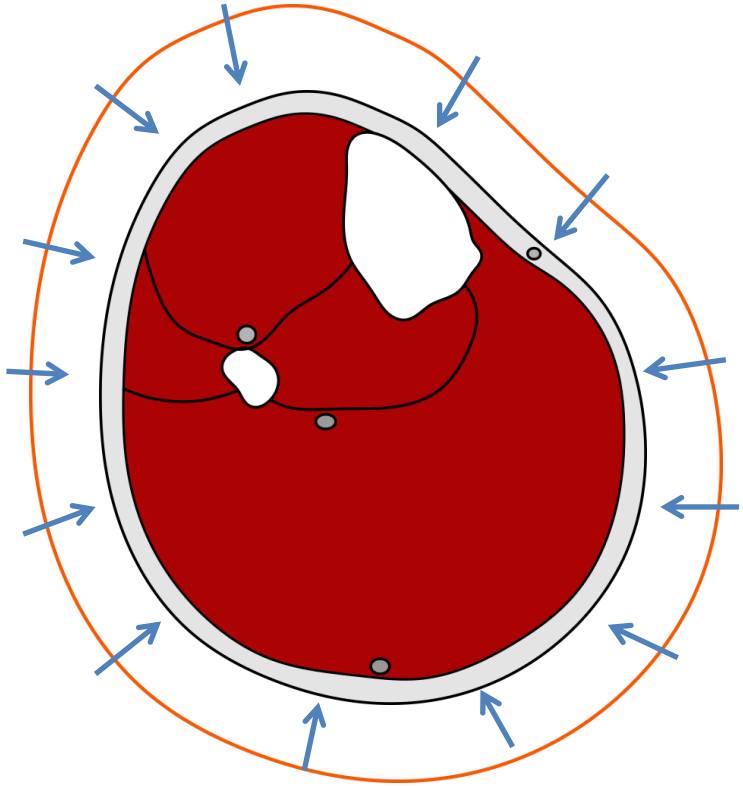
WHAT IMPACTS INTERFACE PRESSURE APPLIED BY ELASTIC COMPRESSION BANDAGES?

F. Chassagne, P. Badel, R. Convert,
P. Giraux, J. Molimard

Medical compression bandages

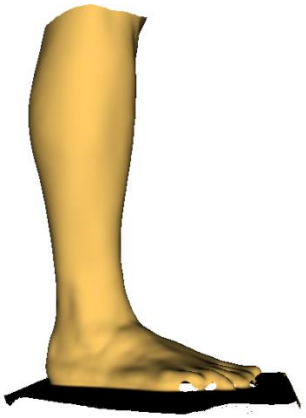
- Venous or lymphatic pathologies
- Stretched fabric applied on the limb
- Interface pressure transmitted through soft tissues to the veins



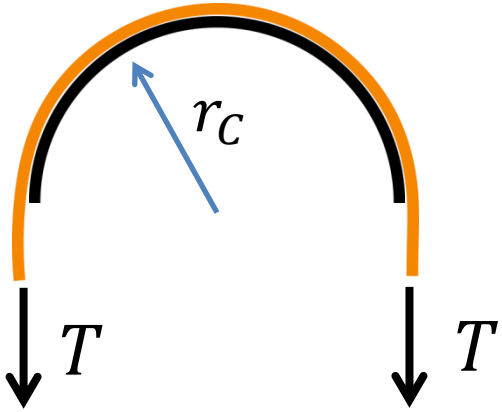
Better control of interface pressure
⇒ Better controlled treatment

How to predict interface pressure ?

Laplace's Law



+



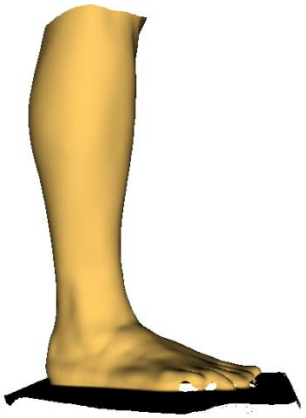
Underformed leg geometry
(r_c = radius of curvature)

Bandage tension *(T)*

Application technique
(n = number of layers)

