

Executive Summary

This project develops a removable, radiolucent cushioning attachment for EMS spine boards to reduce pressure and discomfort during patient immobilization. Conventional boards are rigid at high-pressure areas increasing pain and risk of secondary injury, especially during the transport by EMS to hospital ER. The design uses a lightweight, durable, and disinfectable cushioning layer to improve pressure distribution. Its effectiveness is evaluated using force-sensing resistors (FSRs) and a microcontroller system to measure pressure changes with and without the cushion. Results focus on reductions in peak and average pressure, along with patient comfort. Overall, the project offers a low-cost, practical solution that improves comfort while maintaining standard EMS functionality.

Background

Rigid EMS spine boards are essential for spinal immobilization, but they often create high-pressure regions that lead to discomfort and potential secondary injury to the patient during the transport from accident scene to hospital ER. Existing solutions do not effectively balance patient comfort, imaging compatibility, and real-world usability. This highlights the need for a practical, removable cushioning system that improves pressure distribution without disrupting EMS workflows.



Requirements

Functional Requirements	Physical Requirements
Reduce pressure at shoulders, sacrum and along the spine	Radiolucent (X-ray, CT compatible) immediate imaging diagnosis
Improve patient comfort during immobilization	Lightweight and easy to handle
Maintain spinal support and stability	Durable and puncture resistant
Ensure consistent performance across trials	Waterproof and easy to disinfect
Allow integration with pressure sensors (FSRs)	Removable and secure attachment

