

Stress Distribution in Direct to Multi-Unit Abutment Prostheses: A Finite Element Comparison of Powerball, Rosen, and DESS Prosthetic Screws

Julia Collazo, DMD, LCDR/DC/USN; Stacy Yu, DDS, FACP, CDR/DC/USN; Samuel Richards, DDS, FACP, CDR/DC/USN
Naval Postgraduate Dental School, Uniformed Services University of the Health Sciences
Walter Reed National Military Medical Center, Bethesda, MD

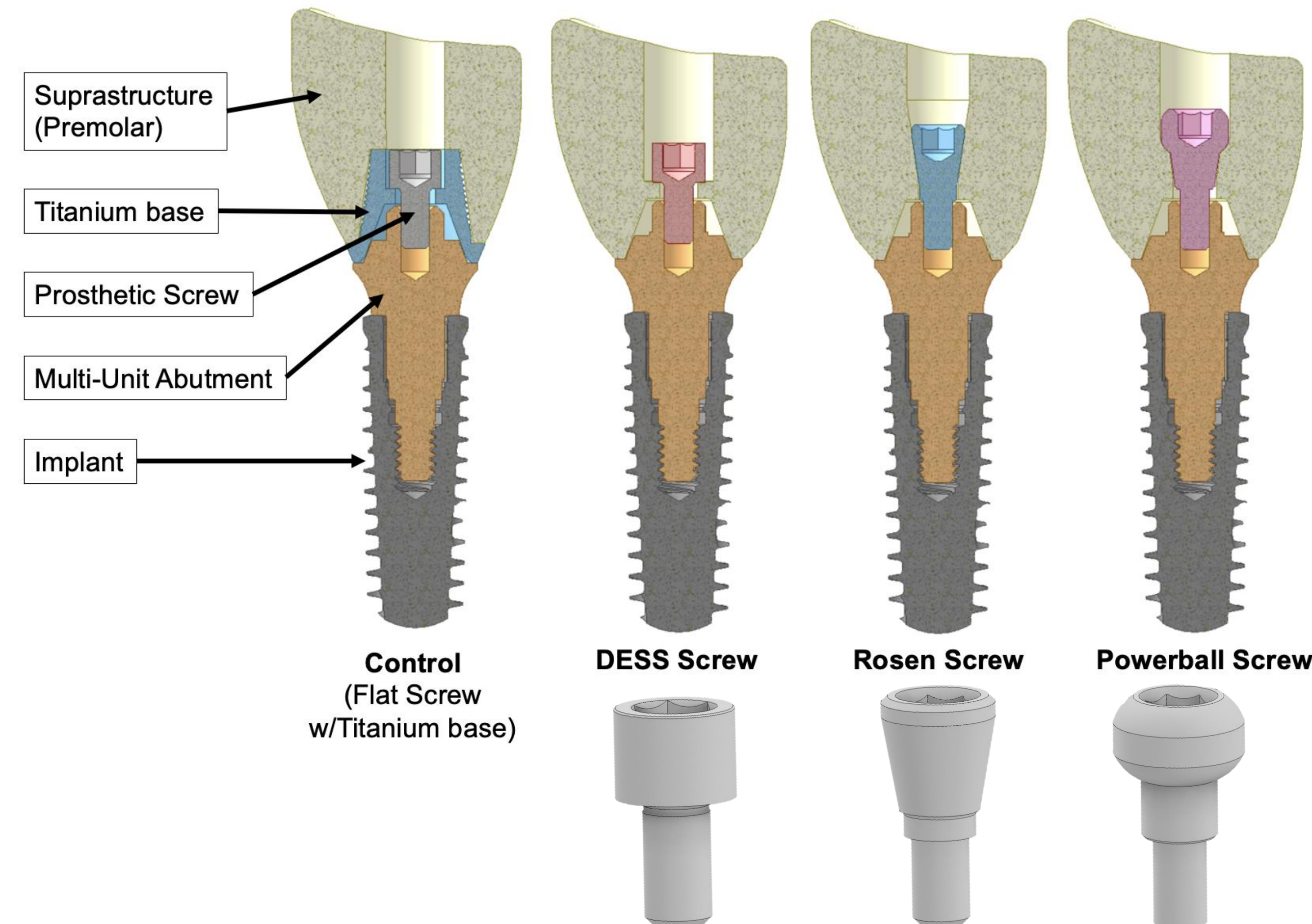


Purpose

This study compares stress distribution in screw-retained prostheses using three direct to multi-unit abutment (MUA) screws—Powerball, Rosen, and DESS—versus a titanium base. Using finite element analysis (FEA), the study aims to understand how the unique geometry of each screw may affect stress distribution, and consequently, the structural integrity at the restorative interface.