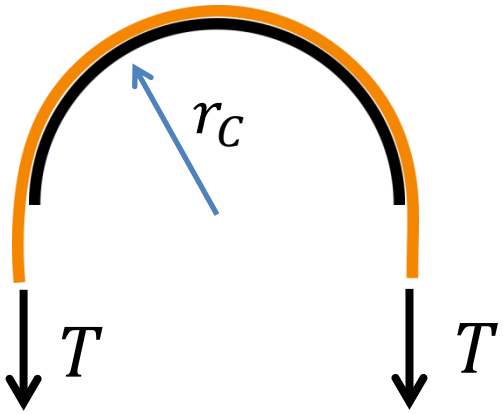
$$P = \frac{n\,T}{r_C}$$

Laplace's Law



+

→



30 subjects

Biflex 16 ® (Thuasne)

2-layer bandage

Biflex 17 ® (Thuasne)

3-layer bandage

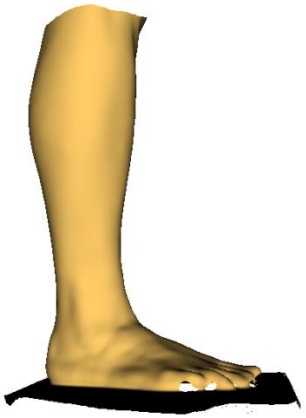
$$P = \frac{n\,T}{r_C}$$

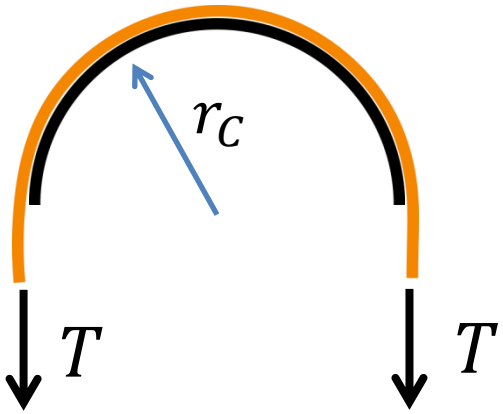
Pressure was proportional to number of layers

<u>BUT</u> pressure was not directly proportional to bandage tension

[1] Chassagne et al. "Experimental Investigation of Pressure Applied on the Lower Leg by Elastic Compression Bandage." *Annals of Biomedical Engineering* 43, no. 12 (December 2015): 2967–77. doi:10.1007/s10439-015-1352-1.

Laplace's Law





Underformed leg geometry
(r_c = radius of curvature)

Bandage tension *(T)*

Application technique
(n = number of layers)

