

A novel diagnostic parameter,
Foraminal Stenotic Ratio on 3D-MRI,
could discriminate
**between lumbar foraminal stenosis
with and without requiring surgery.**



Dept. of Orthopaedic Surg,

Wajokai Eniwa Hospital

Kentaro Yamada, Yuichiro Abe,
Shigenobu Satoh



Conflict of Interest

All authors have declared no funding or conflict of interest in this study.

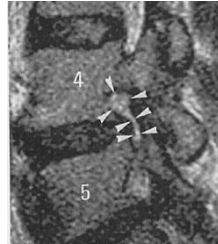


The diagnosis of Lumbar Foraminal Stenosis

- Golden standard

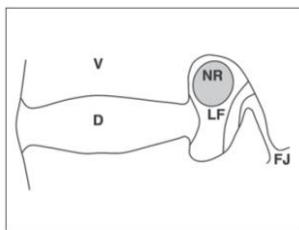
- ✓ Fat obliteration on parasagittal image of MRI

Wildermuth S. Radiology. 1998



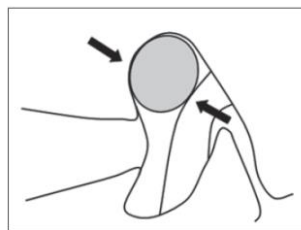
Lee's classification

Grade 0



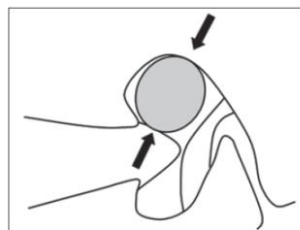
A

Grade 1

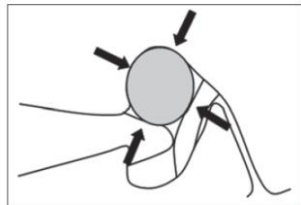


B

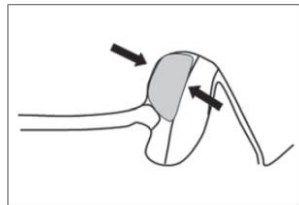
Grade 1



C



D



E

Grade 2

Grade 3

However, there were many **False-Positive cases** in this evaluation

Aota Y. Spine. 2007

The reason of False-Positive

- 1) Evaluation from **only 1-slice** of parasagittal images
- 2) Difficulty of **recognition for the whole root image, especially far-out region**

Purpose

We have suggested a novel diagnostic technique, **Foraminal Stenotic Ratio (FSR)**, using 3D-MRI to overcome flaws of conventional MRI evaluation.