Experimental Setup and Test Plan

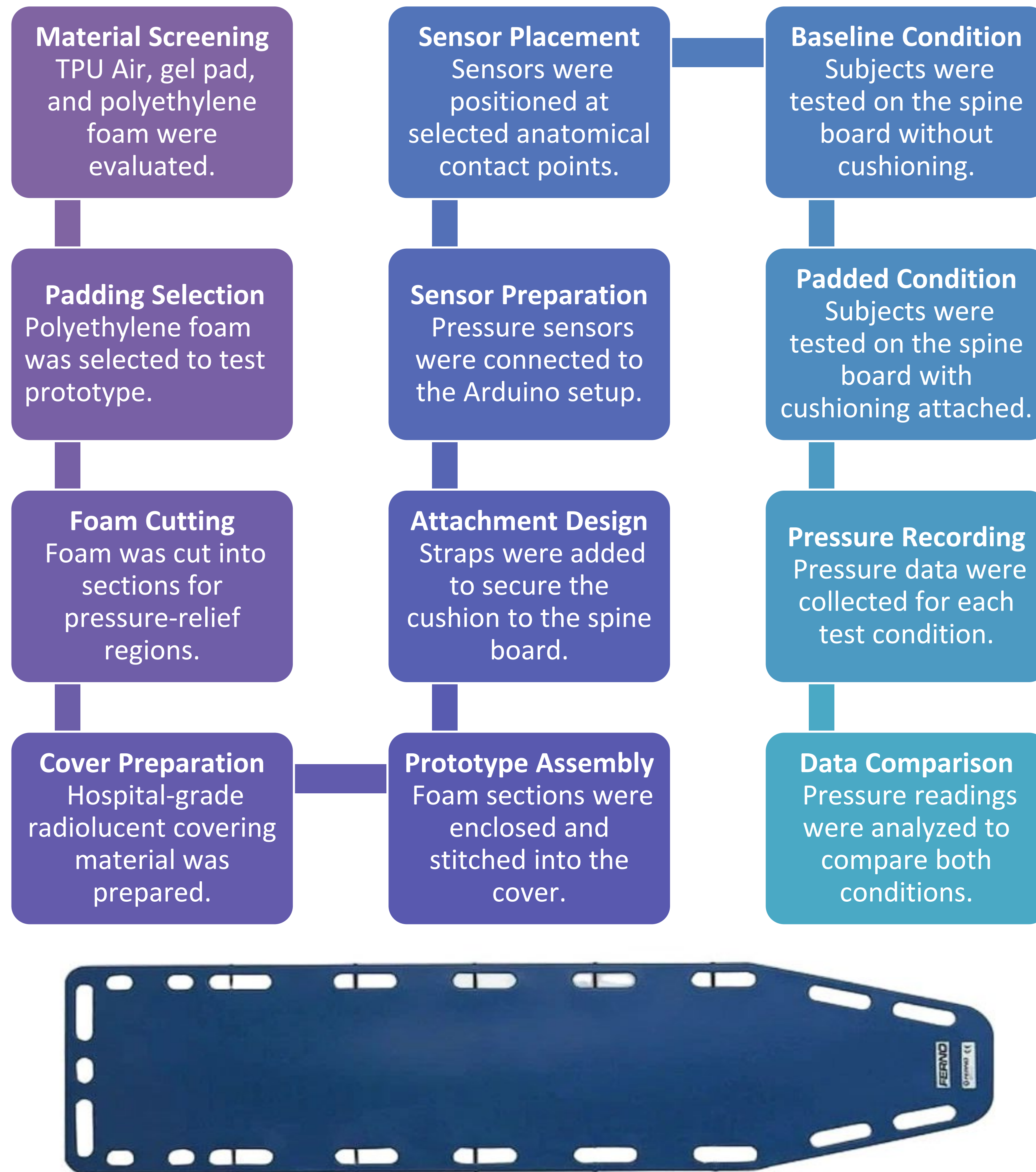


Fig 1: A conventional spine board used by EMS

