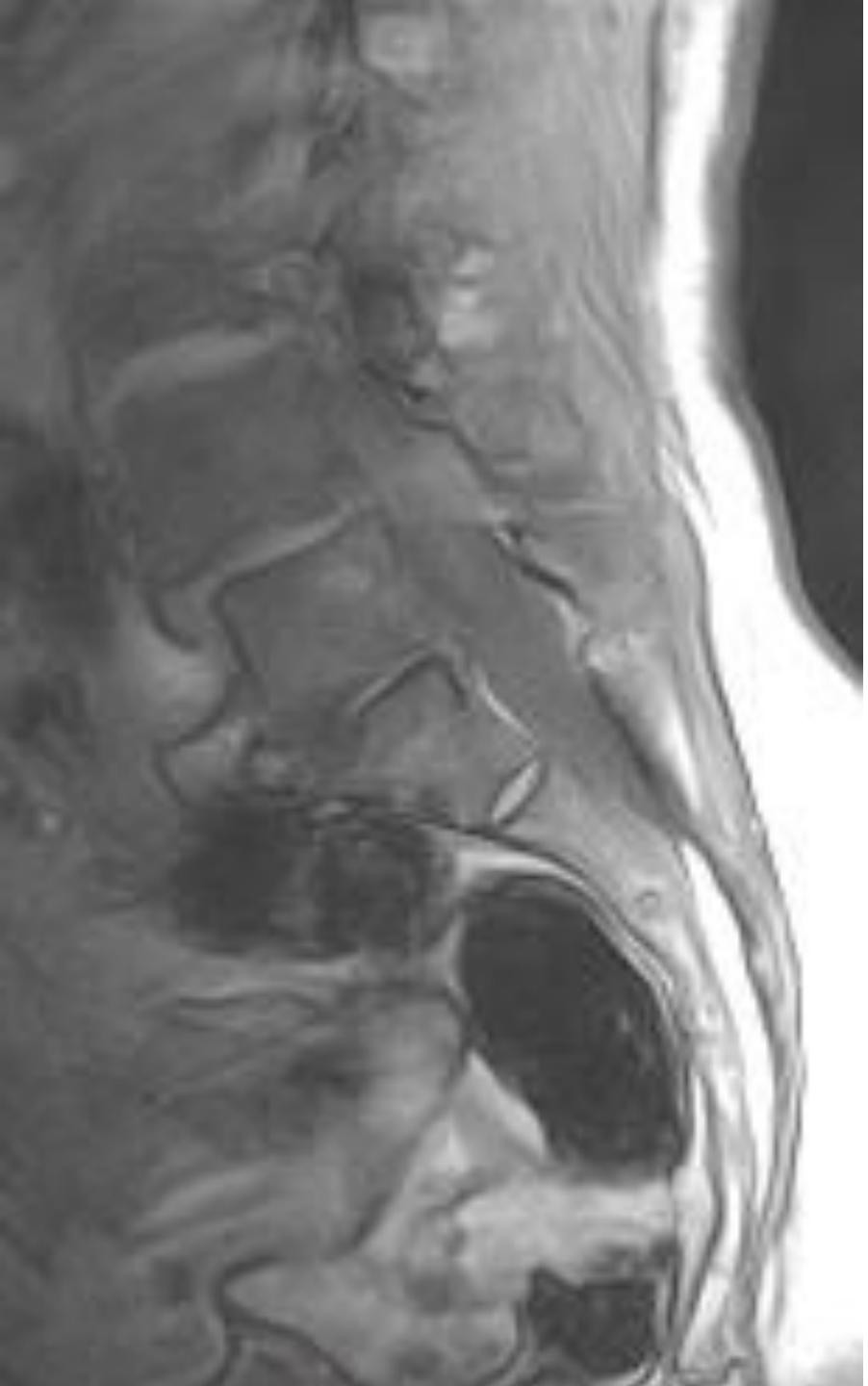


Effect of Posture on Lumbopelvic Muscle Morphometry and Geometry in Adult Spinal Deformity Patients from Upright MRI

Shaikh N.[1,2,3], Zhang H.[4,5], Beresford-Cleary N.[5], Street J.[2,5], Wilson D.[2,4,5], Oxland T.[2,3,5]

[1]Biomedical Engineering, University of British Columbia (UBC), Vancouver, Canada
[2]ICORD, UBC, Vancouver, Canada, [3]Mechanical Engineering, UBC, Vancouver, Canada
[4]CHHM, UBC, Vancouver, Canada, [5]Orthopaedics, UBC, Vancouver, Canada

Feburary 2021

Contact: noor.shaikh@alumni.ubc.c

The Canadian Spine Society is a collaborative organization of spine surgeons and health care professionals with a primary interest in advancing excellence in spine patient care, research and education.