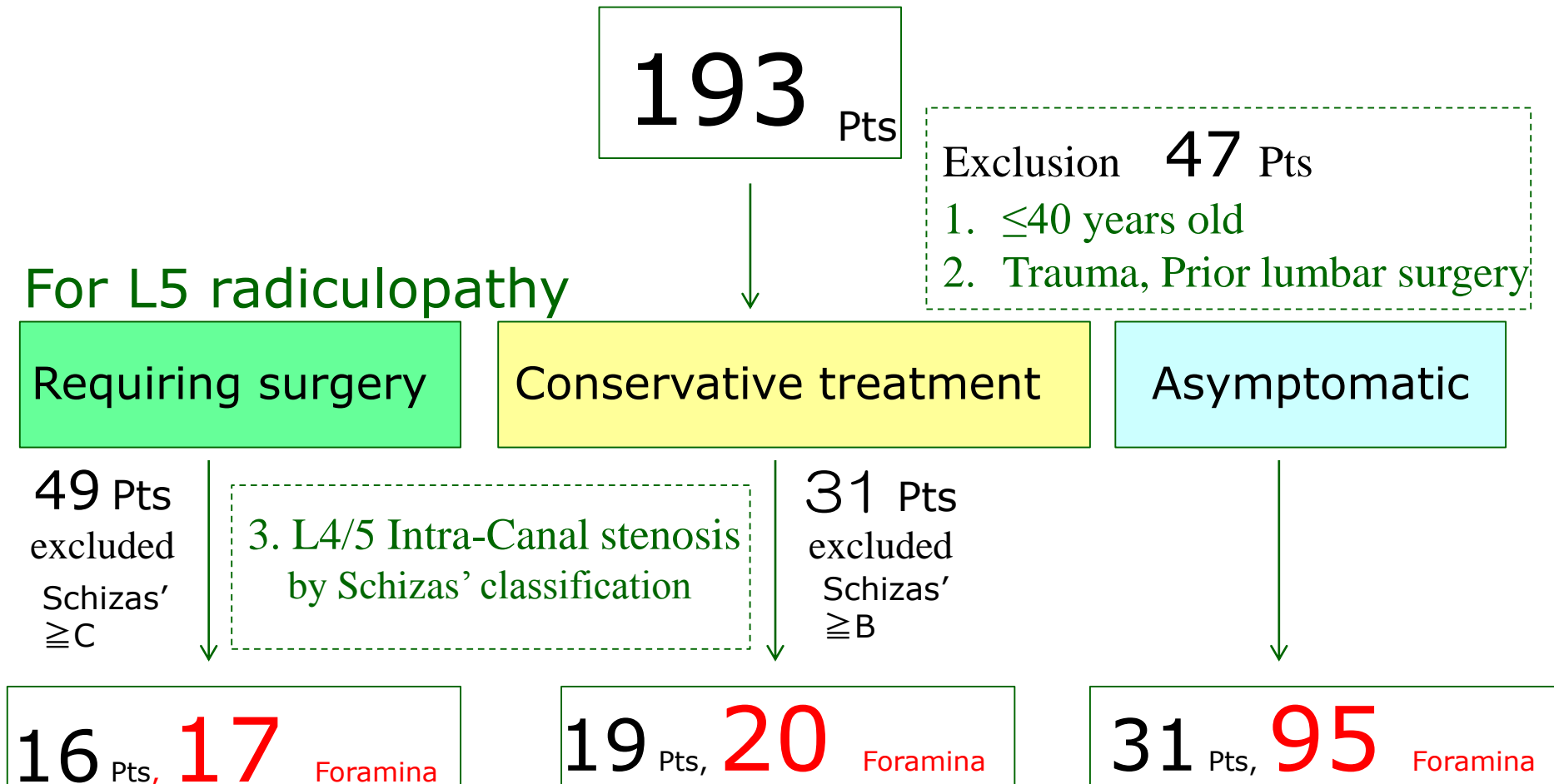
The purpose of this study was • •

- (1) to evaluate **difference of FSR** coupled with past reported parameters **among patients requiring surgery, those with successful conservative treatment, and asymptomatic patients** for the lumbar foraminal stenosis **at L5-S level**,
- (2) to investigate the threshold of conservative treatment.



Patients enrollment

- ✓ Patients who have taken the **3D-MRI** to diagnose radicular leg pain between May 2014 and Aug. 2015