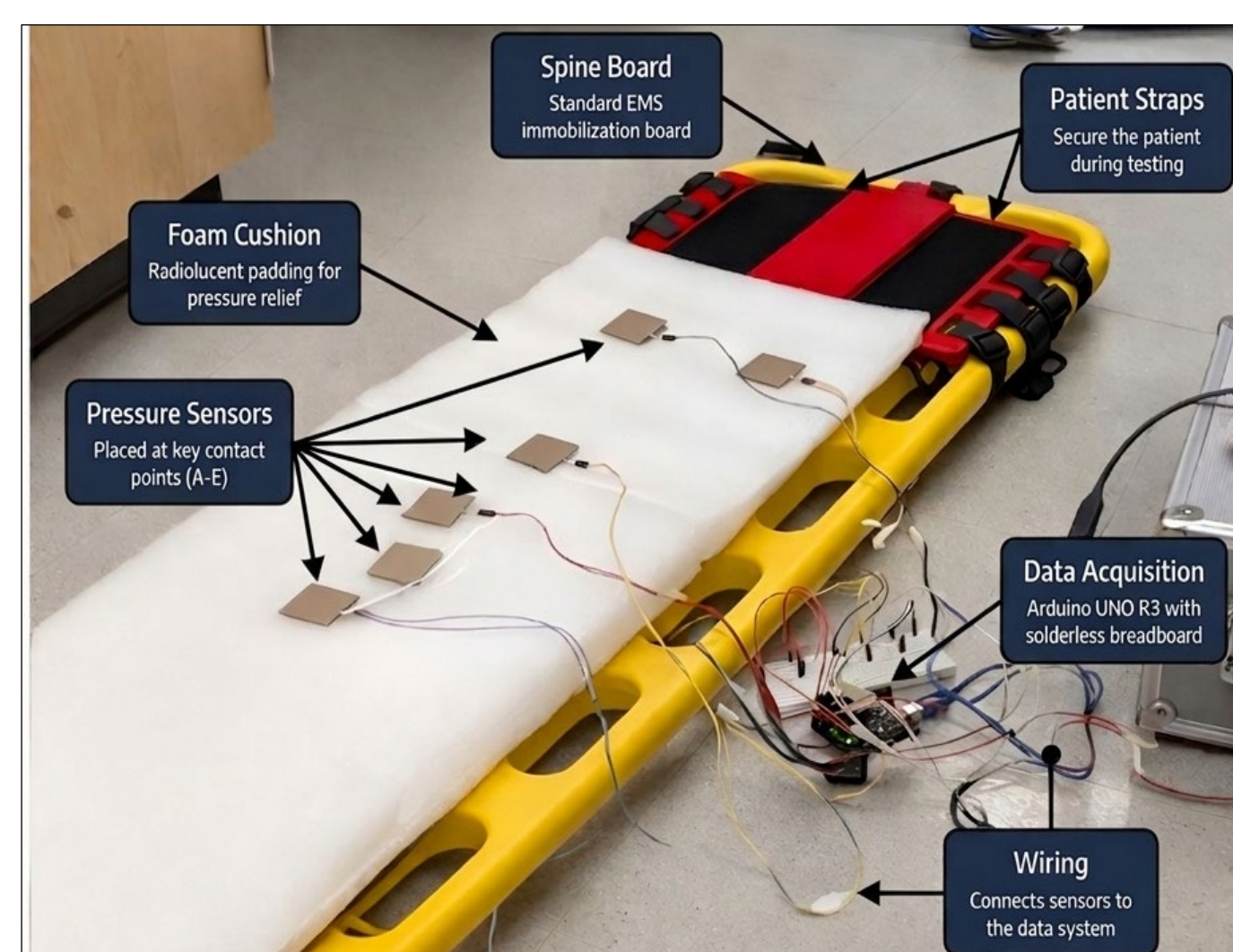


Fig 2: A spine board with cushion and pressure sensors deployed at locations comparable to A-E