DISCLOSURE OF POTENTIAL CONFLICT OF INTEREST FORM

This page must be the first slide of your presentation (oral, e-poster, symposium, debate)

○ I **DO NOT** have any affiliations (financial or otherwise) to declare. Speakers who have no involvement with industry should inform the audience that they cannot identify any conflict of interest.

◉ I **HAVE / HAD** an affiliation (financial or otherwise) to declare. Complete the section below as it applies to you during the past two years. Please indicate the commercial organization(s) with which you have/had affiliations, and briefly explain what connection you have/had with the organization. You must disclose this information to your audience.

	RELEVANT DISCLOSURE RELATIONSHIPS	COMPANY/ORGANIZATION
A	I am a member of an Advisory Board or equivalent with a commercial organization.	
B	I am a member of a Speaker Bureau.	
C	I have received payment from a commercial organization (including royalties, gifts or other consideration or 'in kind' compensation).	
D	I have received a grant(s) or an honorarium from a commercial organization.	Funding for this work was received from Medtronic Canada.
E	I hold a patent for a product referred to in the CME/CPD program or that is marketing by a commercial organization.	
F	I hold investments in a medical devices company, pharmaceutical organization or similar.	
G	I am currently participating in or have participated in a clinical trial within the past two years.	

CHECK ALL THAT APPLY: Presenter ☑ Program Committee ☐ Moderator ☐ Speaker ☐

NAME OF EVENT: 21st Annual Scientific Conference of the Canadian Spine Society

DATE: Feb 3,10,15,17,24, 2021 **LOCATION:** Virtual Conference ON Canada

Please enter all abstract numbers you are presenting
ABSTRACT NUMBER(S): 30

Please enter your title, first & last name
ACKNOWLEDGEMENT: Noor Shaikh

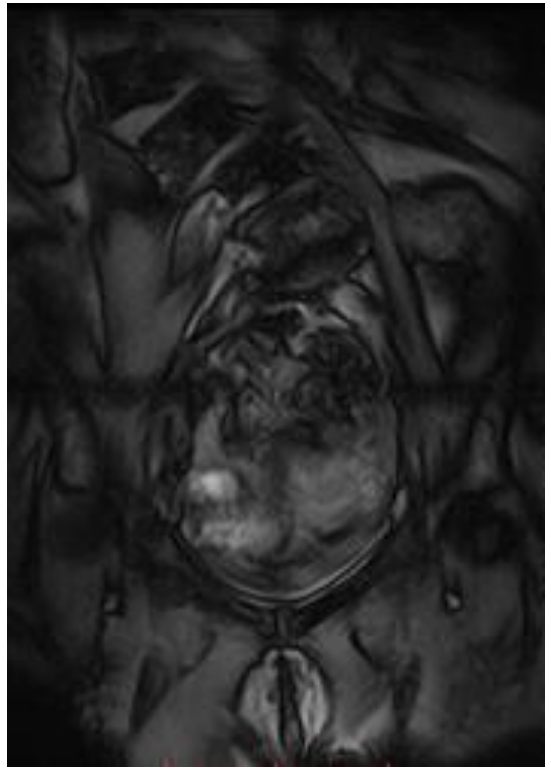
I acknowledge that this information is accurate. I understand that this information will be publically available.