Analysis of 3D-MRI

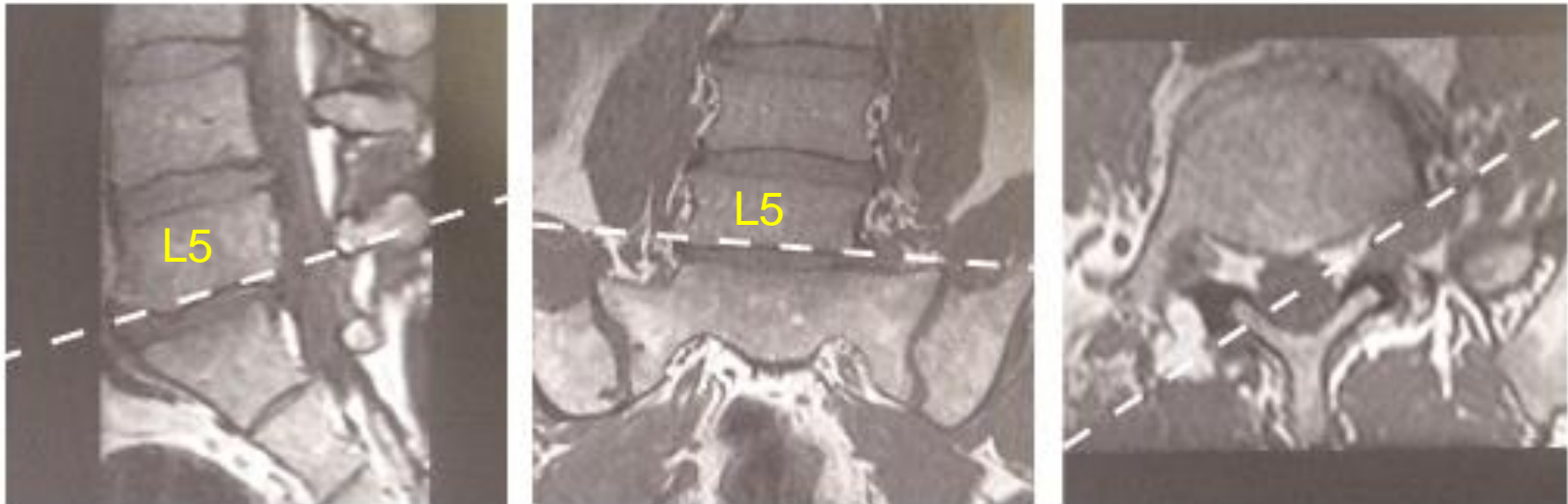
- **MRI:** Skyra 3.0-T, Siemens, Munich, Germany

T1 Sampling Perfection with Application optimized Contrasts using different flip angle Evolution (SPACE) sequence (Coronal Base)

FOV 300mm, Slice thickness 0.7mm TR/TE 500/34
Imaging time 5m25s

- **Reconstruction of 3D-MRI:**

The oblique images were reconstructed along L5-S foramen.

