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CENTER FOR DISRUPTIVE MUSCULOSKELETAL INNOVATIONS

Biomechanical Evaluation of the Newly Developed Decompression Surgery: Transforaminal Ventral Facetectomy

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Background: PEVF

- Percutaneous Endoscopic Transforaminal Ventral Facetectomy (PEVF)
  - *Sairyo et al. J Med Invest 2017*
- Using the PEVF, foraminal and lateral recess stenosis can be simultaneously performed.
- Ventral aspect of the facet joint is removed.

- **However, the biomechanical effects of the PEVF are not clear.**

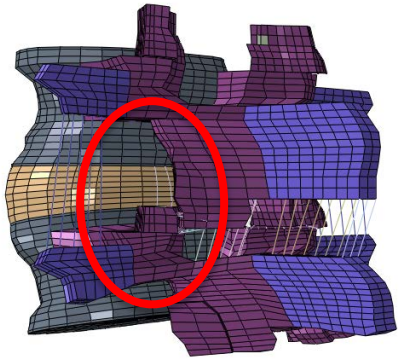
Project Aims

Aim: Elucidate the biomechanical effects of the PEVF using the finite element approach

Hypothesis: PEVF will provide better segmental stability than traditional approach

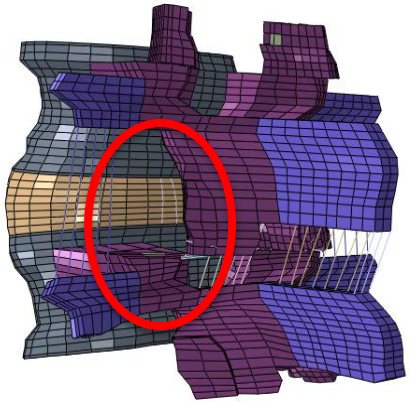
Finite Element (FE) Models

Finite element modeling: L4-L5 motion segment



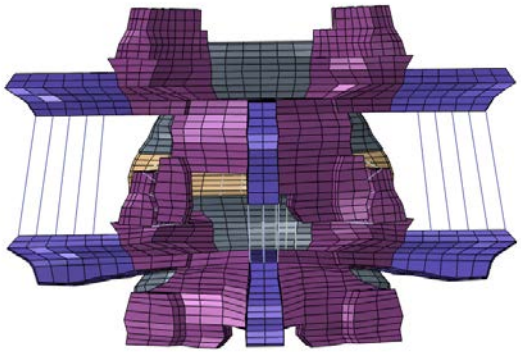
1. 50% PEVF

50% resection of the superior articular process



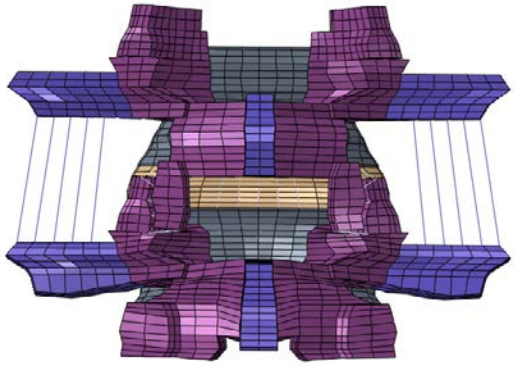
2. 100% PEVF

100% resection of the superior articular process



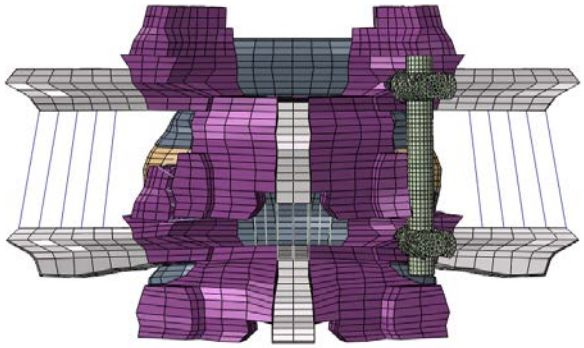
3. MIS laminectomy

Resection of the medial parts of the facets the adjacent lamina on the procedure side