$$P = \frac{n\,T}{r_C}$$

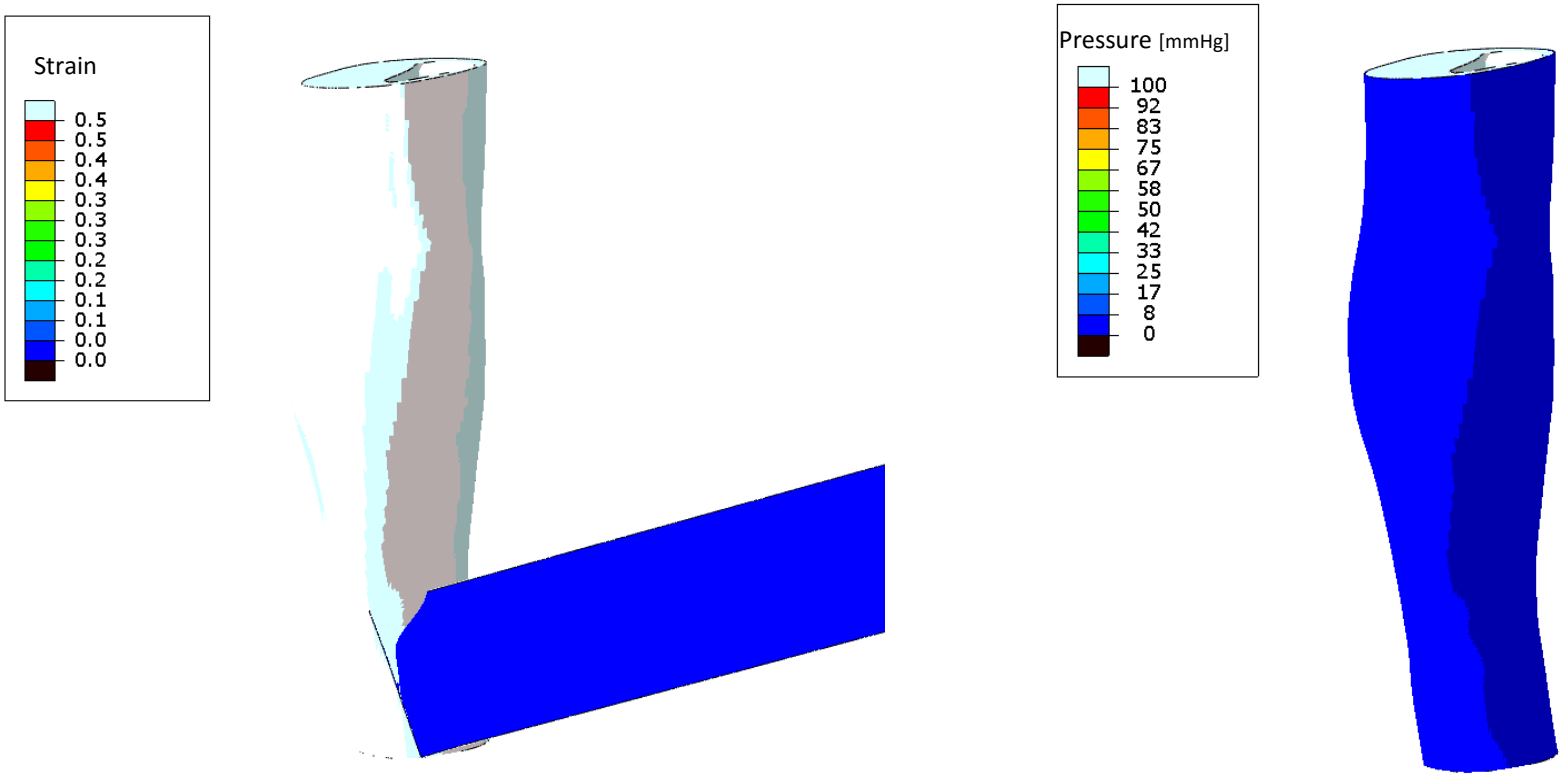
These 3 parameters are not sufficient
to explain interface pressure distribution [1]

→ Which parameters impact interface pressure ??

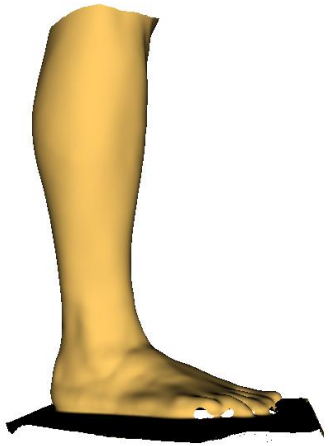
[1] Chassagne et al. "Experimental Investigation of Pressure Applied on the Lower Leg by Elastic Compression Bandage." *Annals of Biomedical Engineering* 43, no. 12 (December 2015): 2967–77. doi:10.1007/s10439-015-1352-1.

Methods

- Evaluation of the impact of different parameters on interface pressure thanks a numerical model of bandage application



New problem definition (1)



