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# The Effect of Seating Setup on Shear Forces Experienced at the Seating Interface

By Jacob Redwood-Thomas

## Definition of shear:

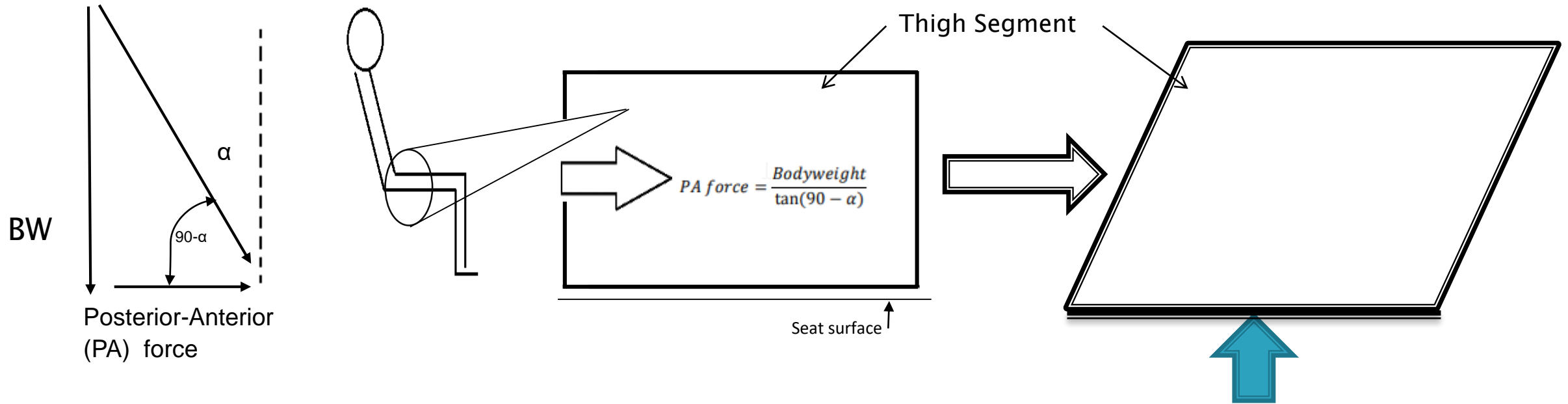
*‘an action or stress resulting from applied forces, which causes or tends to cause two contiguous internal parts of the body to deform in the transverse plane’*

*– National Pressure Ulcer Advisory Panel (NPUAP) 2015*

# Background

- ▶ Pressure ulcer cost to the NHS is estimated to be £1.74billion for 2017/2018<sup>[7]</sup>
- ▶ Animal studies found that when shear forces are present, there is an increased severity of pressure ulcer in comparison to pressure alone<sup>[4][5]</sup>
- ▶ Shear forces have been shown to reduce ability of blood to flow<sup>[2][3][6]</sup>
- ▶ The effect of shear is worse than pressure, as shear forces will cut off the blood supply to a larger area<sup>[8]</sup>
- ▶ Almost half the pressure is required to reduce blood flow to a point where ischaemia occurs when sufficiently high shear forces are present  
[1]

# Effect of increased recline



↑

Skin in contact with seat surface is held in place by friction, whilst the rest of the segment is free to move forward