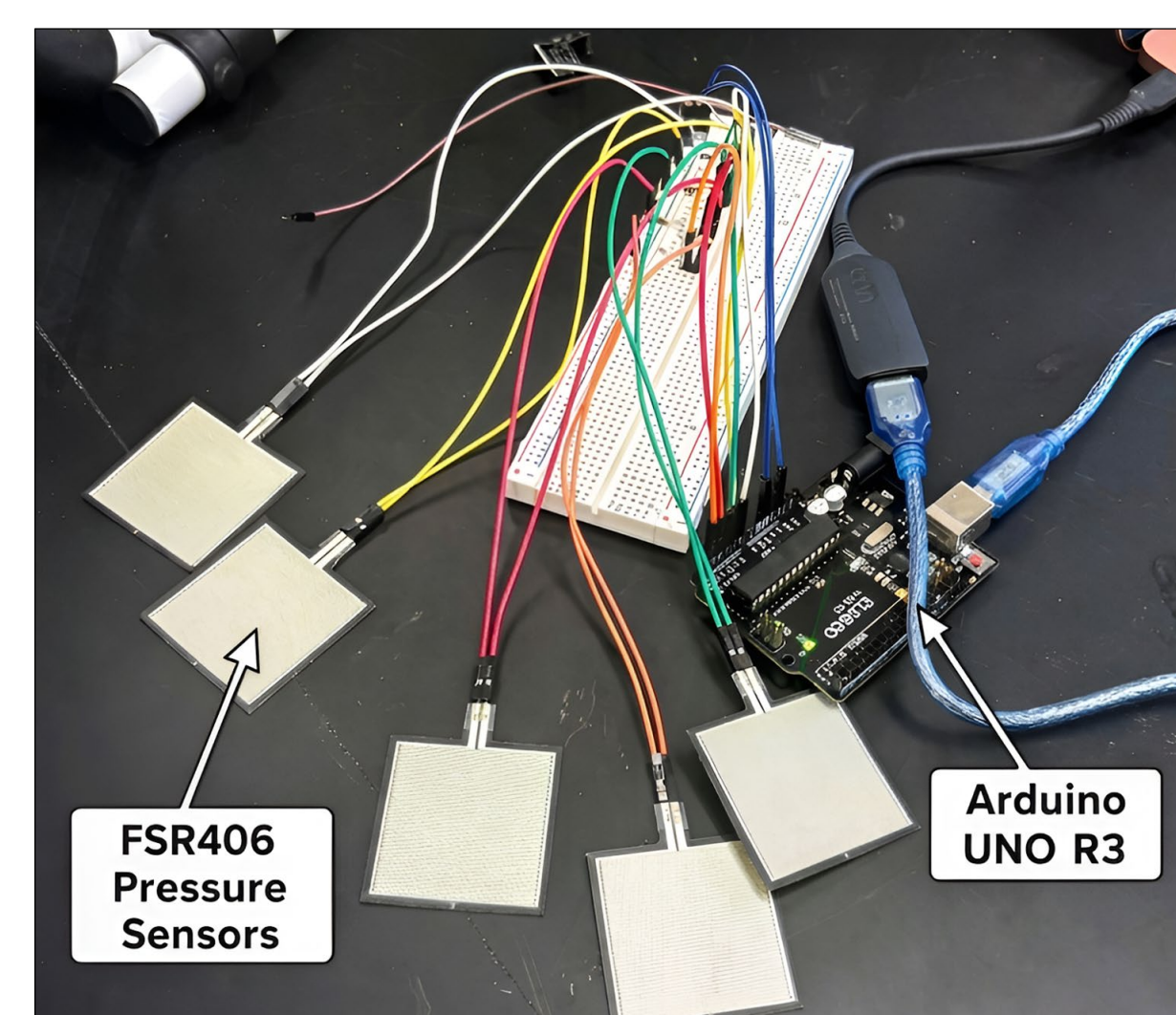


Fig 3: Arduino UNO R3 used to process, synchronize pressure inputs and to control outputs to a laptop for data storage and results display

Experimental Results

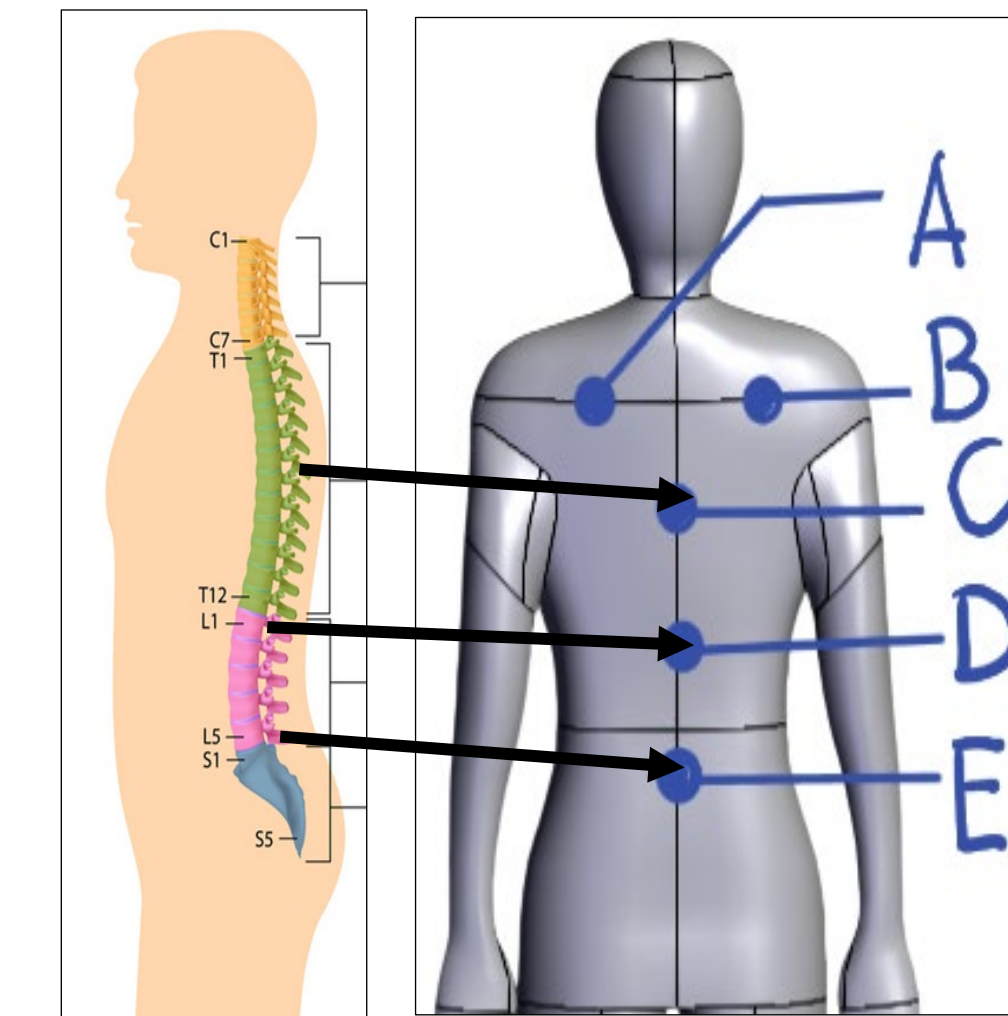


Fig 4: Regions of pressure sensors and comparable intervertebral disc anatomy: A (Left scapula), B (Right scapula), C (T6), D (L1), E (L5)