Morphology modified by bandage application

Leg soft tissue mechanical properties

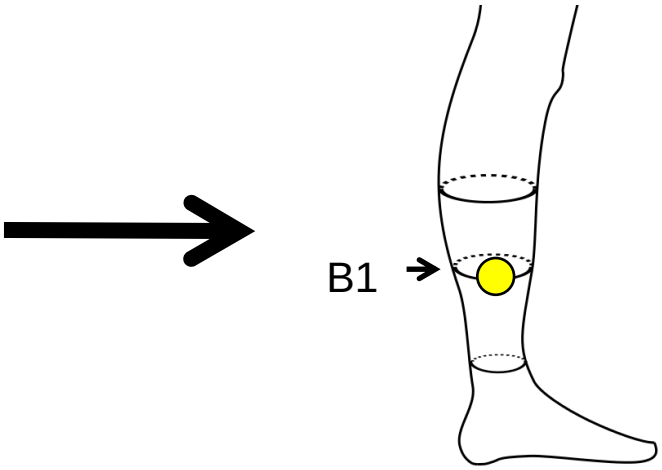
+

Skin – Bandage interactions

Bandage mechanical properties

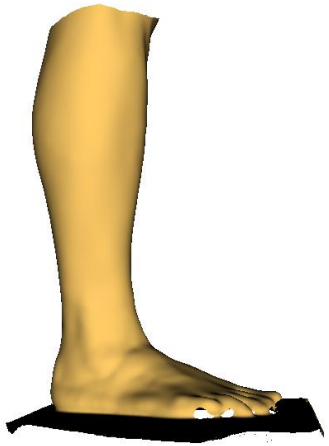
Application technique

Bandage – Bandage interactions

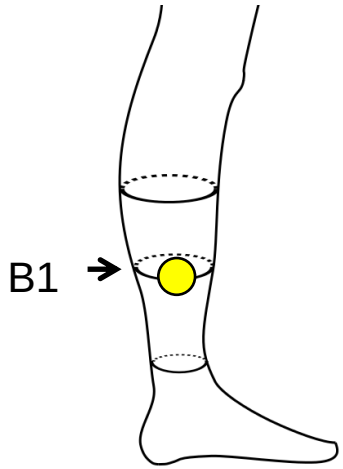


Interface pressure at measurement point B1 ?

New problem definition (1)



+



Interface pressure at measurement point B1 ?