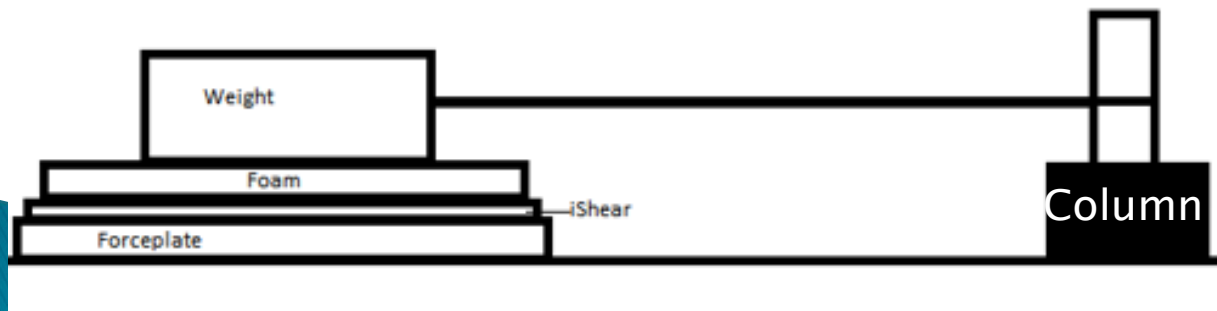
# Measuring Shear Forces

- ▶ Measuring shear is difficult as devices/sensors interfere with the shear phenomenon
- ▶ The iShear was used in this study
  - Placed under the user and cushion
  - Produces a total shear force reading (TSF) for the whole loading scenario



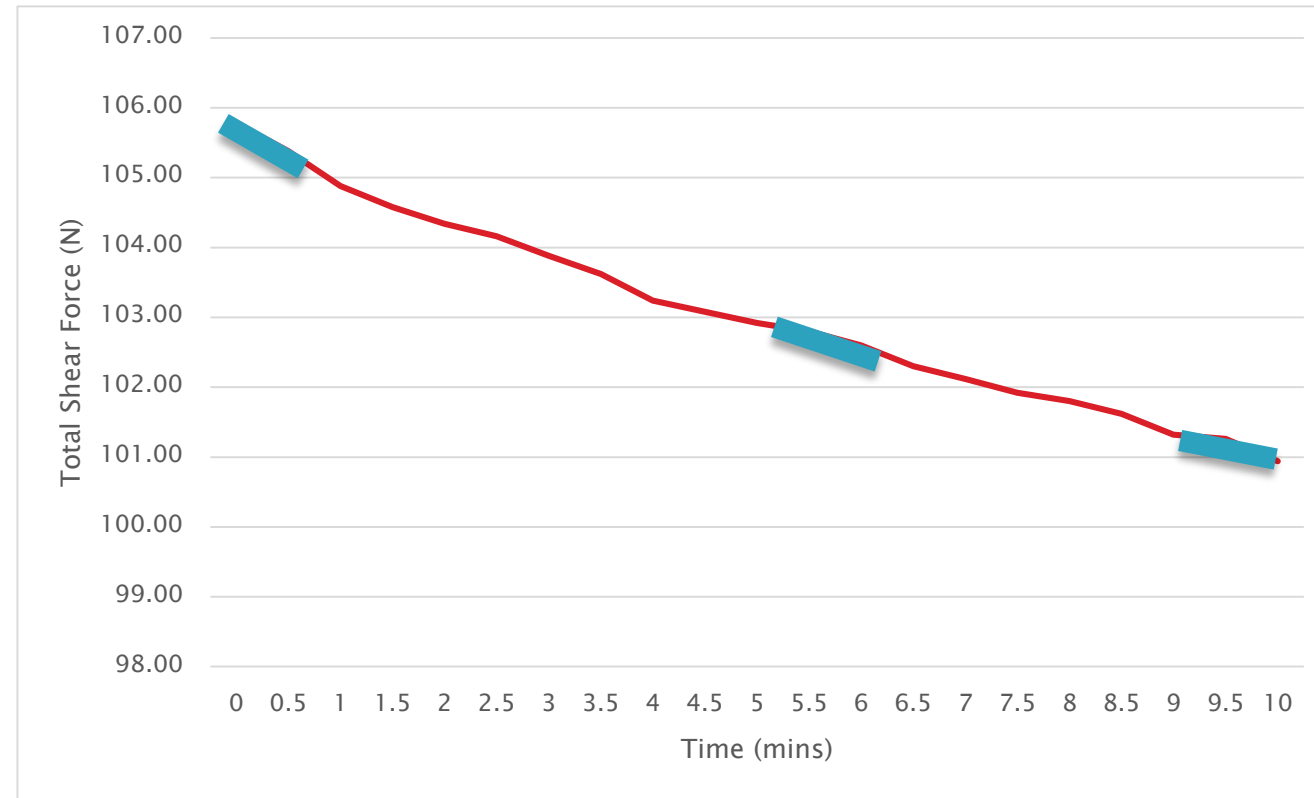
# Preliminary Testing – Validation

- ▶ iShear was validated against a Kistler force plate
- ▶ 25kg, 50kg and 75kg weights used
- ▶ 13 loading conditions (per weight)
- ▶ Pearson correlation of 0.977 for the 50kg test
- ▶ Spearman's rho correlation of 0.986 was calculated for the 25kg and 75kg