SIGNATURE: Noor Shaikh **DATE:** Jan 9, 2021

Email completed form to **registration@spinecanada.ca**

Adult Spinal Deformity (ASD)

- Previously thought primary causes were degenerative changes in intervertebral discs or facet joints leading to asymmetric collapse and deformity [1]
- Recent work highlights importance of *lumbopelvic muscle* [2] – however all supine imaging



Example ASD patient coronal scout

Goal:

To assess the effect of *upright posture* on *lumbopelvic musculature* & geometry in pre-operative *ASD* patients using upright magnetic resonance imaging (MRI)

[1] Ames, 2016; [2] Glassman, 2016

Methodology – Imaging & Postures

- 0.5T upright MRI (MROpen, Paramed)
  - T1-weighted Spin Echo sequences
  - 5 postures (Fig. 1)
- Measures:
  - *Muscles* multifidus/ erector spinae, psoas major, gluteus, iliopsoas (Fig. 2)
  - *Muscle parameters* muscle cross-sectional area (CSA), position (radius & angle) (Fig. 2)
  - *Bony geometry parameters*: pelvic tilt (PT), pelvic incidence (PI), sacral slope (SS), L1-S1 lumbar lordosis (LL)

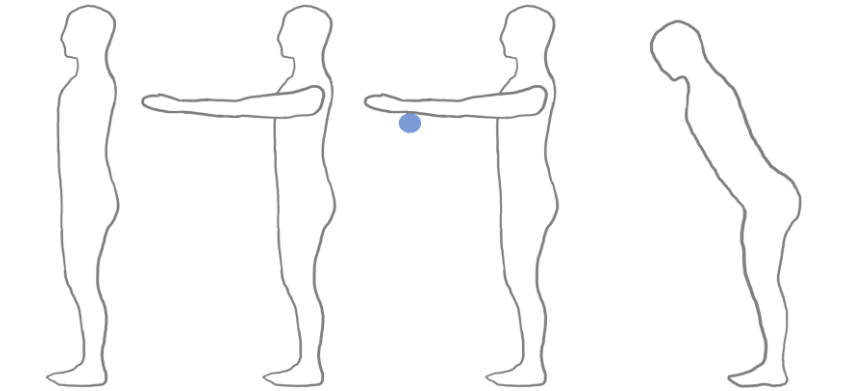


Fig 1. Four of five postures, supine not shown.