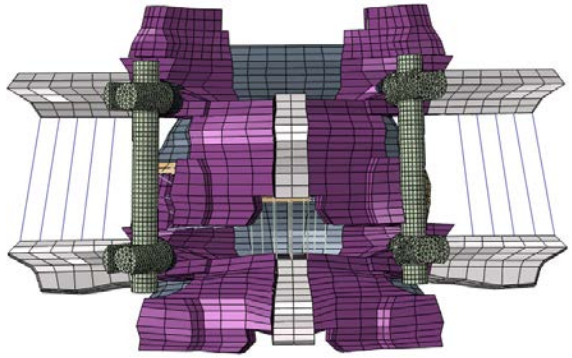


4. OPEN laminectomy

Resection of the medial parts of the facets, the adjacent lamina on both sides



5. Unilateral TLIF



6. Bilateral TLIF

Disc Degeneration Models

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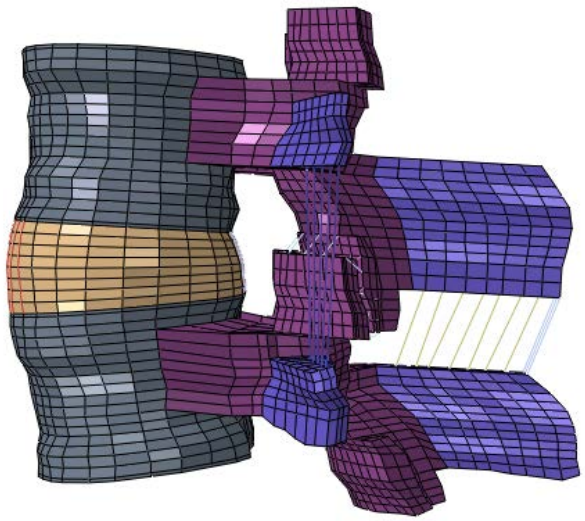
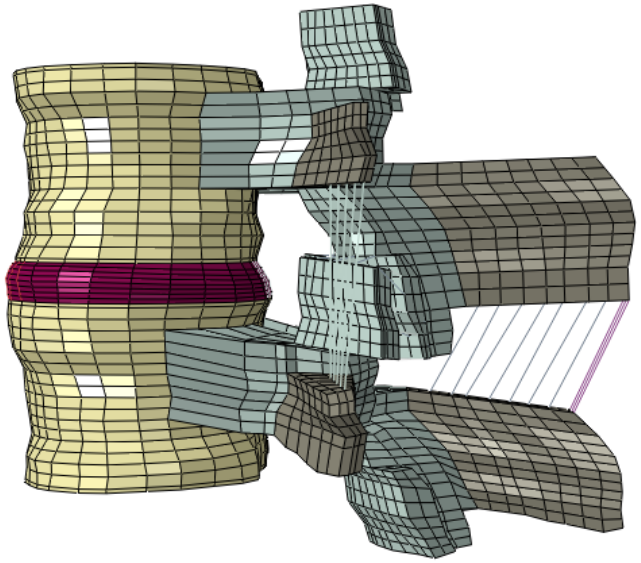
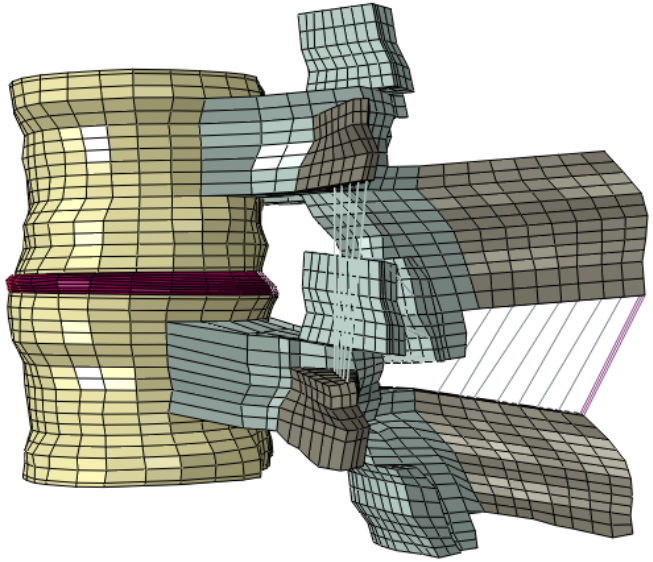
NORMAL DISC	50% DISC COLLAPSE	80% DISC COLLAPSE







Updates from Spring 2018 meeting

- ROM, Disc Stress and Facet Stress data was presented for Normal Disc Models
- 50% & 80% degenerated disc models were created and simulations had been started.