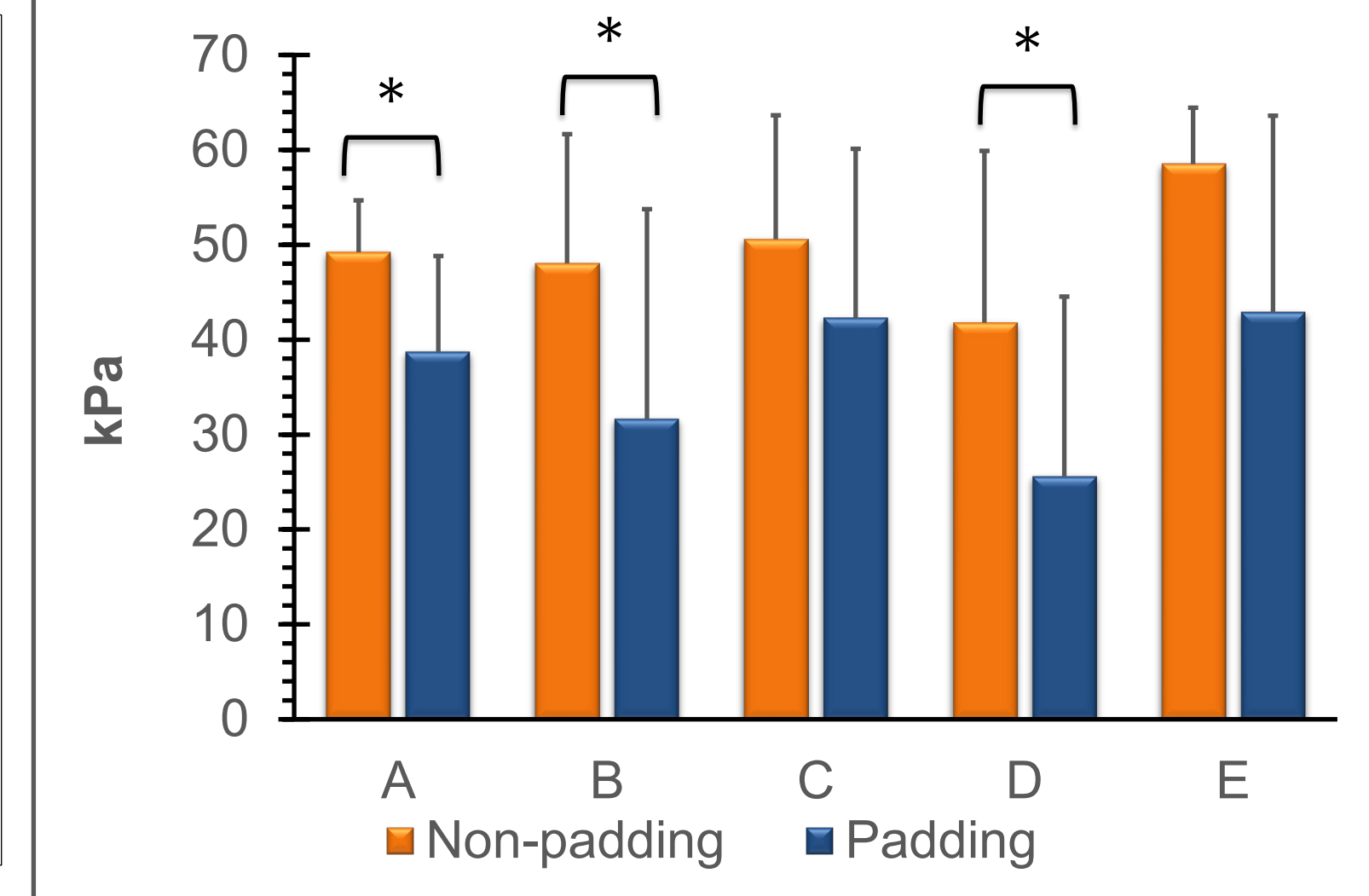


Fig 5: Pressure in kPa from region A, B, C, D, E (n = 10). A "*" meaning statistically different at $p < 0.05$