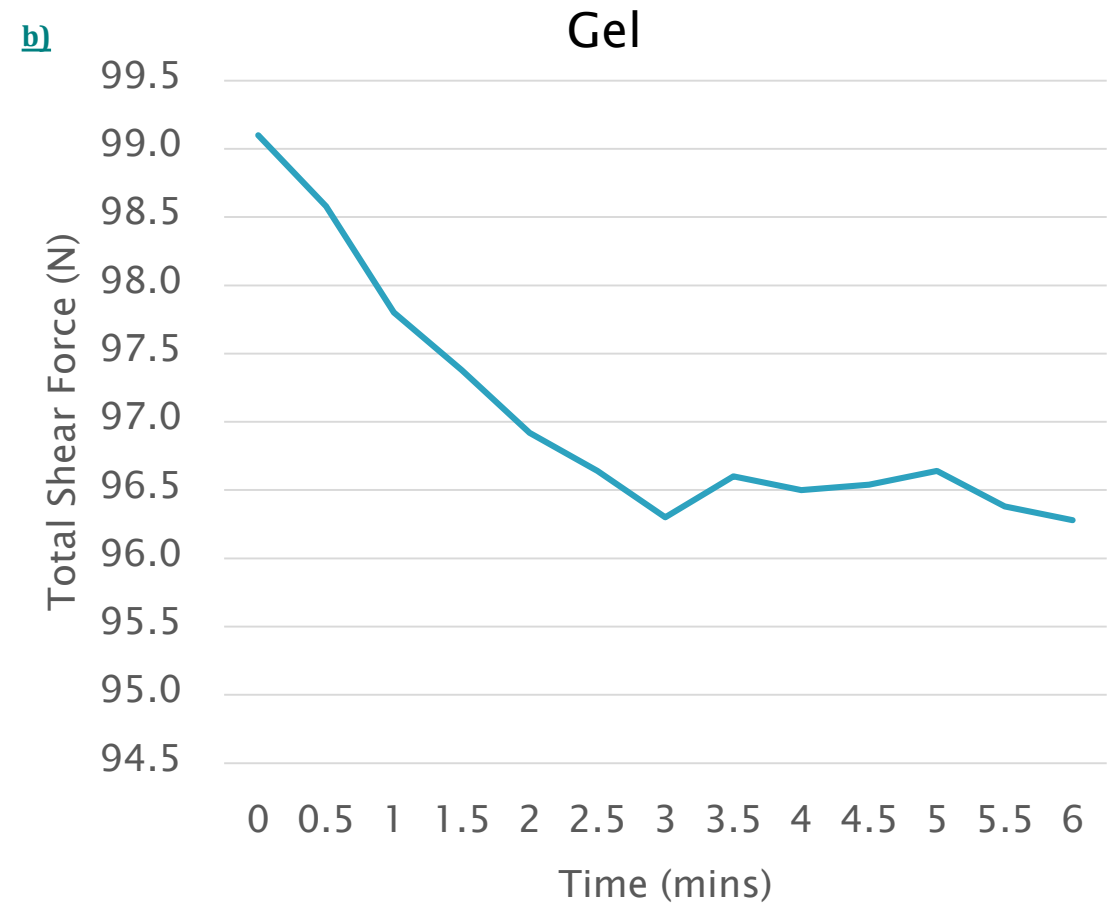
