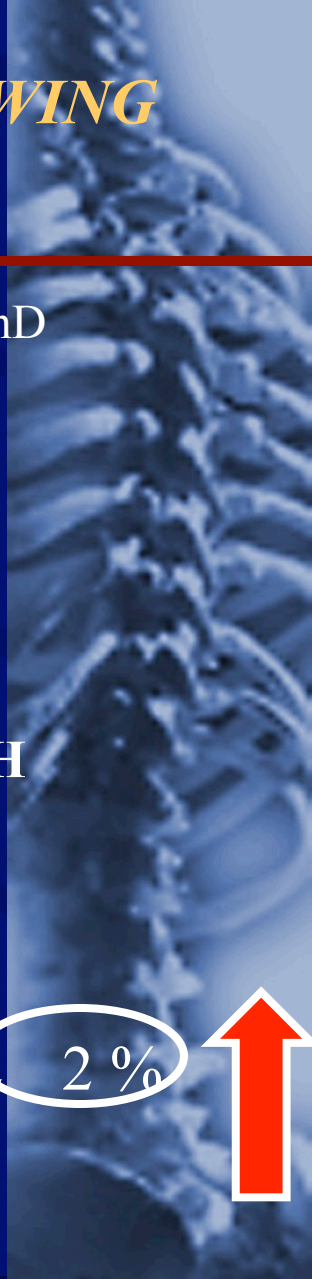
18 %

36 %

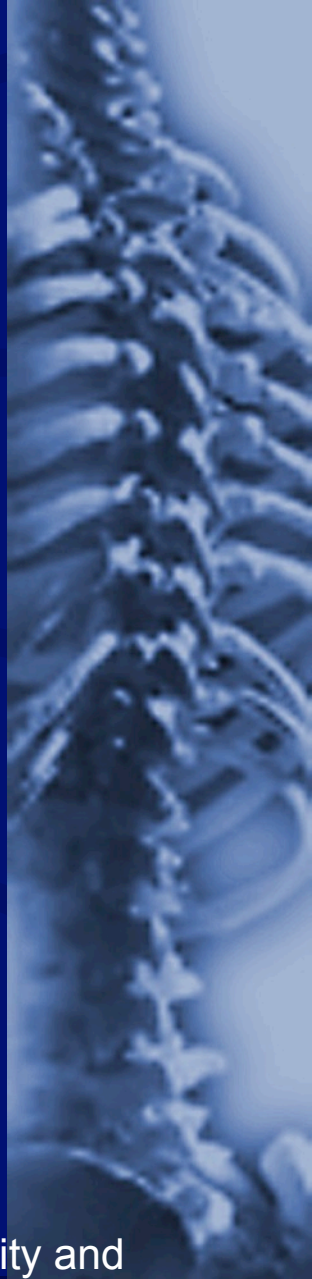
MED

MEAN INCREASE

2 %



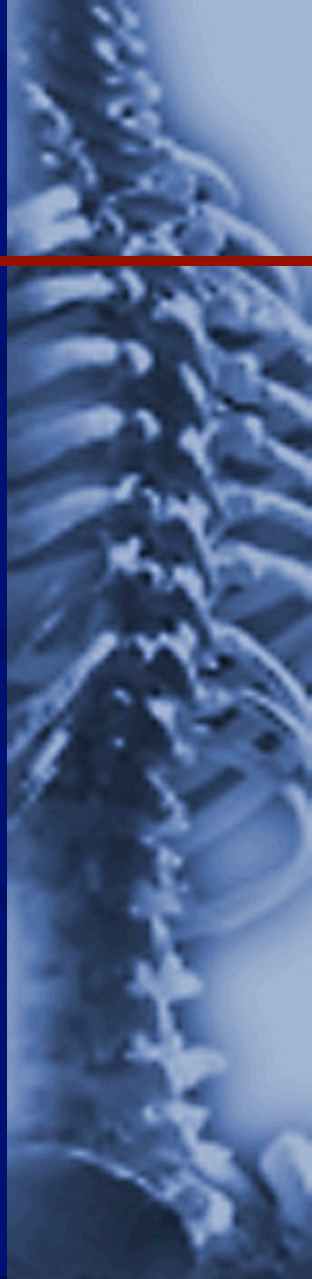
HIGH RISK: MORBID OBESITY



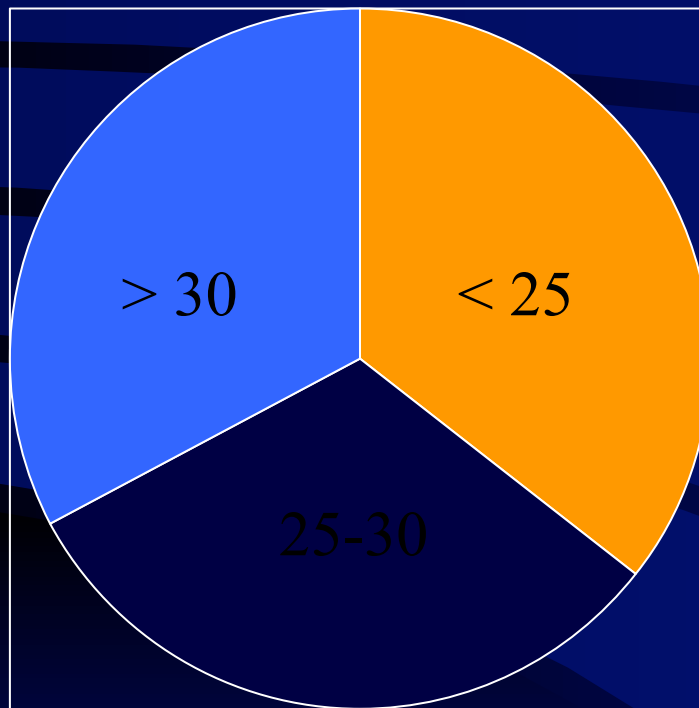
Rosen, D., Ferguson, S., Ogden, A.T., Huo, D., Fessler, R.G.: Obesity and Self Reported Outcome after Minimally Invasive Lumbar Spinal Fusion Surgery. Neurosurgery 63:956-960, 2008.

DEMOGRAPHICS

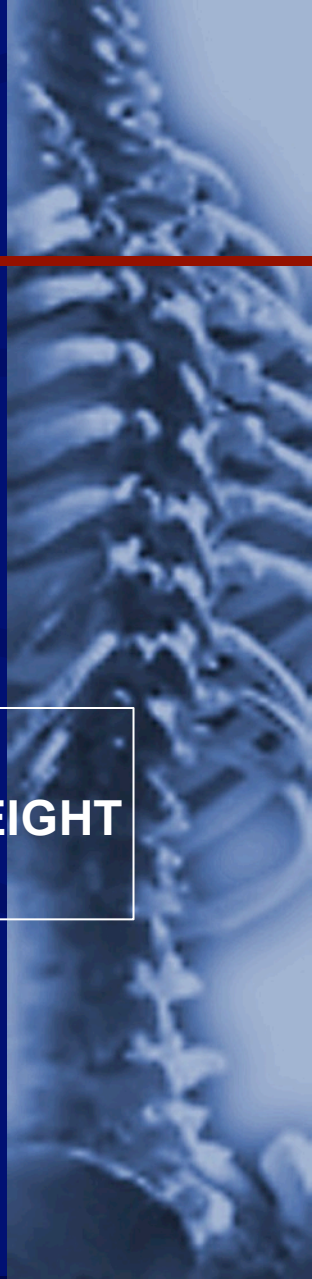
- Age 56.4 (19-85)
- Height 169 cm
- Weight 82.2 kg
- BMI 28.7 kg/m²
- TOTAL 110 patients