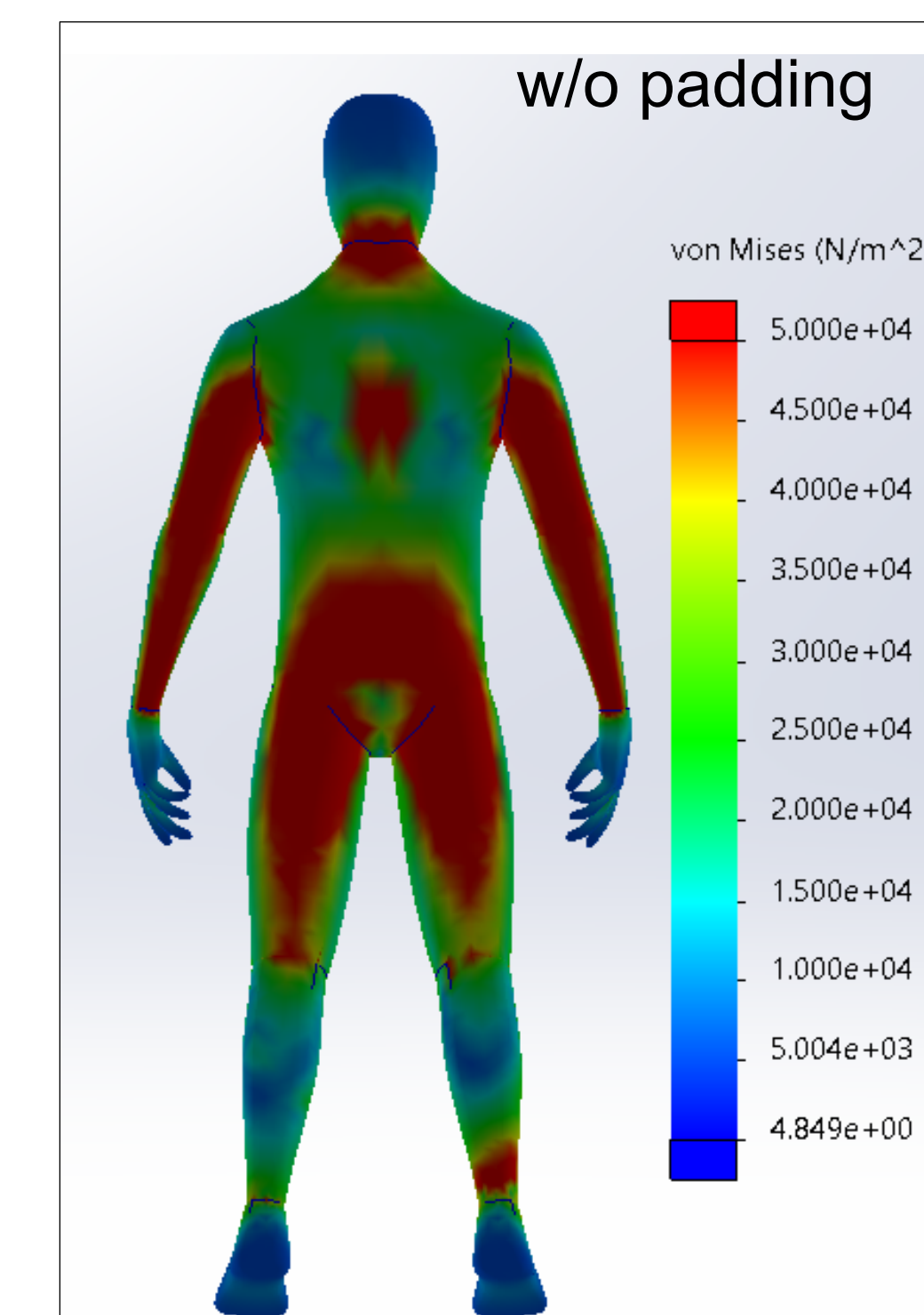


Fig 6: FEM of pressure distribution of a typical adult (170 lb) at supine on a spine board (SolidWorks)