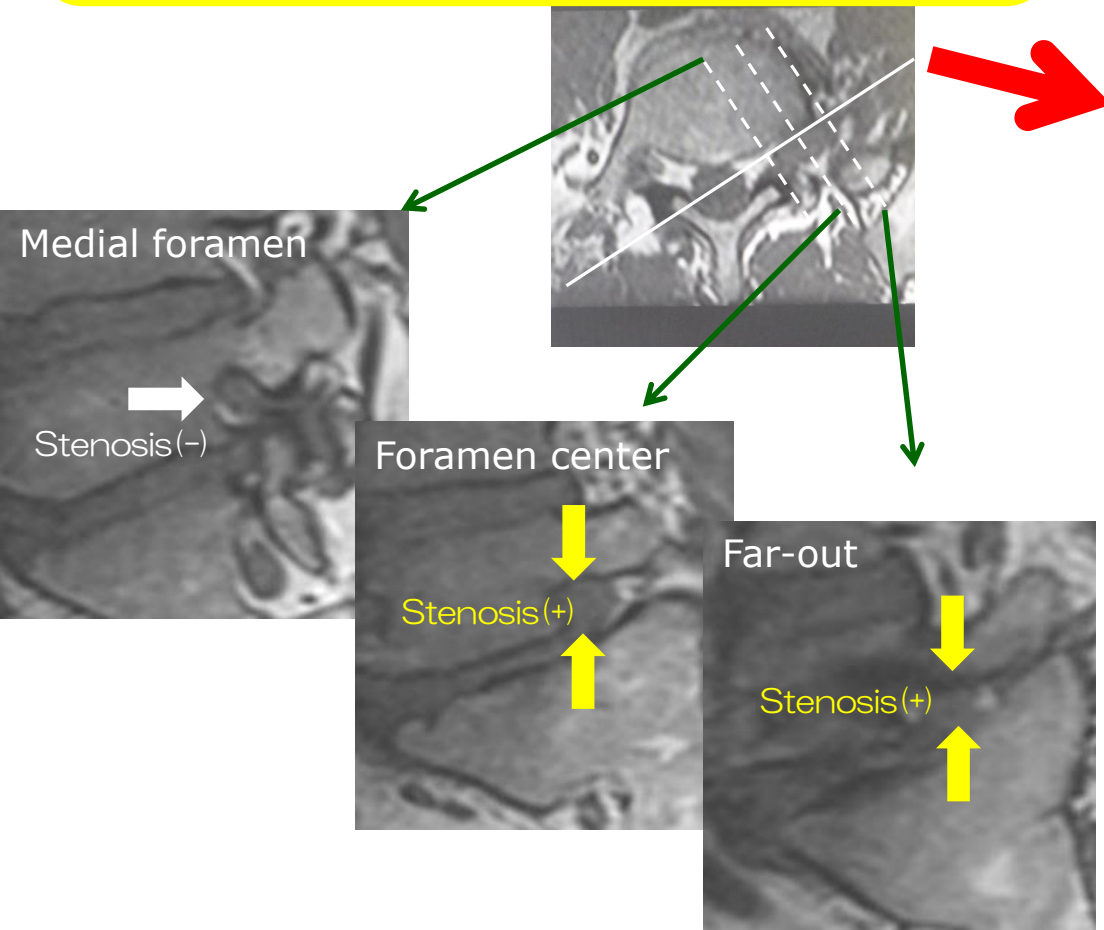


Evaluation of FSR

Oblique sagittal view

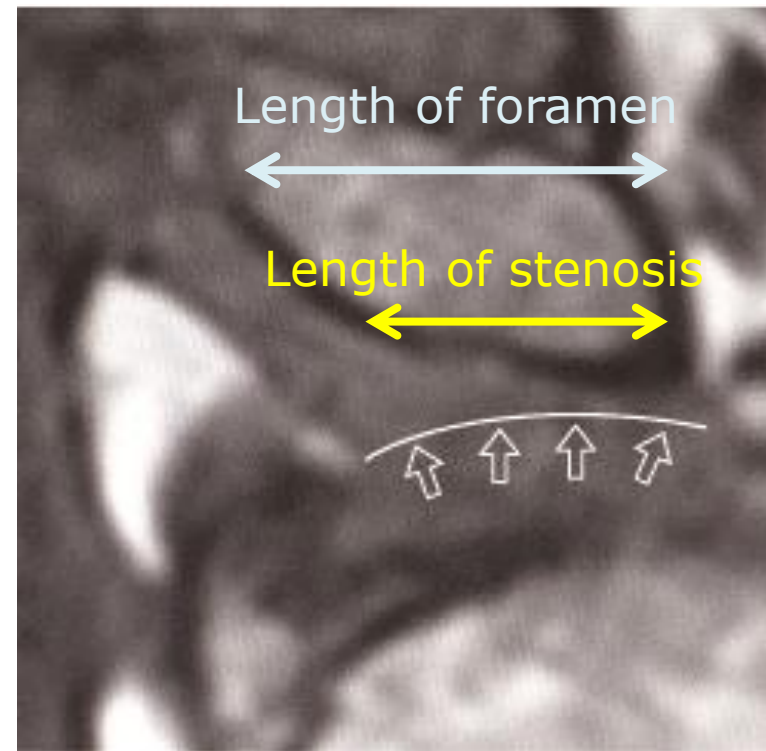
A slice of perineural fat obliteration either on cranial-caudal or front-back direction

→ **Stenosis(+)**



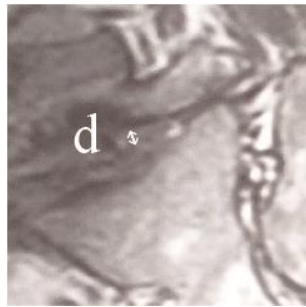
Oblique Coronal view

$$\text{FSR} = \frac{\text{Length of stenosis}}{\text{Length of foramen}} \times 100 (\%)$$