WEIGHT DISTRIBUTION



- < 25 NORMAL
- 25-30 OVERWEIGHT
- > 30 OBESE

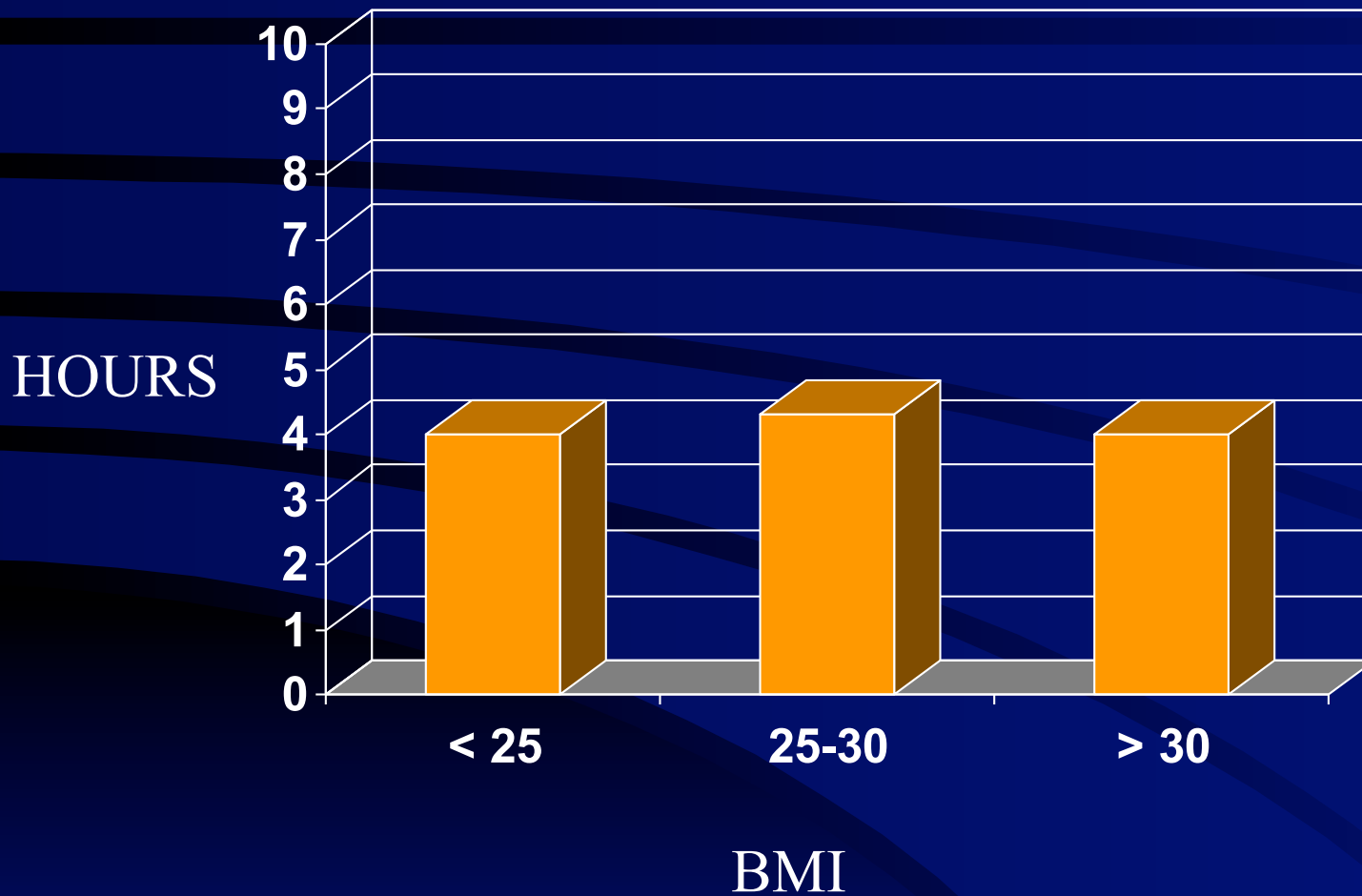


RESULTS

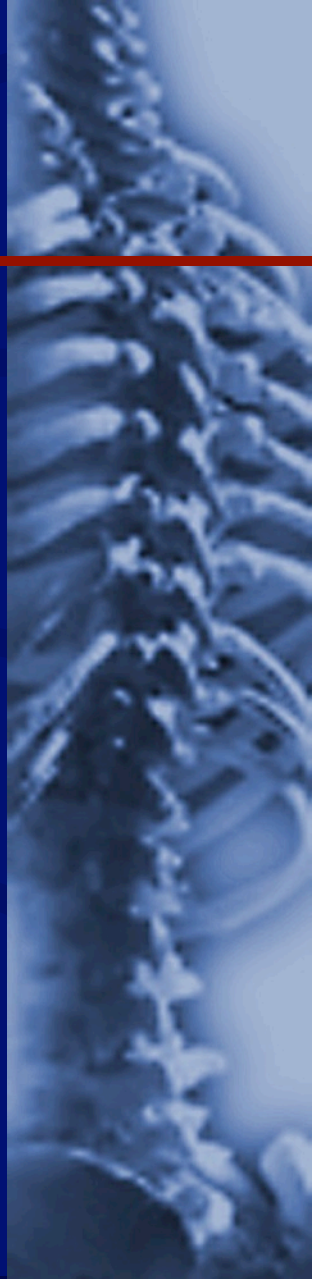
- **VAS = NS DIFFERENCE between groups**
- **ODI = NS DIFFERENCE between groups**
- **SF-36 = NS DIFFERENCE between groups**
- **Linear Regression Analysis = No correlation between BMI and any outcome measure**