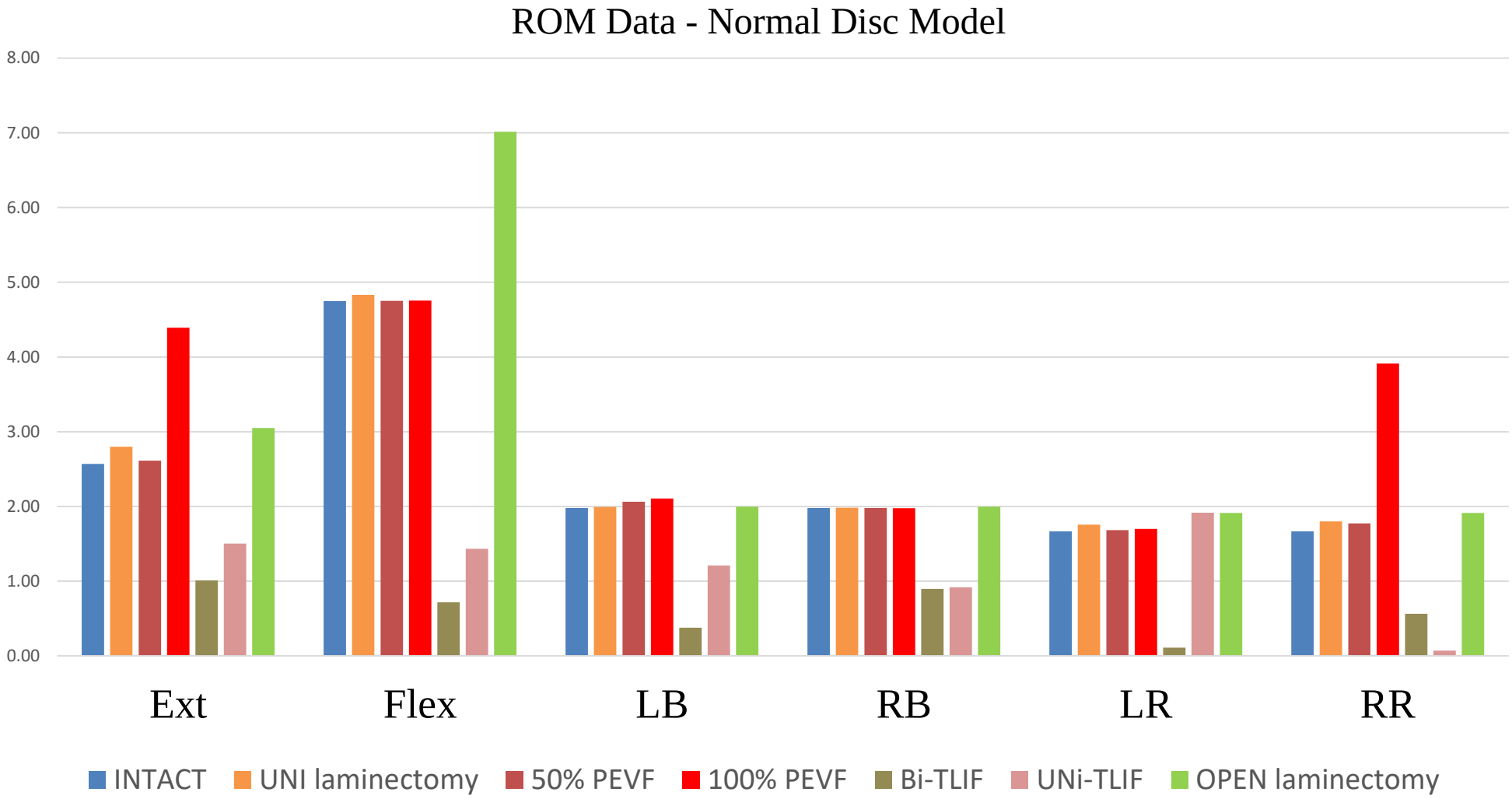
IAB Questions Spring 2018 meeting

- How does PEVF scale with changes in disc height ? – Results presented here.
- How does PEVF compare to standard Facetectomy in terms of stability ? – Simulations will be done as a part of the final update
- How does PEVF scale with change in size of the spine ? - Simulations will be done as a part of the final update
- Is a cadaver study planned for this project? – Not under the current scope of the project

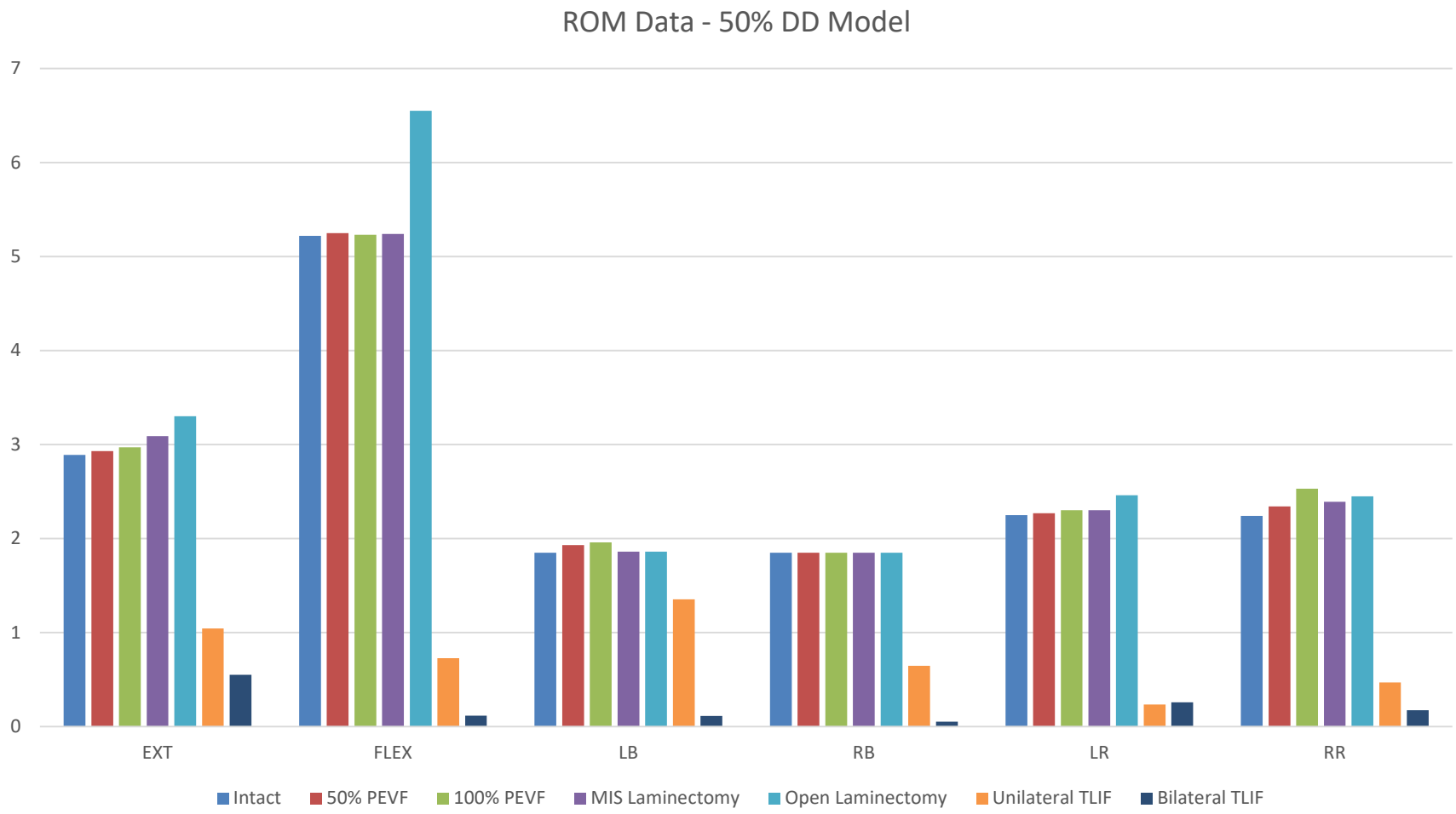
Project progress for the Summer 2018 Update

- ROM, Disc Stress and Facet Stress data compiled for the 50% & 80% degenerated disc models.
- Models with expandable interbody cages created and started simulations