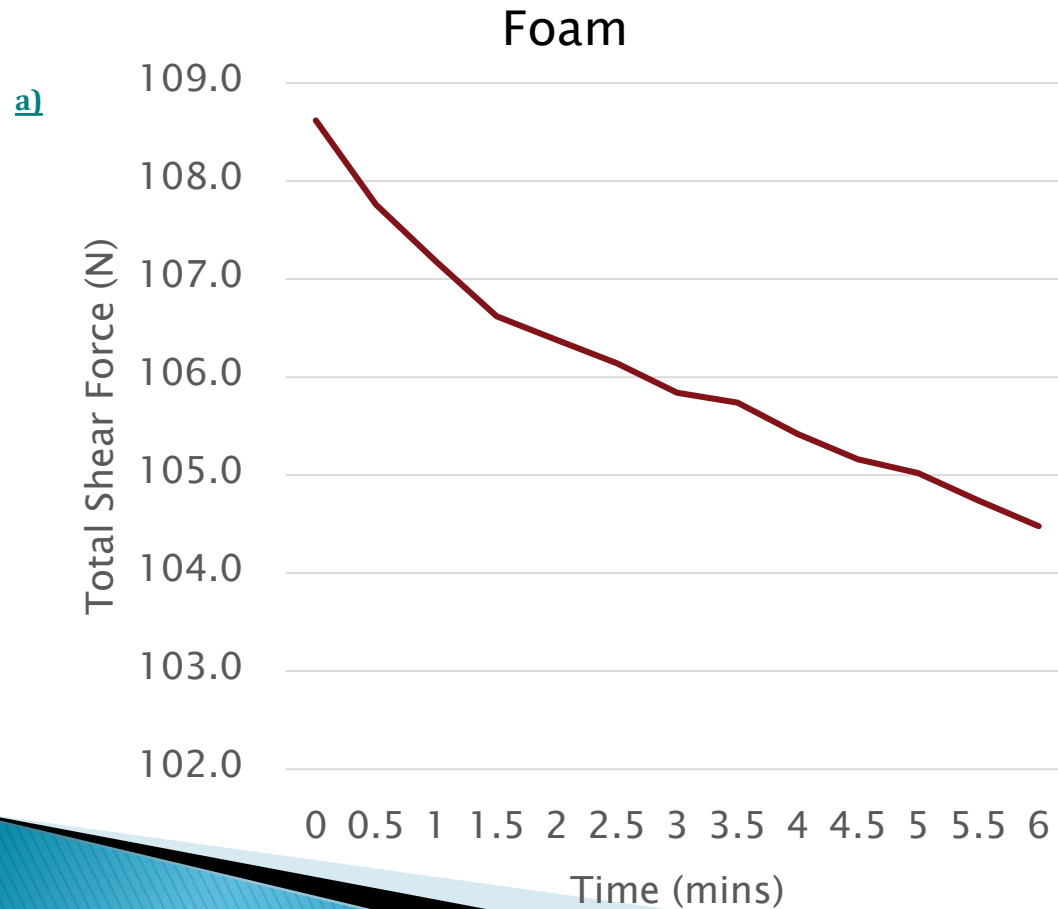
# Preliminary Testing – settling time