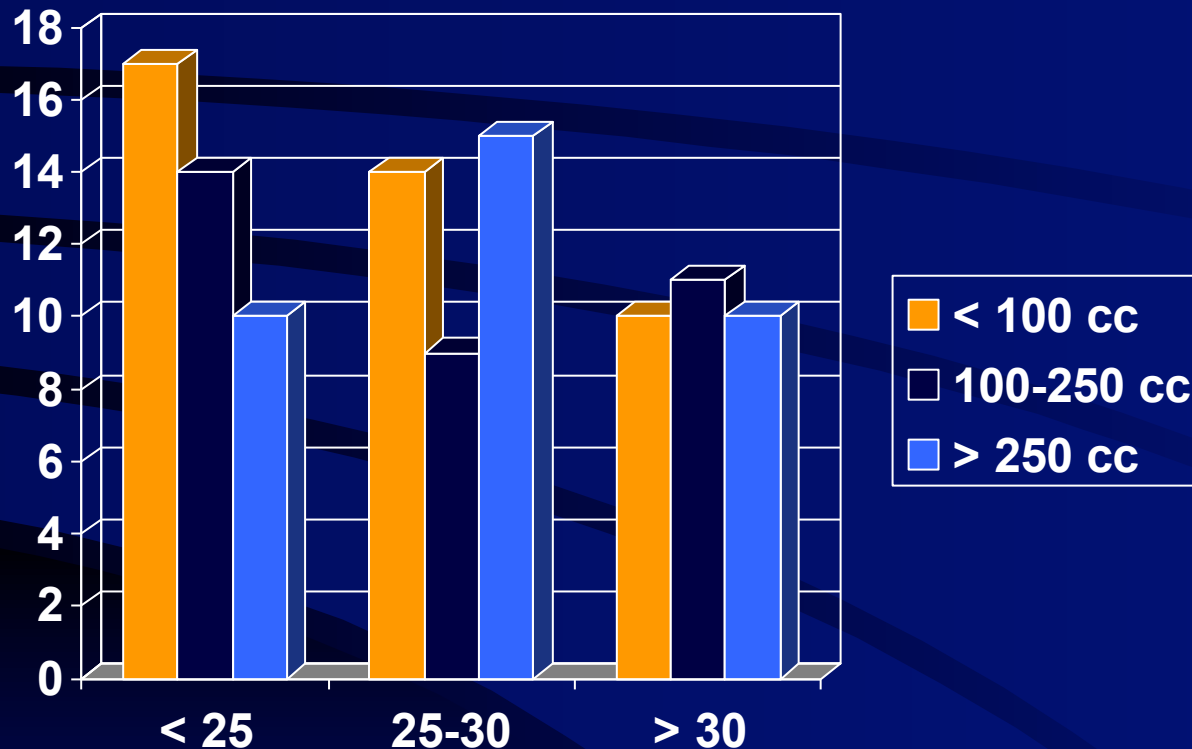
OPERATIVE TIME



No significant difference



ESTIMATED BLOOD LOSS



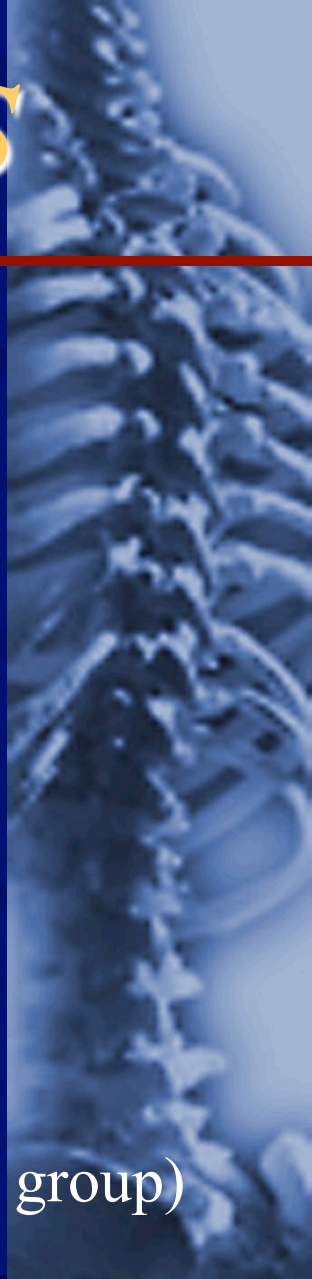
No significant difference

MAJOR COMPLICATIONS

1 Positioning injury (?)

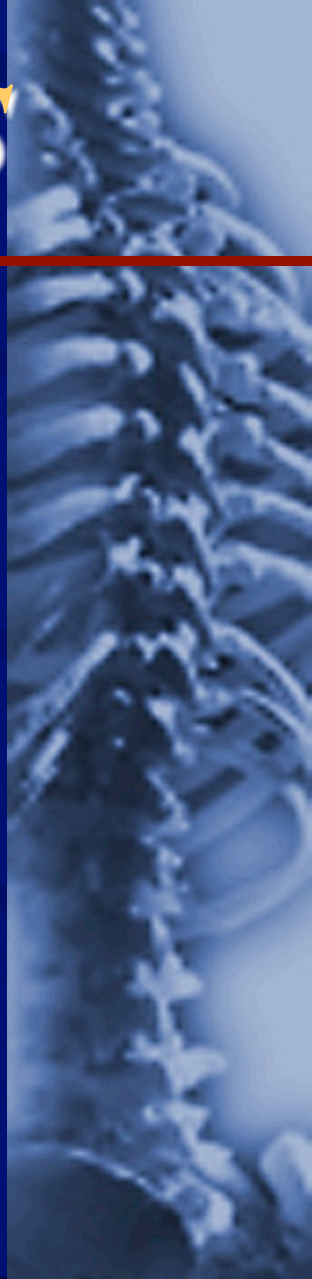
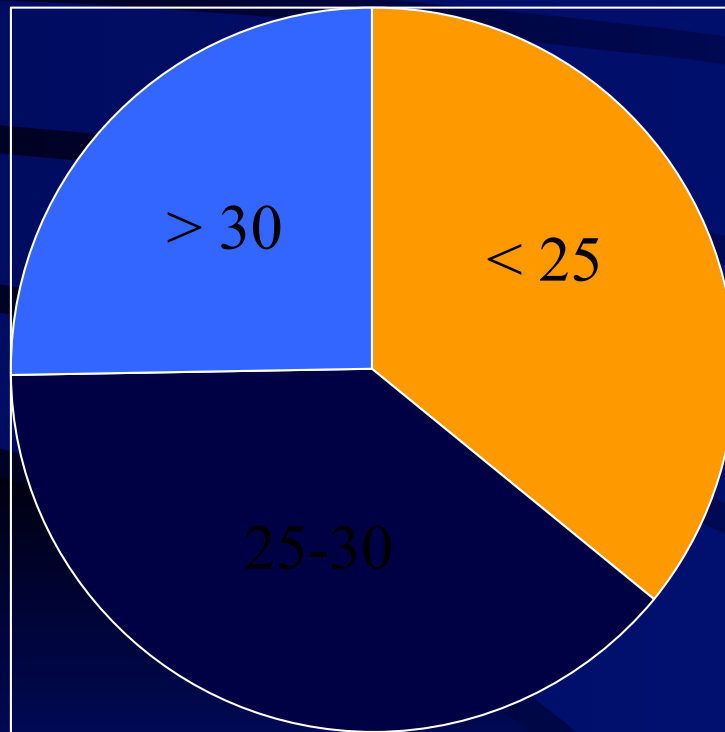