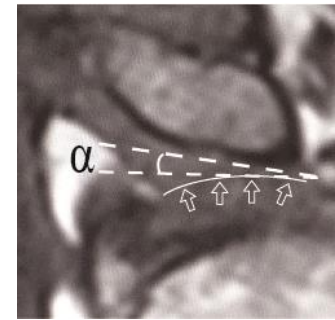


The other evaluated parameter

- ✓ The minimum diameter of the nerve root (d) mm



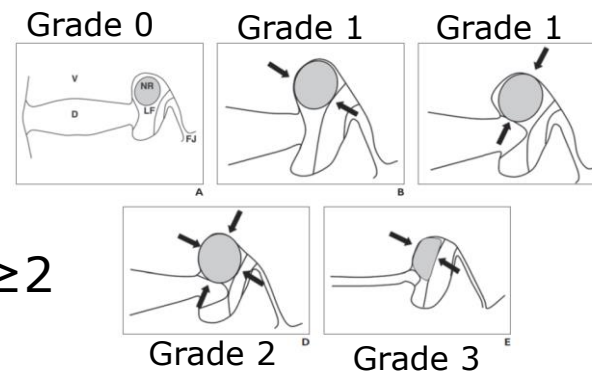
- ✓ The maximum transverse angle of the nerve root (α) °