Skin – Bandage interactions

Mean morphology

Bandage mechanical properties

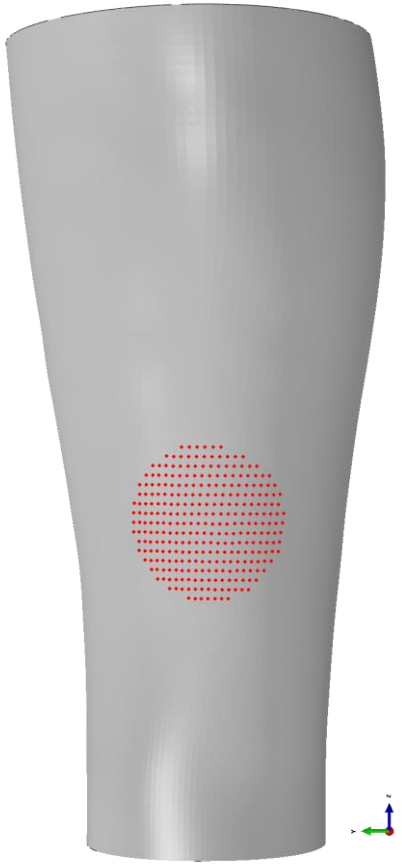
Leg soft tissue mechanical properties

2-layer bandage

3-layer bandage

Bandage – Bandage interactions

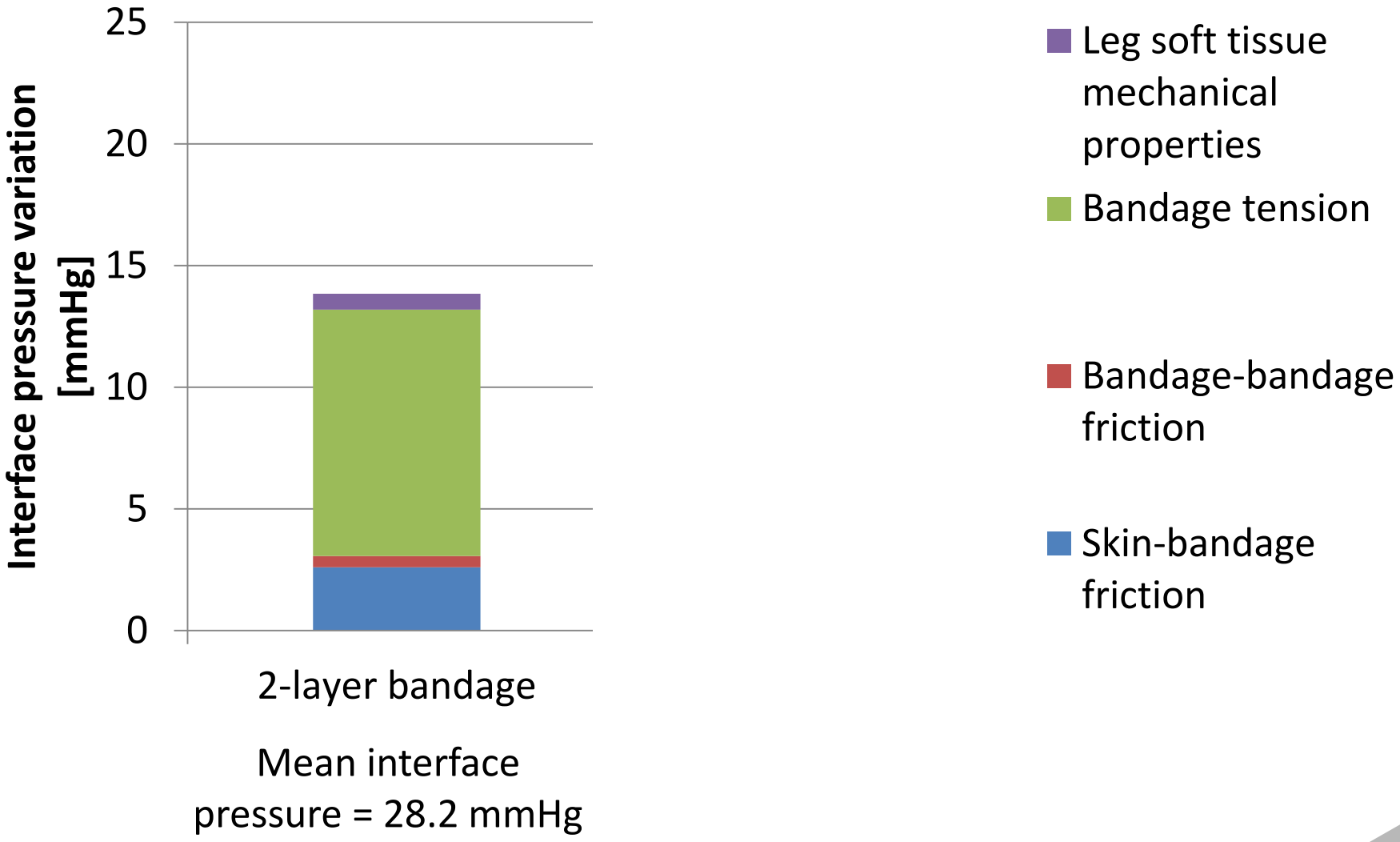
New problem definition (2)