= 0.8 %

(This occurred in the “normal” group)

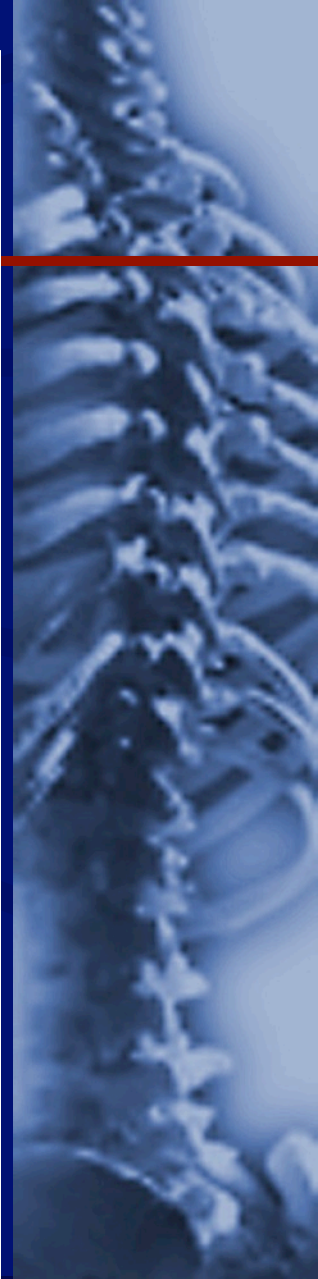


MINOR COMPLICATIONS

OVERALL 22 %



	BMI < 25	BMI 25-30	BMI > 30
Post-op radiculopathy		3	2
Lower extremity weakness	1		
Urinary retention	2		
Durotomy	1	1	
Superficial wound infection	1		
Delirium		3	2
Nausea			1
CHF exacerbation	1		
Hypertension	1	1	
Hypotension	1	1	
Ileus	1		
PERCENT OF TOTAL	23	26	14



DIAGNOSIS

Complication	No. of patients
Urinary retention	6
Transient delirium	5
Unintentional durotomy	3
Fever	3
Urinary tract Infection	2
Atrial fibrillation	1
Constipation	1
Pneumonia	1