- ✓ Lee's classification

Lee S. AJR Am J Roentgenol .2010

Foraminal stenosis(+) : Grade ≥ 2

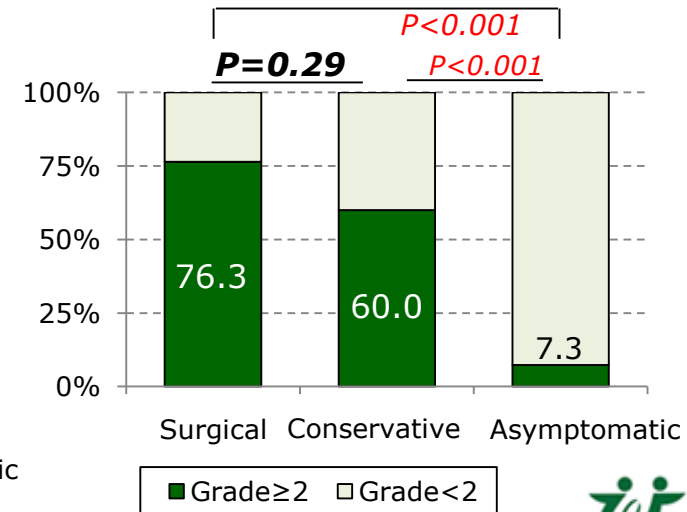
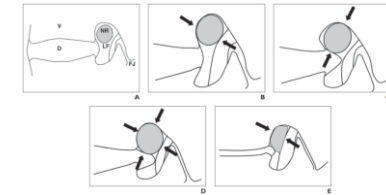
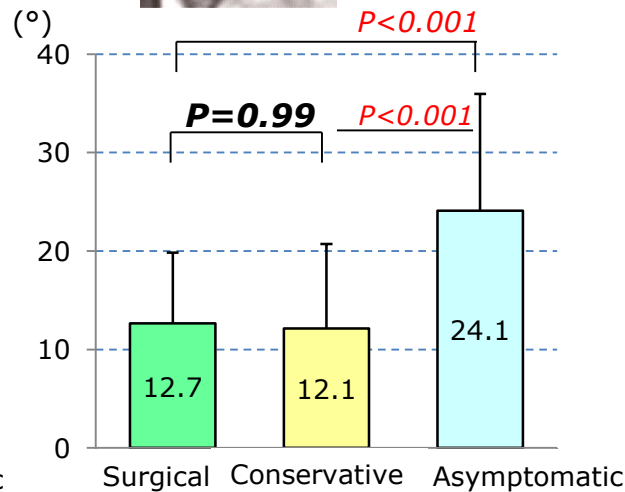
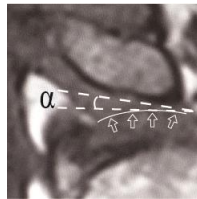
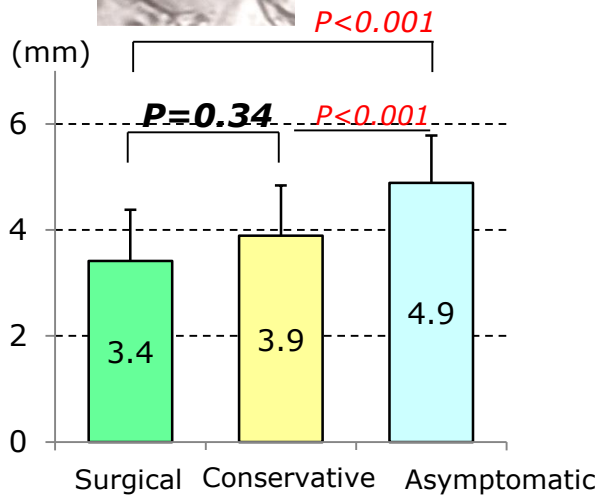
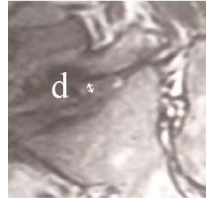
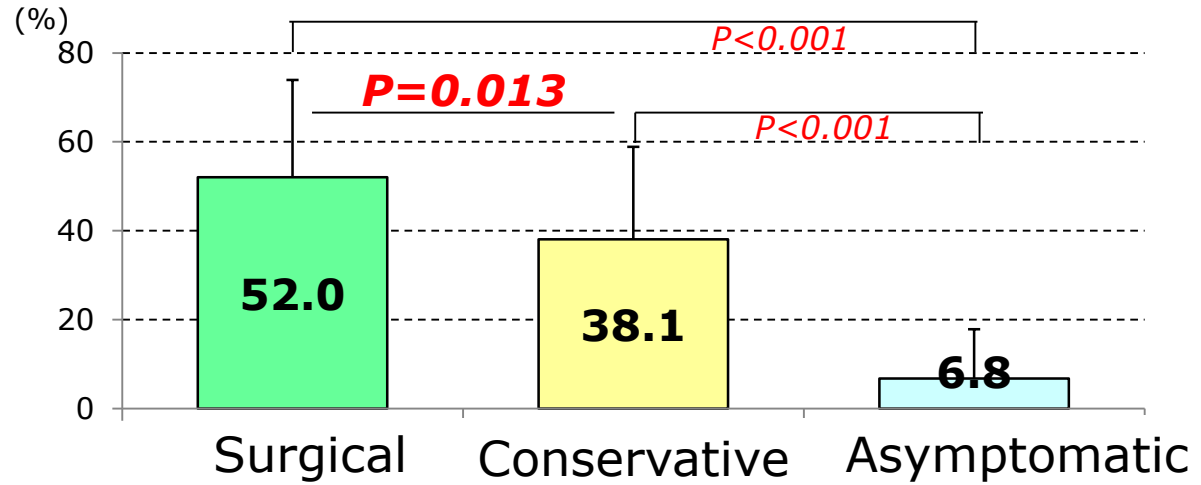
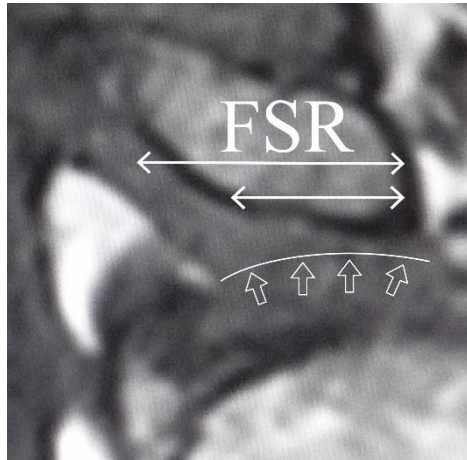


The analysis

- ✓ The differences of each parameter among 3 groups.
- ✓ Calculation area under curve (AUC) by ROC curve
- Setting optimal cut-off value.