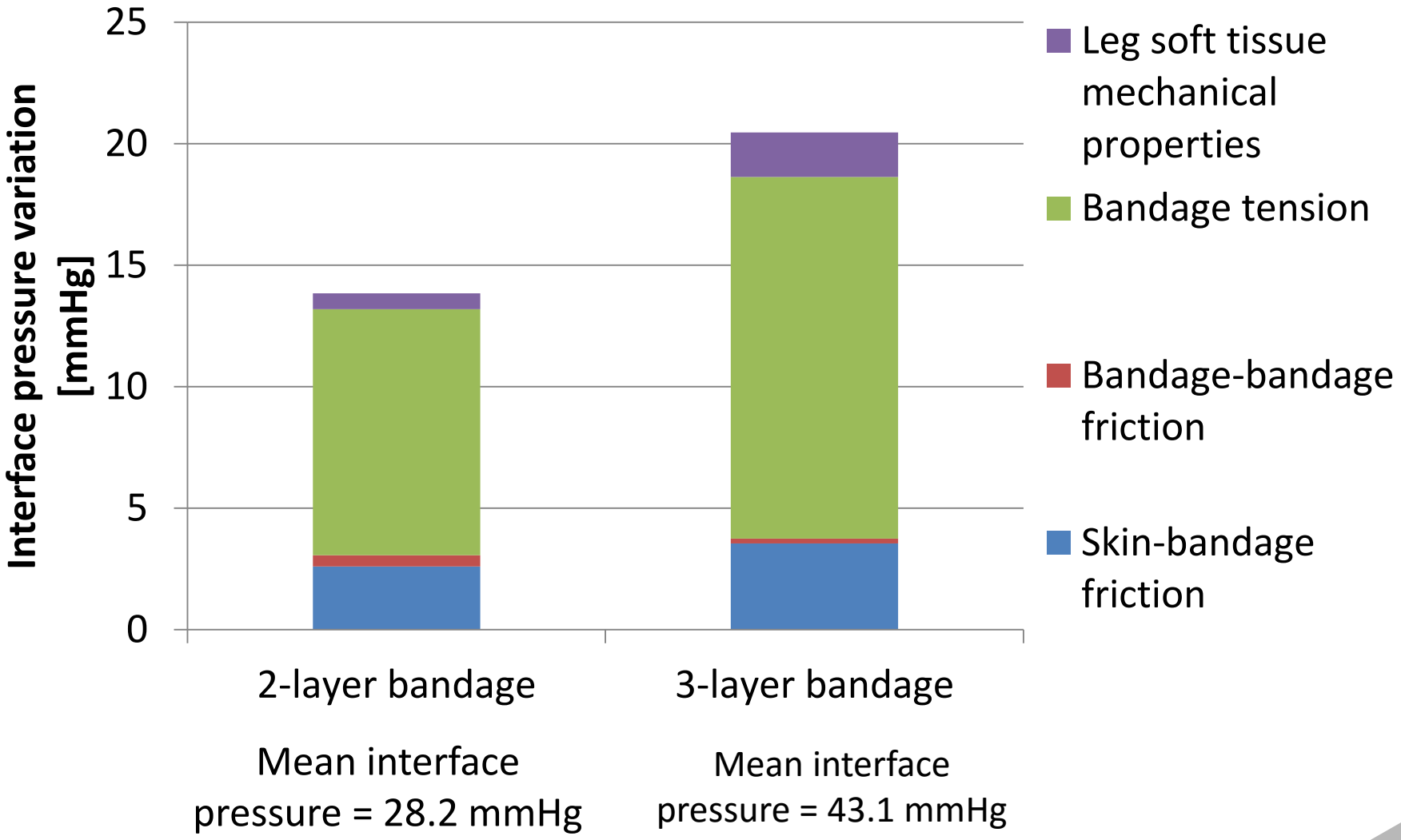
Mean leg geometry

Lowest value	Parameter	Highest value
0.10	Skin-bandage friction coefficient	0.30
0.50	Bandage-bandage friction coefficient	0.70
0.29	Bandage tension [N/mm]	0.68
2.00	Leg soft tissue mechanical properties c_{10} [kPa]	8.00

Contribution of the different parameters to pressure variation



Contribution of the different parameters to pressure variation



Discussion

Skin – Bandage friction

Bandage – Bandage friction

Bandage mechanical properties

Leg soft tissue mechanical properties

→ Significant impact ($p<0.05$) on interface pressure

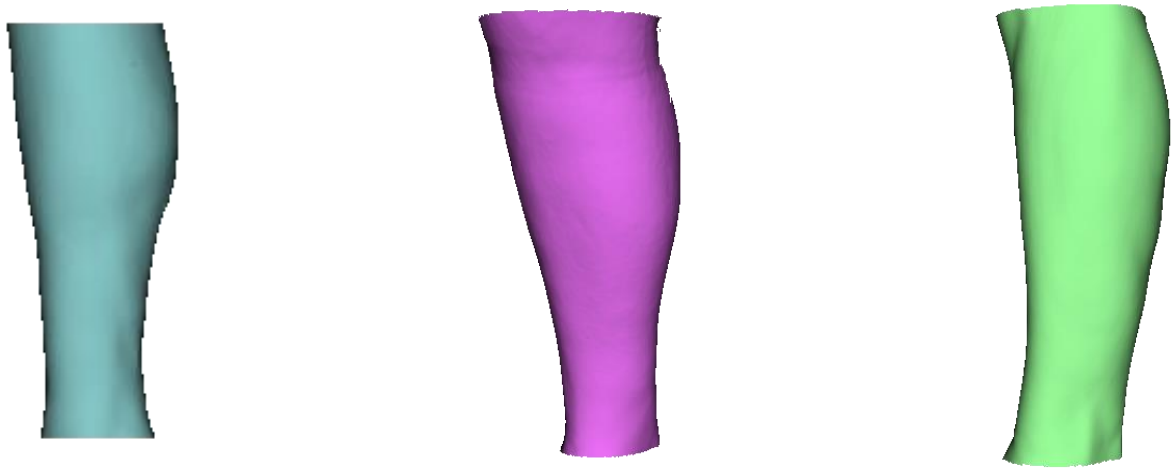
→ Relevant description of interface pressure ($R^2 \geq 0.96$)

→ $Pressure_{\ 3-layer\ bandage} \approx 1.5 * Pressure_{\ 2-layer\ bandage}$

(in agreement with Laplace's Law)

Prospects

- Include the leg morphology in the problem



- Experimental interface pressure measurements to validate the numerical simulation

- How can the pressure sensor modify interface pressure ?

Thank you for your attention

Any question?