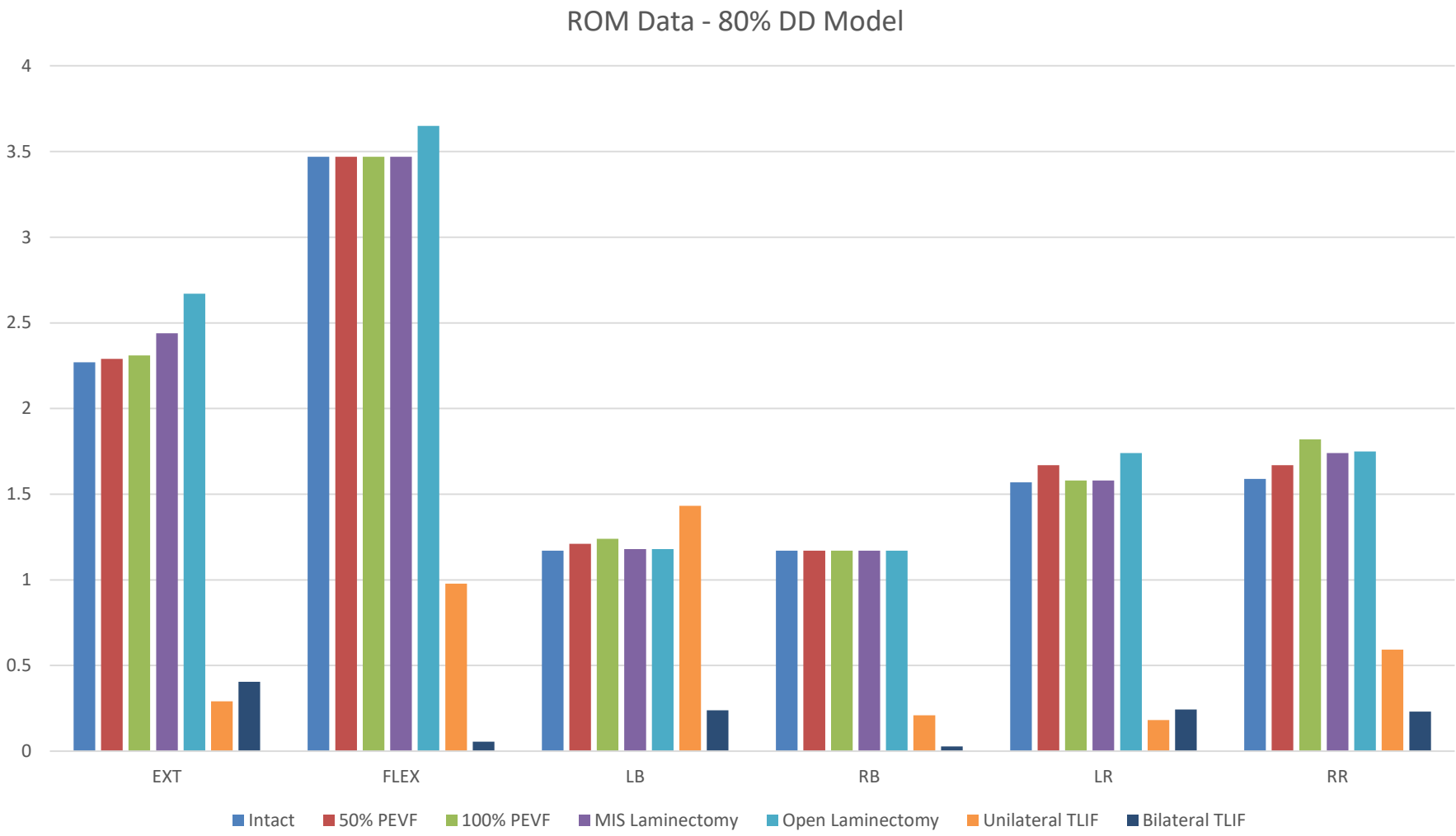
Results


ROM Data - Normal Disc Model
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Ext
Flex
LB
RB
LR
RR
INTACT
UNI laminectomy
50% PEVF
100% PEVF
Bi-TLIF
UNi-TLIF
OPEN laminectomy