Materials and Methods

Digital models of each screw and its restorative interface were created using dental design software program (Exocad, Chantilly, VA). Cross-sectional renderings were analyzed in a mechanical computer-aided design (CAD) software program (Autodesk inventor, San Francisco, CA) to perform digital stress analysis. FEA and heat mapping were used to evaluate stress distribution across each screw-restoration interface, with a zirconia or polymethyl methacrylate (PMMA) suprastructure.



Disclaimer

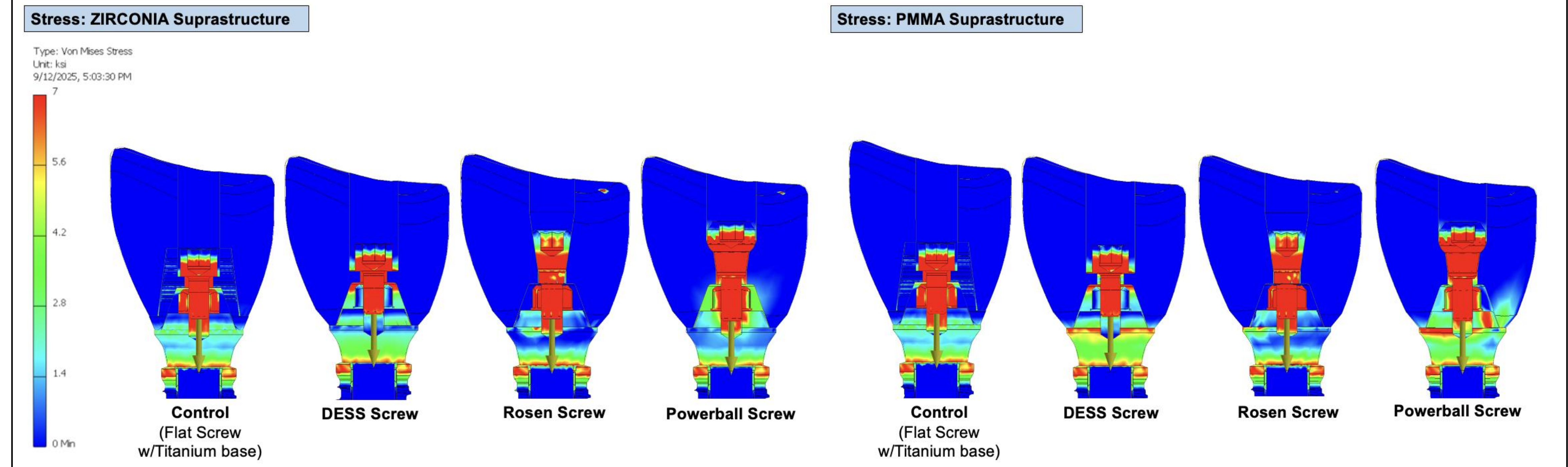
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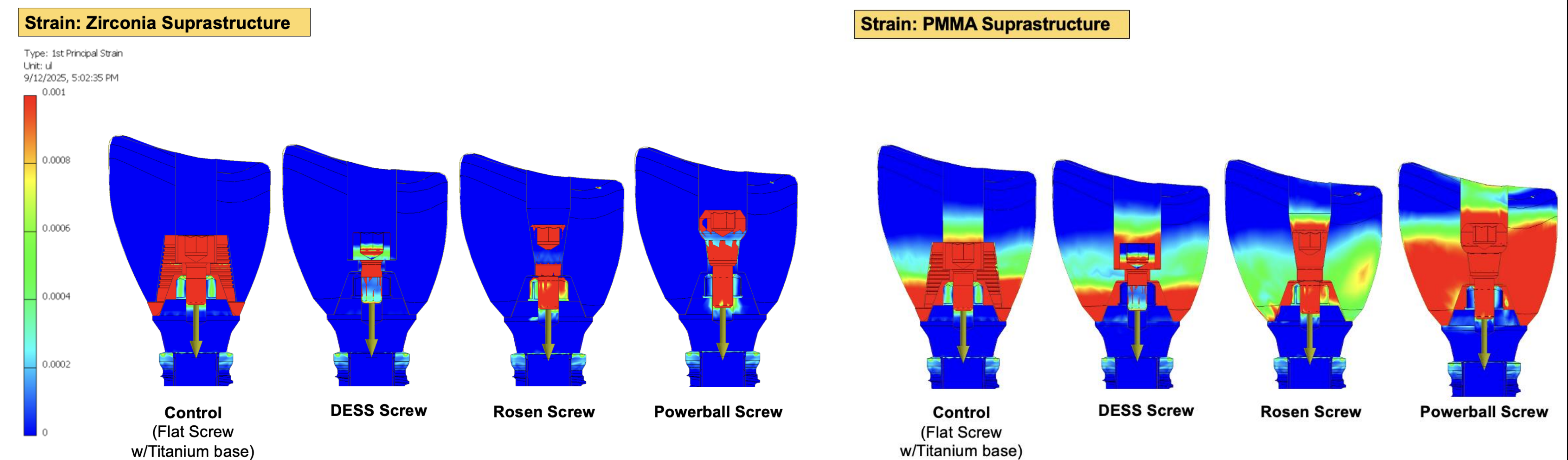
Results