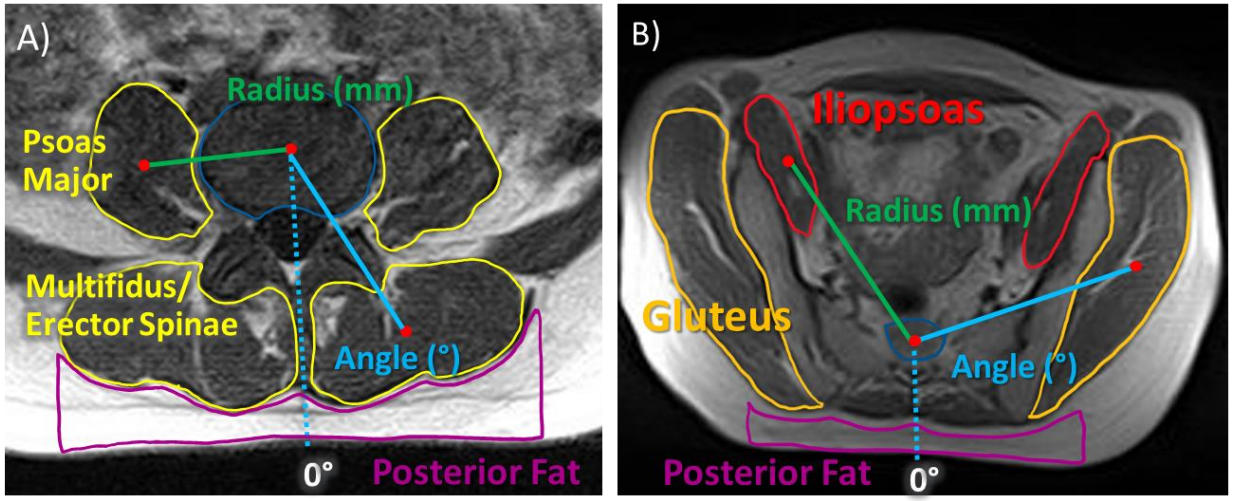
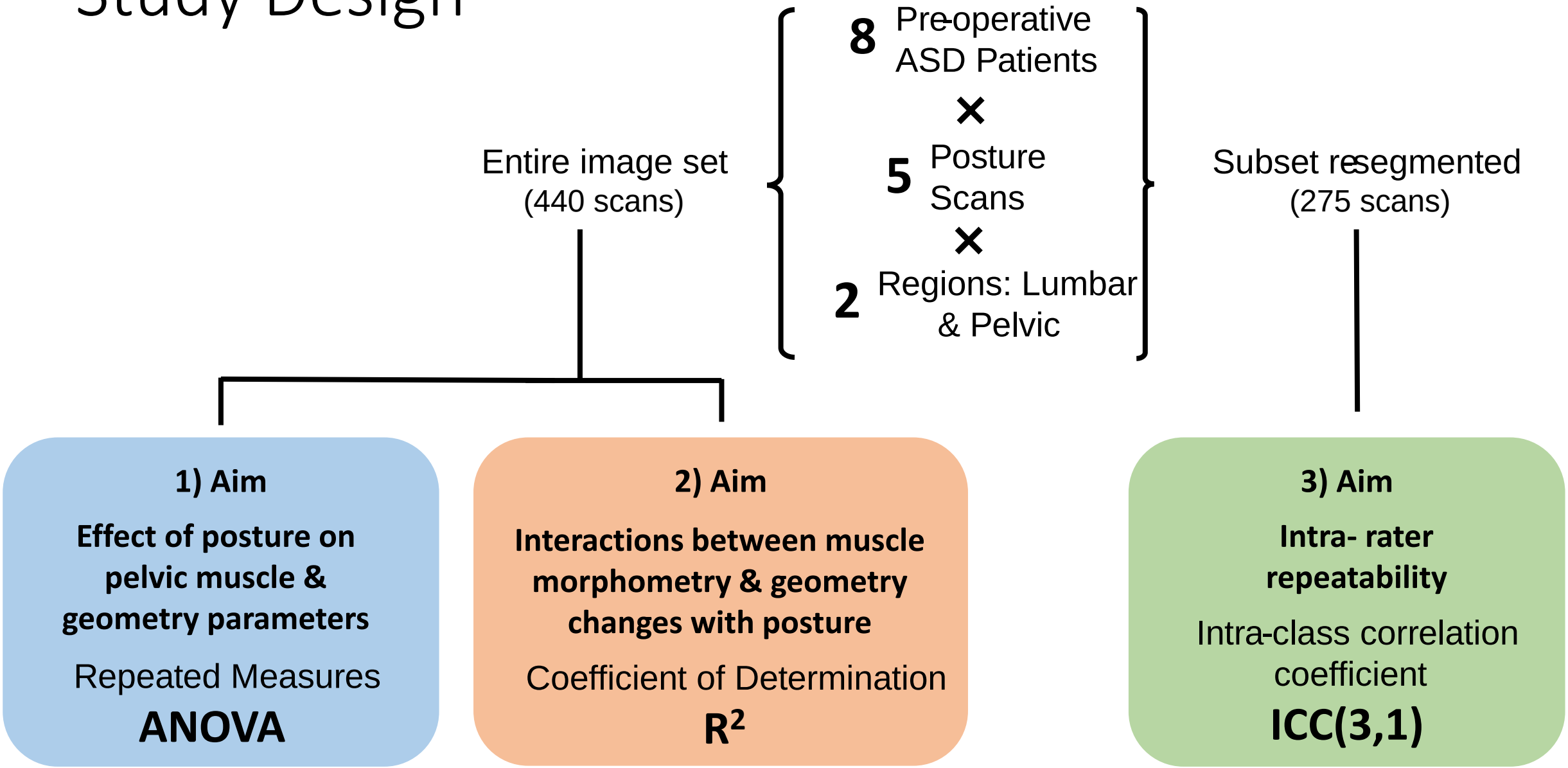


Fig 2. Lumbar and pelvic parameters, muscle CSA (yellow, red outlines), radius (mm) (dark green), angle (degrees) (blue). A) Lumbar measures. B) Pelvic measures.