- Settling time: time taken for sensor readings to settle
- User sat on cushion a top of iShear to determine settling time with readings recorded every 30 seconds
- Initial gradient was  $y = -0.45x + 106.25$
- Gradient between 5.5 minutes and 6.5 minutes is  $y = -0.25x + 103.07N$
- Gradient between nine and ten minutes is  $y = -0.19x + 101.55N$



# Preliminary Testing – settling time

- Gradient of curve reducing therefore the change of shear over time is decreasing
- Pressure mat settling time has been found to be six minutes<sup>[10]</sup>
- Six minute settling time was chosen based on the above and time/comfort constraints of participants

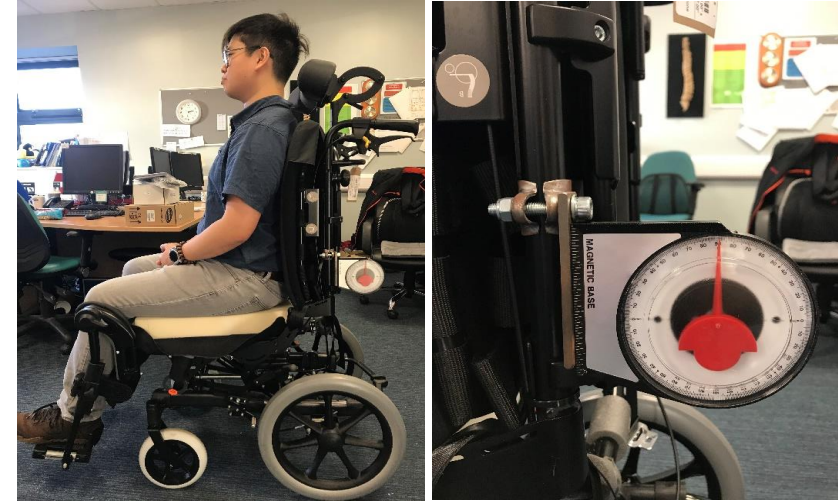




# Seating Setup Testing

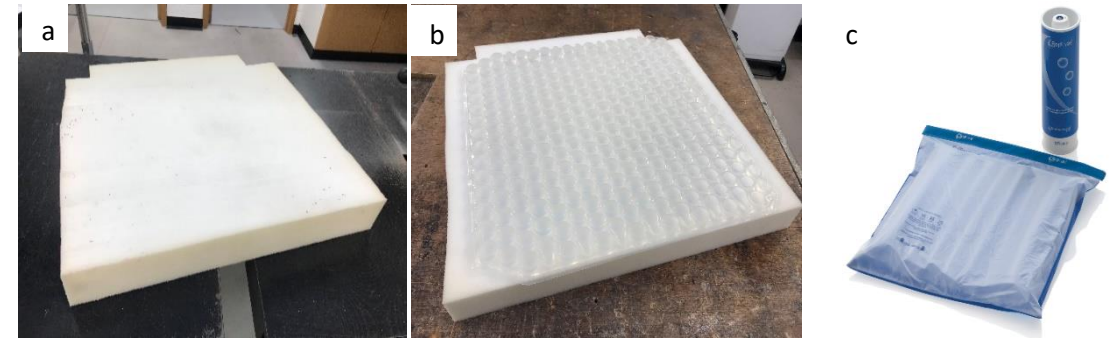
## Test 1

- Ten participants sat at  $0^{\circ}$ T $0^{\circ}$ R,  $0^{\circ}$ T $15^{\circ}$ R,  $0^{\circ}$ T $30^{\circ}$ R,  $15^{\circ}$ T $0^{\circ}$ R,  $25^{\circ}$ T $0^{\circ}$ R and  $45^{\circ}$ T $0^{\circ}$ R
- Total shear force was recorded after six minutes
- Order of testing was randomised to reduce test setup bias



## Test 2

- Ten participants sat at  $0^{\circ}$ T $30^{\circ}$ R on air, foam and gel cushions
- Total shear force was recorded after six minutes
- Order of cushion material was randomised to reduce test setup bias



# Seating Setup Results

- ▶ Repeated one-way ANOVA used to analyse the results of the recline, tilt and cushion material

Test	Comparison	Statistically Sig. Difference (p < .05)	Change in TSF?	Difference (N)
Recline	0° to 15°	Yes	Increase	23.7
	0° to 30°	Yes	Increase	24.8
	15° to 30°	No	Increase	1.1
Tilt-in-space	15° to 25°	Yes	Decrease	22.5
	15° to 45°	Yes	Decrease	60.5
	25° to 45°	Yes	Decrease	38.0
Material	Air to Foam	Yes	Increase	16.0
	Air to Gel	Yes	Increase	13.7
	Gel to Foam	No	Increase	2.3

# Conclusion

- ▶ Seating set-up impacted on the TSF at the user-seat interface
  - Increasing recline increased TSF
  - Increasing tilt reduced TSF in the PA direction
  - Increasing tilt above  $\sim 25^\circ$  induces shear in the opposite direction
  - Air was the most effective cushion in reducing TSF
- ▶ Readings provided are for the whole system as opposed to what is occurring within the tissues
- ▶ Horizontal/shear forces can increase the risk of developing a pressure ulcer<sup>[4][5]</sup>
- ▶ Some seating set ups which may be advised for optimal pressure relief, may be sub-optimal for shear

# References

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# Thank you for listening

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