Major complications: 0

[illegible]

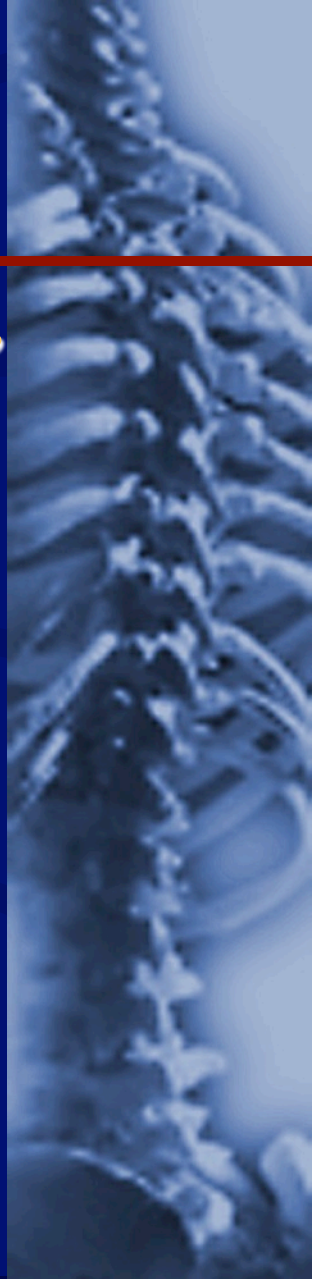
Degenerative spine disease leading to cervical spondylitis and spondylosis is a major cause of morbidity among the elderly (34). Although clinical symptoms can occur at any age, the incidence of degenerative disease causes chronic pain and functional impairment, resulting in limitations of mobility and of the ability to perform activities of daily living (35). The prevalence of degenerative disease has been found to be increasing frequently (36, 37). Long-term studies have demonstrated significant changes for surgery (38). However, the management of degenerative spine disease for elderly patients are not considered, but many factors for surgery because of age, comorbidity, and, in some cases, subjective depression of a patient's fitness for surgery.

Although the elderly population has not been developed for the surgical treatment of lumbar spinal disease (1, 37, 38), these trends require direct focus, consistently used "open" approaches, and the use of minimally invasive, tubular muscle retractor, and "spine" the posterior ligamentum and muscle complex (39). The elderly requires specific clinical management, and the elderly are secondarily affected by degenerative spine disease.

LOWER INFECTION RATE

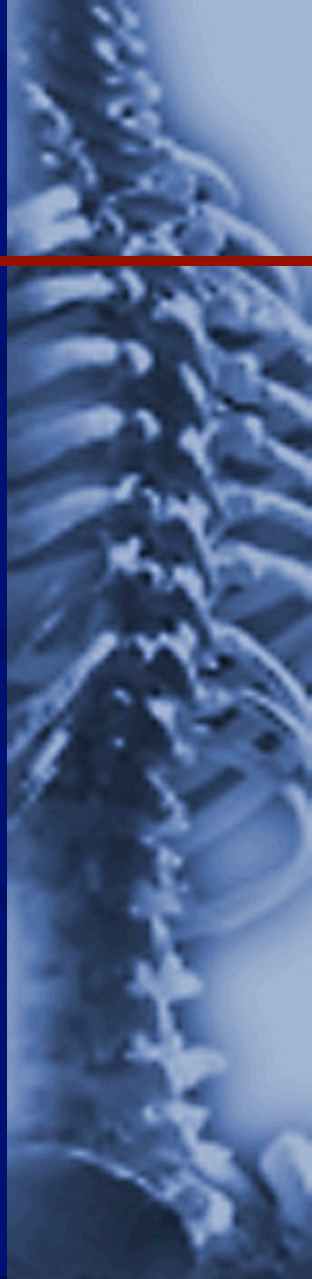
John E. O'Toole, MD, Griffin Meyers, BA, and Richard G. Fessler, MD, PhD Reduction in Spinal Surgery Wound Infection Rates by Minimally Invasive Technique. Journal of Neurosurgery, in press.