Study Design



Results – Muscle

Posture had significant effects & interactions on lumbopelvic muscle parameters

Multifidus/erector spinae: flexion to other postures

- Increase CSA up to 11%, radius up to 4% (Fig. 1, 2)

Gluteus: level dependent effects

- Ex: Standing to supine CSA (S4/S5) increased 17% (Fig

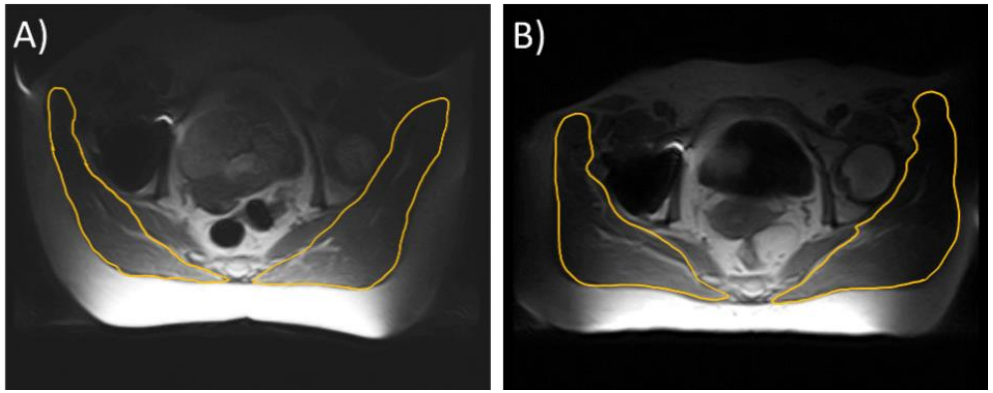


Fig. 3 Increase in gluteus CSA at S4/S5, increased 17% from standing (A) to supine (B)

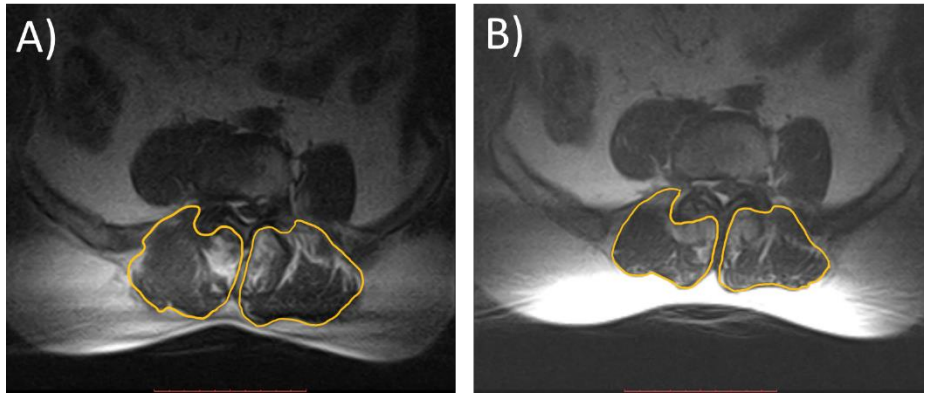


Fig 1. Decrease in multifidus/erector spinae CSA at L4/L5, decreased 11% from standing (A) to flexion (B).

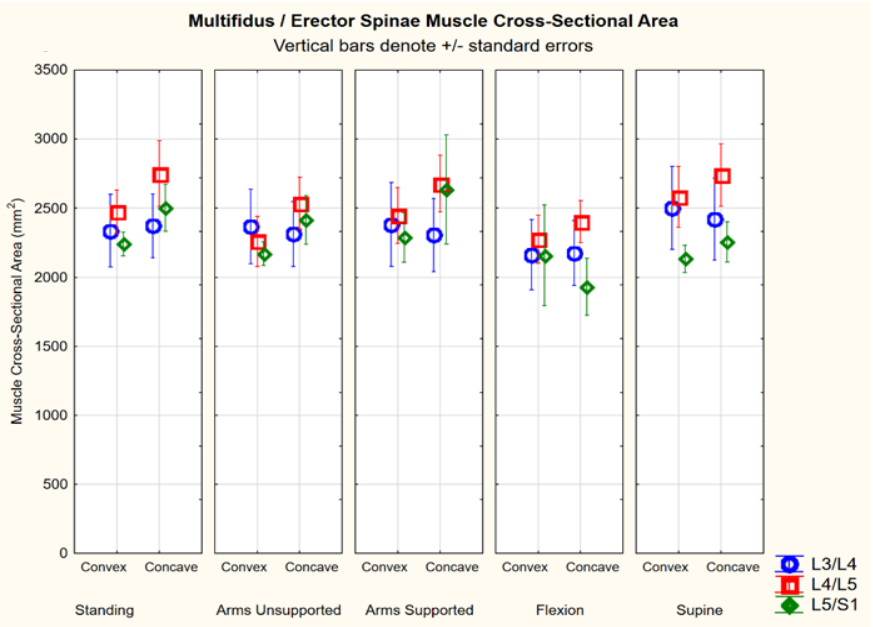


Fig 2. Multifidus/erector spinae CSA by side and level, shown by posture

Results – Muscle (con't)