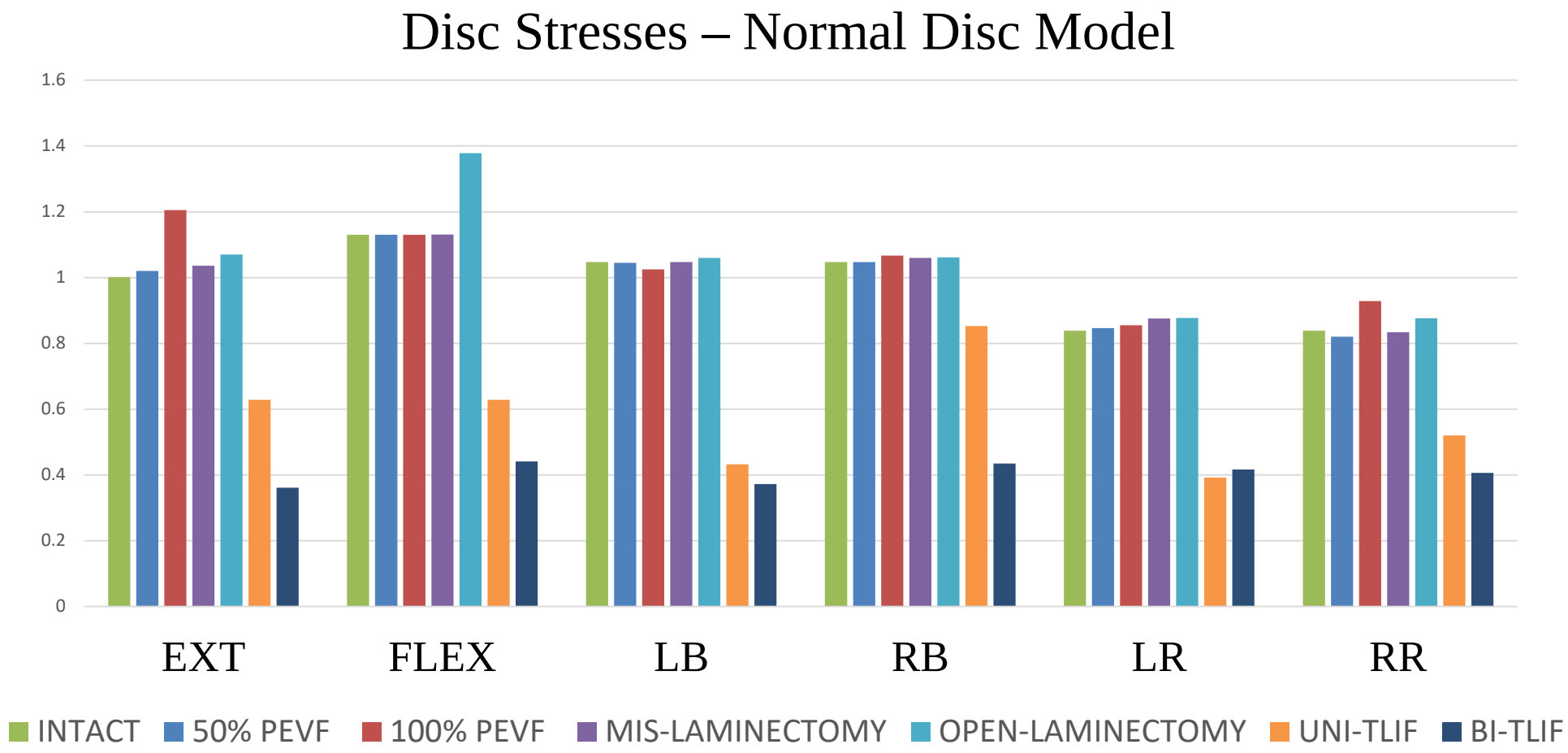
Results



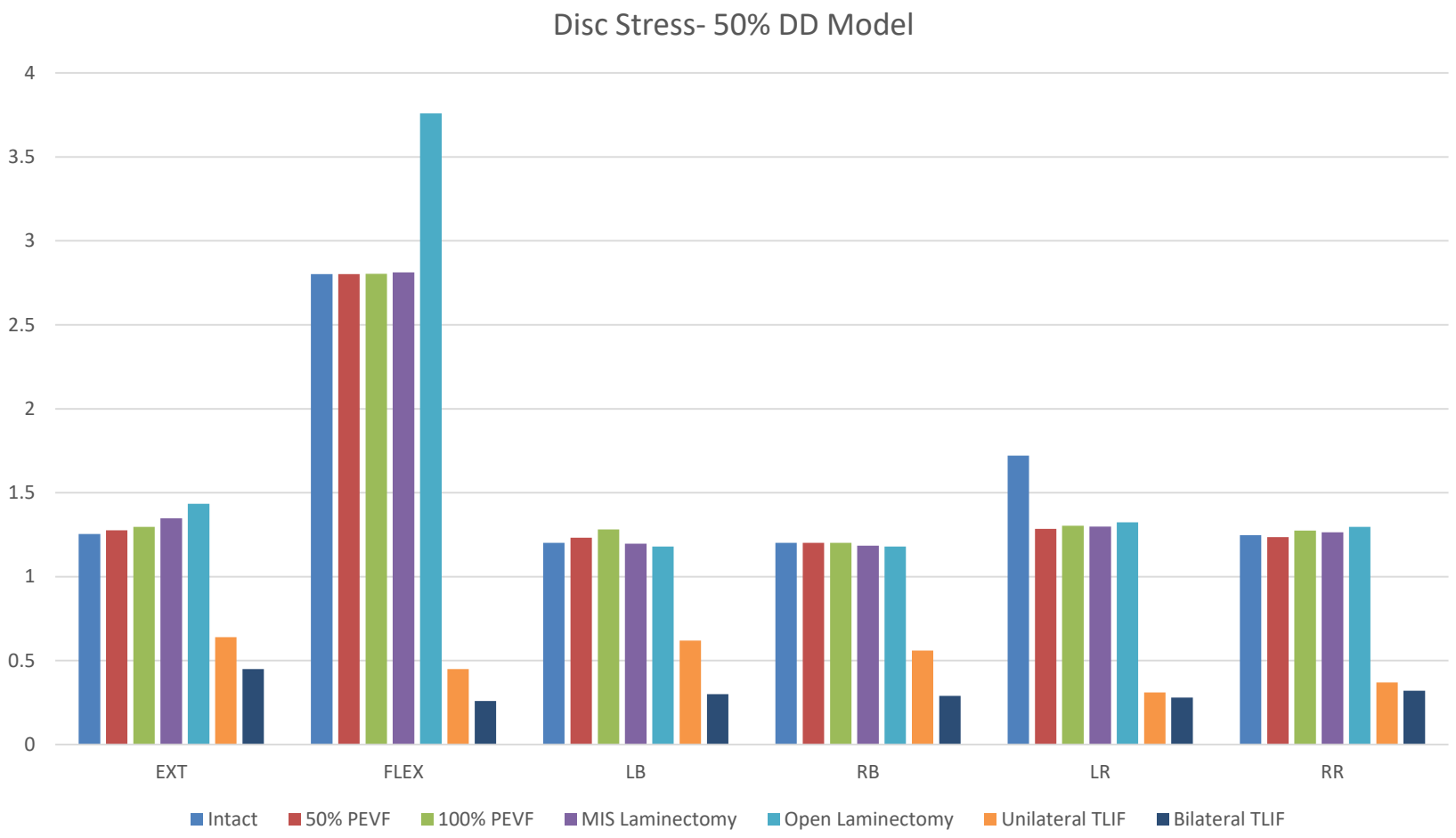
Results



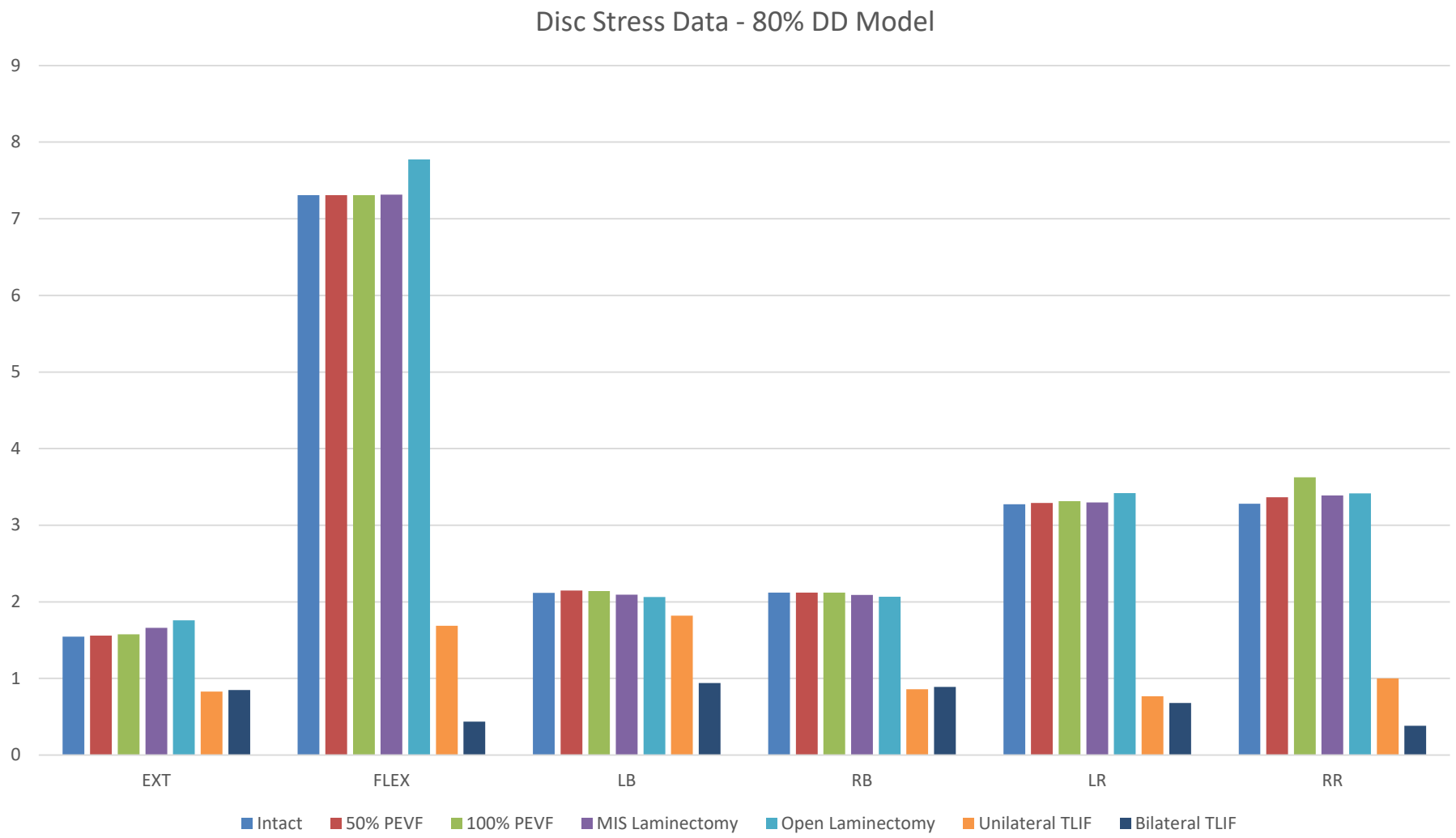
Results


Disc Stresses – Normal Disc Model
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
EXT
FLEX
LB
RB
LR
RR
INTACT
50% PEVF
100% PEVF
MIS-LAMINECTOMY
OPEN-LAMINECTOMY
UNI-TLIF
BI-TLIF