- Reported infection rate in open surgery 0.9 to 15 %.
- 1338 MIS procedures
- 12 mo follow up
- 0.2 % overall infection rate
 - 0.7 % for MEDS and TLIF
 - 0.1 % for all others



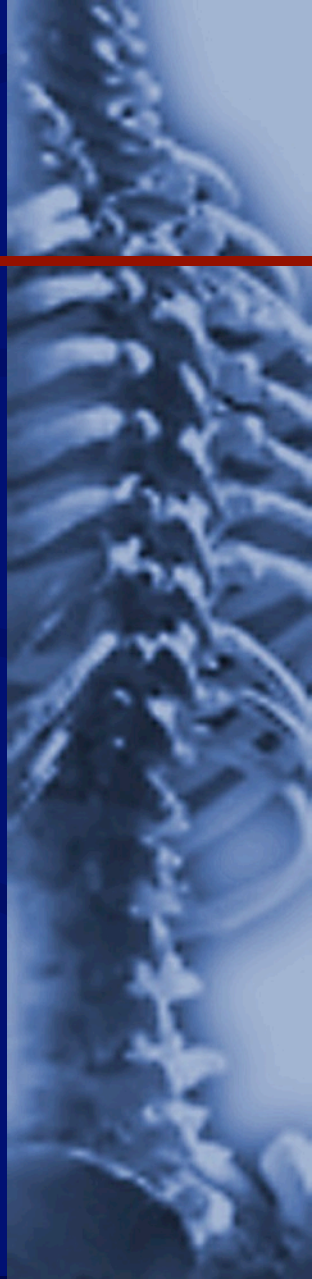
CONCLUSIONS

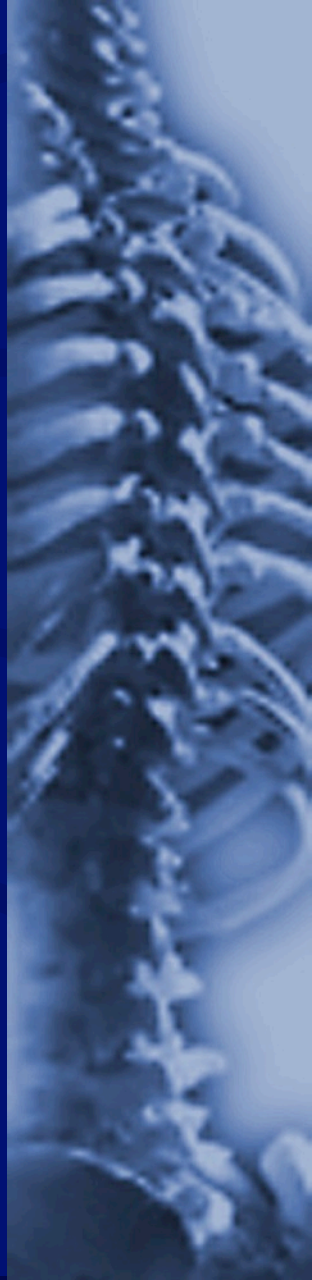
- **MIS is equivalent to or superior to open surgery for:**
 - **Neurologic result**
 - **Pain relief**
 - **Fusion rate**
- **For virtually every operation developed and tested to date.**



CONCLUSIONS

- **MIS achieves these results with**
 - **Less EBL**
 - **Less stress response**
 - **Less pain meds**
 - **Less ICU stay**
 - **Less hospital stay**
 - **Faster D/C**
 - **Faster recovery**
 - **Faster return to work**
 - **Lower complication rate**
 - **Lower infection rate**
- **And can more safely be used in high risk patients**





Thank You