Psoas major:

- Convex to concave, CSA (L3/L4) decreased 16% (Fig. 1)

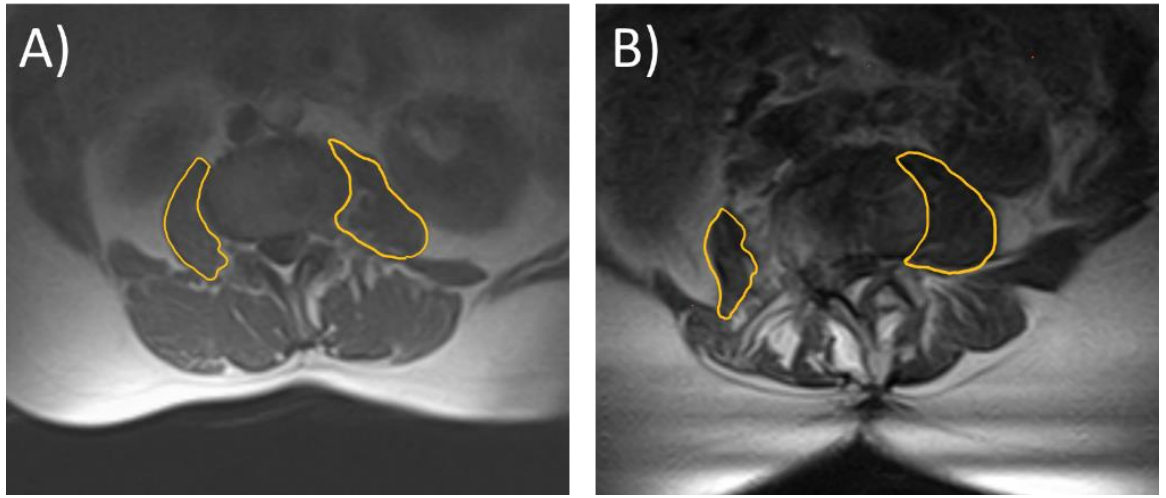


Fig. 1 Decrease in psoas major CSA at L3/L4 by 16% from convex to concave (in two different patients, A and B), (convex on patient left)

Results – Geometry

Posture affected PT (Fig. 2 A), SS, and LL, but not PI (Fig. 2 B)