Stress distribution varied among screw systems, suggesting screw geometry may affect force transfer and strain at the screw-restoration interface. Differences were also observed between zirconia and PMMA prosthetic material.

stress \strēs\ n (14c): force per unit area; a force exerted on one body that presses on, pulls on, pushes against, or tends to invest or compress another body; an internal force that resists an externally applied load or force; it is normally defined in terms of mechanical stress, which is the force divided by the perpendicular cross sectional area over which the force is applied; comp, COMPRESSIVE STRESS, SHEARING STRESS, TENSILE STRESS



strain \str an\ n: change in length per unit length when stress is applied; the change in length/original length; the deformation caused in a body by an external force



Discussion and Conclusion

FEA revealed minimal deformation risk for zirconia suprastructures, with stress concentrated at the MUA level across all restorative interfaces. Zirconia strain mapping indicated comparatively elevated values within the titanium base relative to direct to MUA screws, while PMMA restorations demonstrated substantially greater strain and notable deformation in the apical to middle thirds of the suprastructure, particularly in the titanium base and Powerball screw groups.

Collectively, these findings support continued investigation of direct to MUA screws as potential alternatives to traditional titanium base abutments, as their unique geometries may offer varying clinical results. Further research is required to validate their long-term performance across restorative materials and loading conditions.

Future Research

In addition to their distinct geometries, each prosthetic screw system specifies a unique recommended insertion torque value. Future phases of this investigation will incorporate pre-load assessment and mechanical strength analyses across the restorative platforms. The objective is to correlate FEA findings with empirical preload and static loading data, thereby providing a comprehensive rationale for observed mechanical behaviors. Key questions driving this research include: How will each restorative component perform under static loading conditions, and which material system is most prone to early mechanical failure? The integration of computational and experimental outcomes is expected to advance evidence-based guidelines for restorative screw selection and torque protocols.

References

A comprehensive list of references is available via the provided QR code.