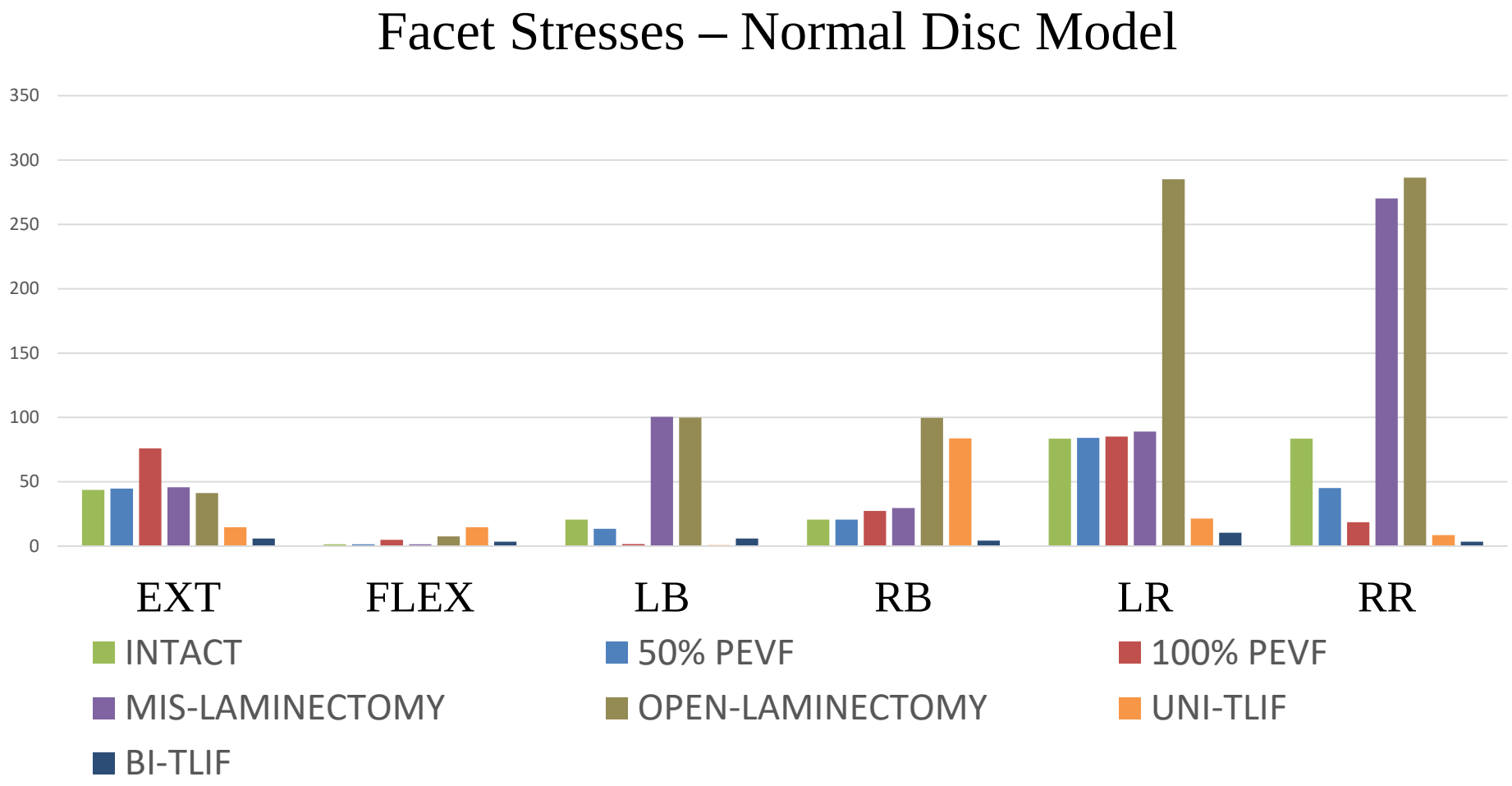
Results: Disc Stress



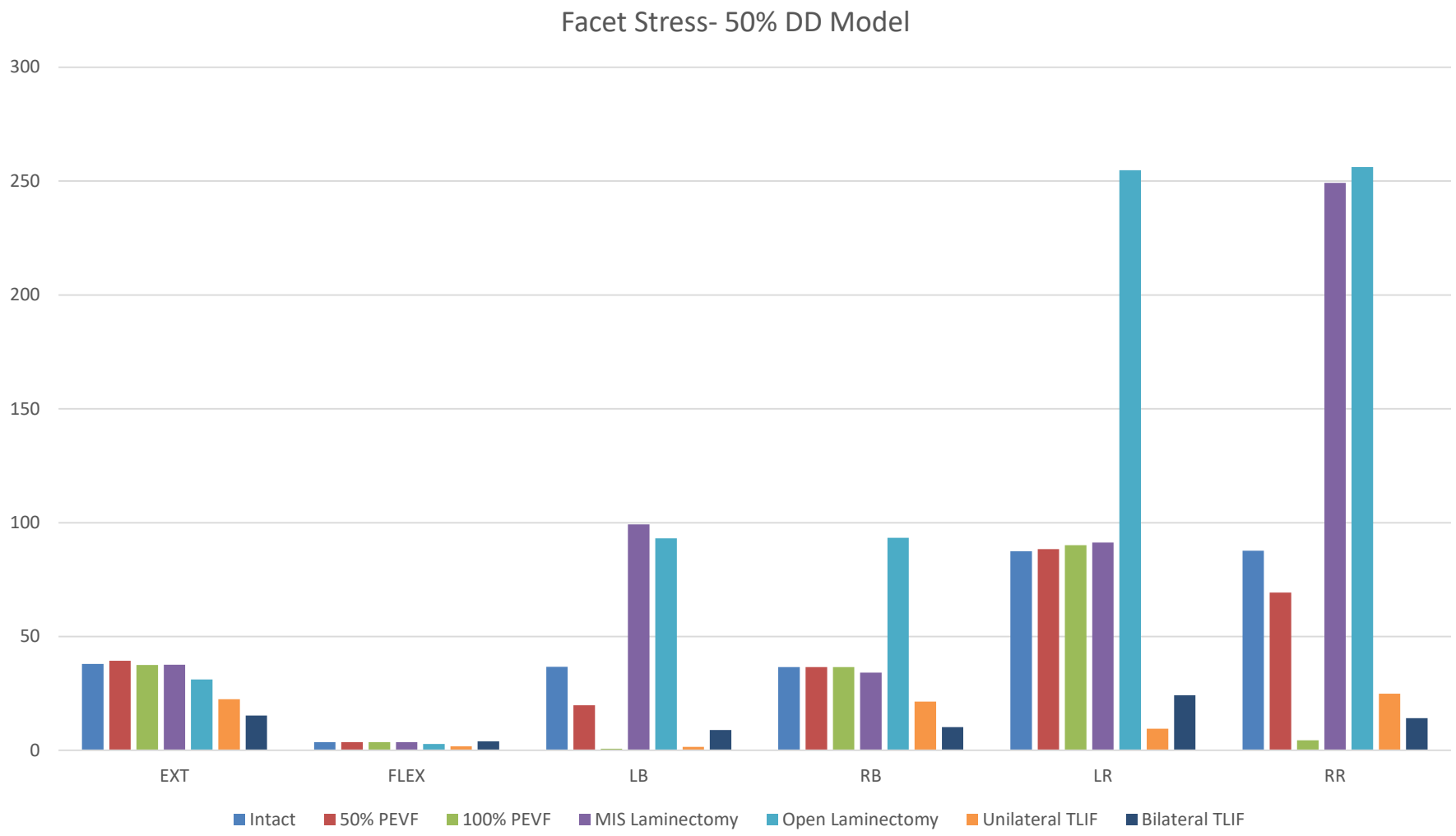
Results


Disc Stress Data - 80% DD Model
9
8
7
6
5
4
3
2
1
0
EXT
FLEX
LB
RB
LR
RR
Intact
50% PEVF
100% PEVF
MIS Laminectomy
Open Laminectomy
Unilateral TLIF
Bilateral TLIF