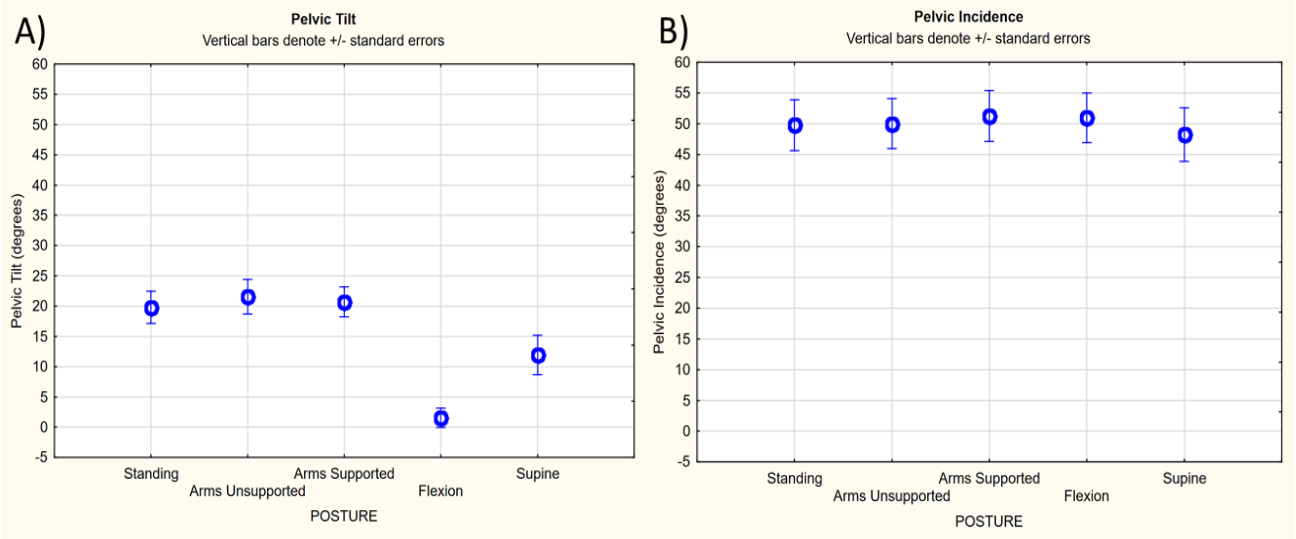


Fig 2. A) Pelvic tilt (PT) by posture, B) Pelvic incidence (PI) by posture

2) Aim

Results – Correlations

Positive correlation expected between muscle CSA & bony geometry

- From passive muscle deformation with changing posture

However, *lack of correlation in 60-75%* of measures

- Between CSA and L3-S1 LL, or CSA and PT (Fig. 1)
- Correlations present were muscle, level, and individual specific

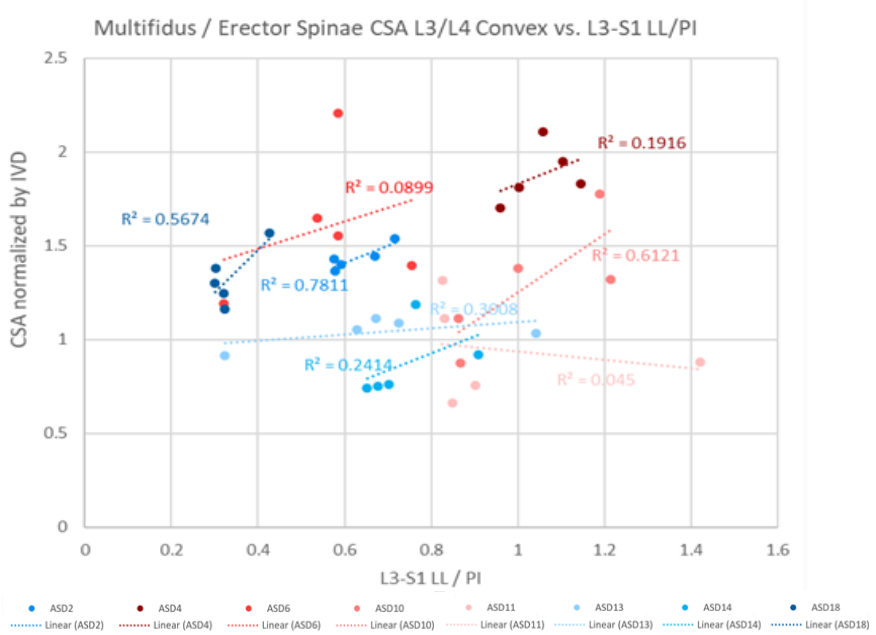


Fig 1. Example correlations for multifidus / erector spinae CSA vs. L3-S1 LL

3) Aim

Results – Repeatability

ICC(3,1) averages were 0.52-0.97 (muscle CSA) and 0.91-0.97 (geometry)

Discussion

- Study *confirms previous supine findings*
  - Scoliosis work showed increased convex psoas CSA [1], observed at L3/L4 (Fig. 1)
  - Trunk flexion reduced extensor CSA (lying on side) [3], observed for MF/ES CSA
- Effects & trends of posture
  - Starts to emphasize *importance of considering upright & postural changes* on lumbopelvic muscle morphometry in ASD
- Effect of posture on PT, SS, and LL but not PI
  - *Aligns with clinical expectation* – PT , SS, and LL are functional (posture dependant), PI is morphometric (fixed)
- *Correlations patient & level specific* between muscle CSA & geometry
  - Influenced by muscle activation? – unique to compensatory mechanisms for upright postures?
- Promising *repeatability*
  - Feasibility of ASD upright imaging of lumbopelvic muscle & geometry in tandem