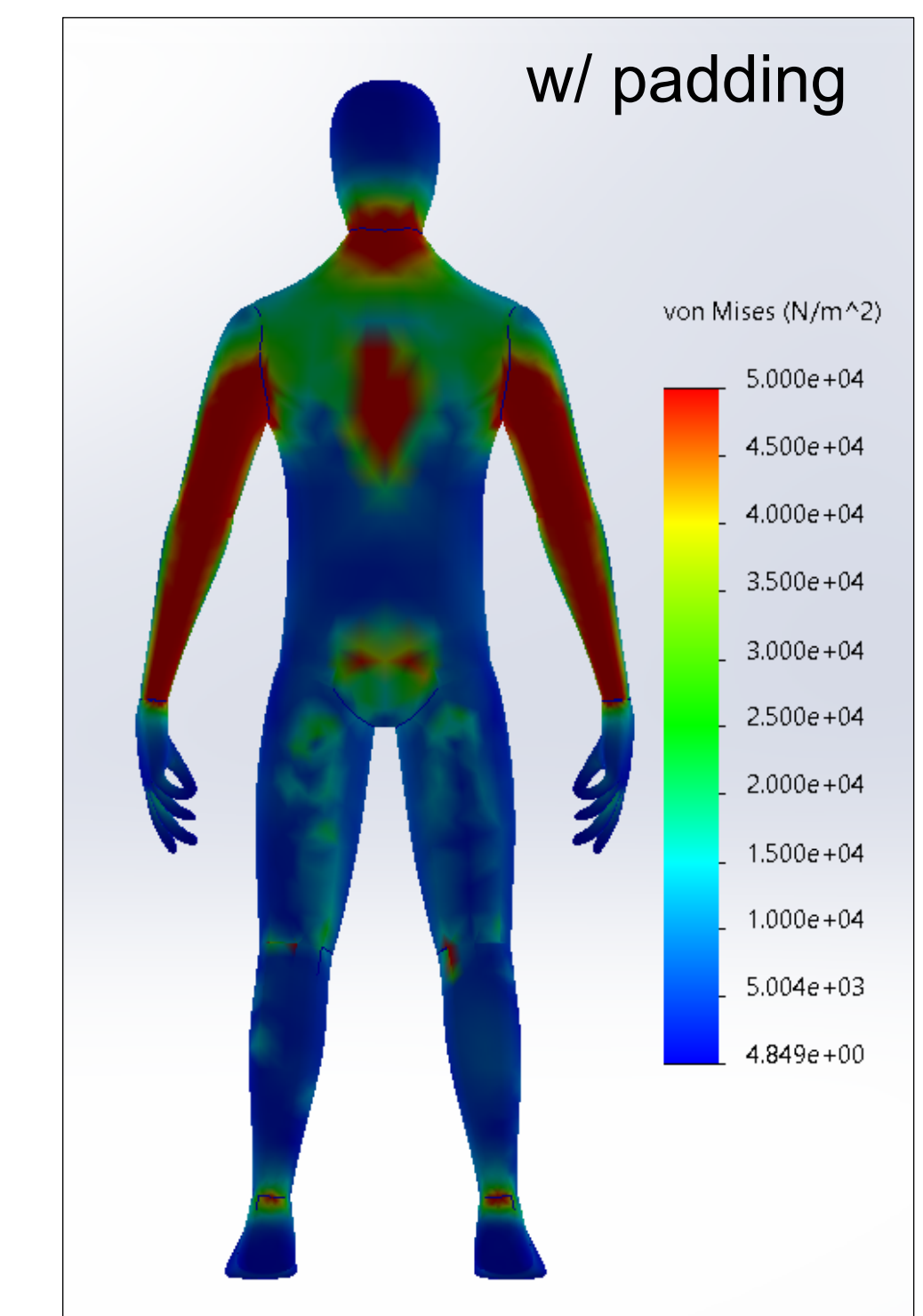


Fig 7: FEM of pressure distribution of a typical adult (170 lb) at supine on a spine board with padding included

Conclusions

Reduced pressure at all anatomical points

Largest reduction at sacrum/lumbar regions

Suggests improved comfort and lower injury risk

Maintains EMS usability and imaging compatibility

Pressure reductions were consistently observed across all tested regions and subjects. Overall, the design demonstrates a practical approach to reducing pressure-related risks in pre-hospital care.

References

Mr First Aid. (n.d.). Spine Board. Retrieved from https://mrfirstaid.co.za/Product/Spine-Board_1087

Acknowledgements

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