Results

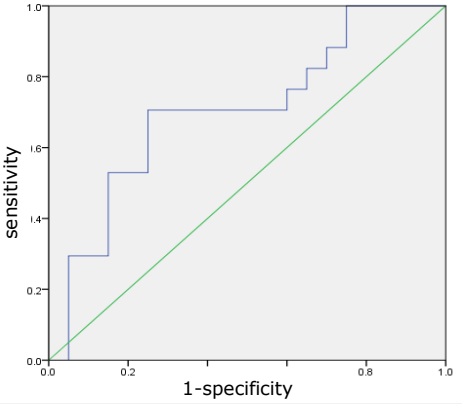
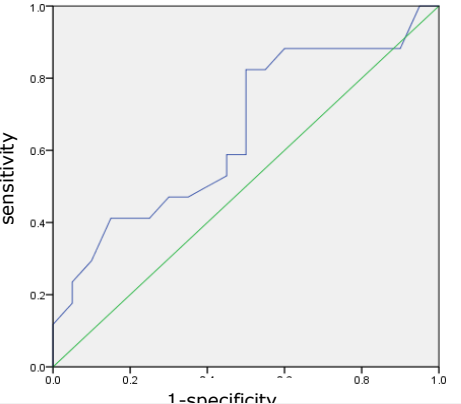
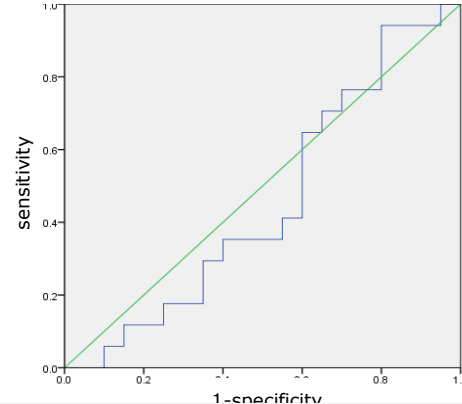
Differences among 3 groups



Results

ROC Curve

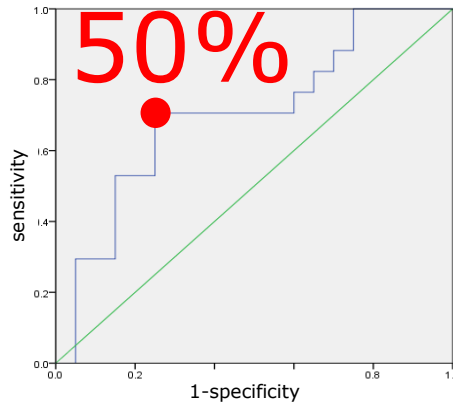
Surgical vs Conservative

	FSR	d	a
Surgical Vs Conservative	 The ROC curve for FSR shows a blue step function above a green diagonal line. The y-axis is labeled 'sensitivity' and the x-axis is labeled '1-specificity', both ranging from 0.0 to 1.0. The curve starts at (0,0) and ends at (1,1), with several steps indicating good performance.	 The ROC curve for 'd' shows a blue step function above a green diagonal line. The y-axis is labeled 'sensitivity' and the x-axis is labeled '1-specificity', both ranging from 0.0 to 1.0. The curve starts at (0,0) and ends at (1,1), with several steps indicating moderate performance.	 The ROC curve for 'a' shows a blue step function above a green diagonal line. The y-axis is labeled 'sensitivity' and the x-axis is labeled '1-specificity', both ranging from 0.0 to 1.0. The curve starts at (0,0) and ends at (1,1), with several steps indicating poor performance.
AUC	0.70	0.65	0.46
P value	0.03	0.12	0.65



Optimal cut-off value

✓ FSR



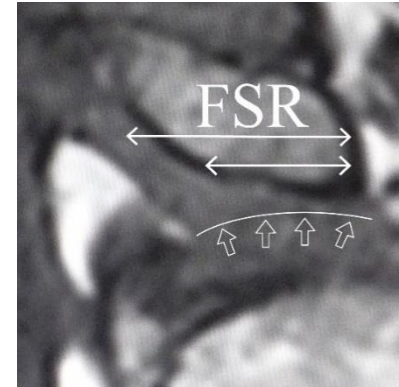
If the patients with $\geq 50\%$ perineural fat obliteration requires surgery...

Sensitivity **70.6%**
Specificity **75%**

Positive Predictive Value
(PPV) 70.6%
Negative Predictive Value
(NPV) 75%

Conclusions

- FSR showed significant difference between patients requiring surgery or not.



- In case of lumbar foraminal stenosis at L5-S, Symptomatic patients with $\geq 50\%$ **perineural fat obliteration in the foramina** were likely to **require surgical treatment**, with a positive predictive value of **70.6%**.