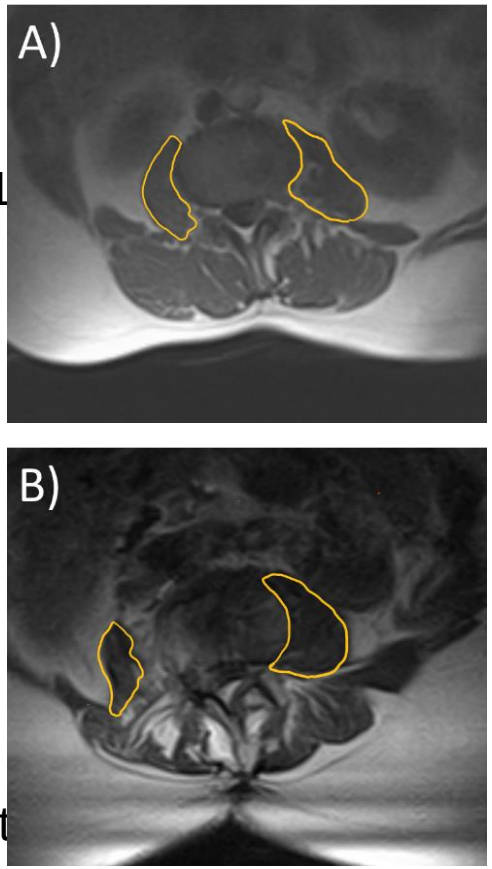
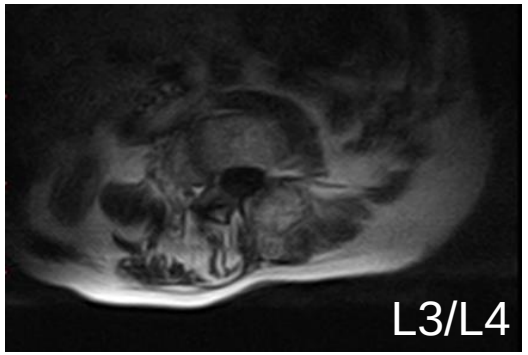


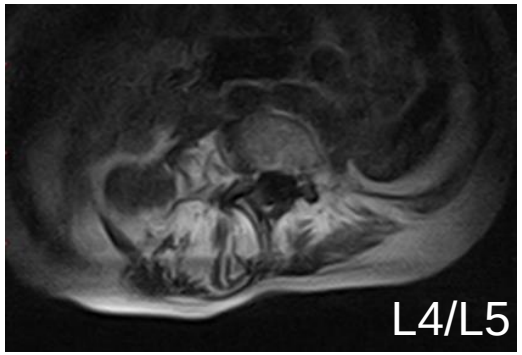
Fig. 1 Decrease in psoas major CSA at L3/L4 from convex to concave, by 16% (two different patients, A, B), (convex on patient L)

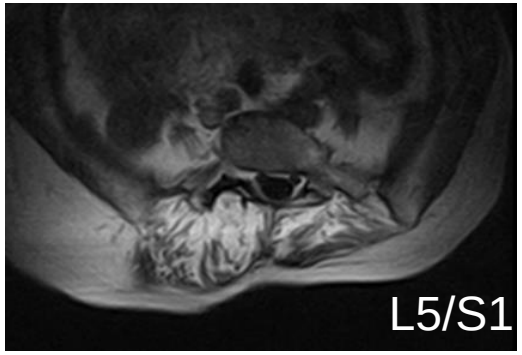
[1] Tang, 2020; [2] Kim, 2013; [3] Jorgensen, 20

Conclusion

- Effects, trends, and correlations with posture
  - Emphasize *importance of considering upright & postural changes* on lumbopelvic muscle morphometry in ASD patient
- *Promising repeatability*
  - Upright imaging of muscle morphometry & bony geometry, in tandem
- Work helps lay foundation for furthering understanding of ASD upright muscle morphometry
  - Could help inform *future biomechanical modeling, mitigation, and treatment of ASD*







Acknowledgements: The authors are grateful to NSERC and Medtronic Canada for financial support in the form of a research grant