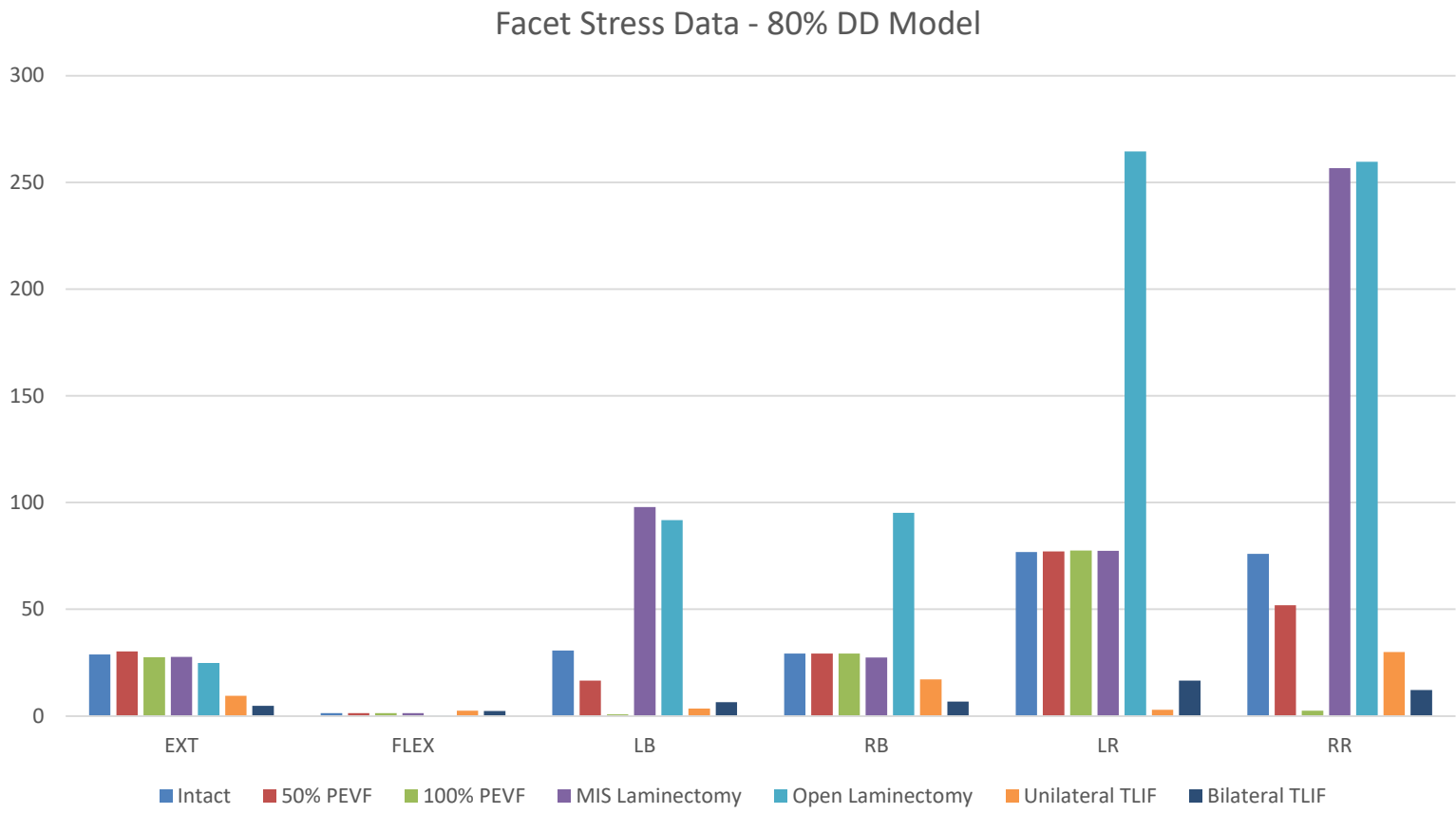
Results


Facet Stresses – Normal Disc Model
350
300
250
200
150
100
50
0
EXT
FLEX
LB
RB
LR
RR
INTACT
50% PEVF
100% PEVF
MIS-LAMINECTOMY
OPEN-LAMINECTOMY
UNI-TLIF
BI-TLIF

Results


Facet Stress- 50% DD Model
300
250
200
150
100
50
0
EXT
FLEX
LB
RB
LR
RR
Intact
50% PEVF
100% PEVF
MIS Laminectomy
Open Laminectomy
Unilateral TLIF
Bilateral TLIF

Results


Facet Stress Data - 80% DD Model
300
250
200
150
100
50
0
EXT
FLEX
LB
RB
LR
RR
Intact
50% PEVF
100% PEVF
MIS Laminectomy
Open Laminectomy
Unilateral TLIF
Bilateral TLIF

Discussion

- Out of all the scenarios without instrumentation, the lowest instability surgery is 50% PEVF.
- Out of all scenarios with & without instrumentation, the lowest instability surgery is TLIF with bilateral fixation.
- The highest instability surgery is 100% PEVF or open laminectomy.
- ROM after PEVF in 50% and 80% disc collapse models decrease when compared with normal disc.
- Even 100% PEVF can be effective in 50 and 80% disc collapse models because ROM of 100% PEVF in disc degeneration model are lower than ROM of intact model in normal disc.
- The lowest stress of disc is with 50% PEVF in all the cases.
- Facet stress with 50% PEVF are less than conventional laminectomy (MIS-laminectomy and open-laminectomy) in all the scenarios.
- These low values of annulus and facet stress in 50% PEVF may prevent subsequent degeneration of discs and facet joints.

Conclusion

- 50% PEVF is the lowest instability surgery.
- Even 100% PEVF may be effective in 50% and 80% disc collapse patients.
- 50% PEVF could be effective in minimizing degeneration of disc and facet after surgery.

Milestones & Timeline

- Develop and validate expandable cage models and PEVF+fixation model - August 2018
- Develop and validate scaled up/scaled down spine models with PEVF – August 2018
- Develop and validate Facetectomy models – August 2018
- Finish/perform all analysis – August 2018
- Data analyses, publications, and final report – September 2018

Acknowledgements

- ECORE Team
- CDMI
- Dr. Sairyo