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Evaluating the regenerative potential of ESWT for cornea indications

Jonas Flatscher[1], Cyrill Slezak[1], Paul Slezak[1]
[1]*Ludwig Boltzmann Institut für Traumatologie, Extracorporeal Shockwave, Vienna, Austria*

Introduction
The clinical use of physical therapies, and ESWT in particular, has significantly expanded in recent years, moving beyond regenerative uses such as wound and bone healing to address a broader spectrum of diseases. This shift requires a comprehensive understanding of the mechanisms of action, safety considerations, and therapeutic potential for novel applications. Our work demonstrates this integrative approach in the context of potential treatments for the eye using various physical therapies. The eye, being a highly sensitive and anatomically complex organ, represents a particularly challenging but promising target for these emerging applications. This study aims to evaluate the feasibility of applying ESWT to sensitive areas, such as the eye, by developing a framework that combines experimental, computational, and safety-focused methods. The goal is to identify safe and effective treatment parameters while addressing potential risks associated with novel indications.

Material & Methods
This study employs a multi-step approach. In-vitro experiments were conducted to analyze cellular responses of pig corneas with an induced defect to various physical field exposures. Direct physical measurements quantified the applied fields, which were then used to simulate their spatial and temporal distribution in the eye's unique anatomy. Established safety parameters were applied to evaluate the potential risks and benefits, focusing on balancing therapeutic efficacy with minimizing adverse effects in the treatment zone.

Results
In-vitro experiments demonstrated promising cellular responses for shockwave treatments, including enhanced regenerative activity under specific field parameters. Subsequent simulations of the physical fields within the eye revealed localized intensities, highlighting critical areas for dose optimization to prevent adverse effects. Safety assessments suggest that certain parameters may indeed be suitable for the effective treatment of indications of the eye. Further refinement is necessary to address potential risks, particularly in high-sensitivity regions before moving to human subject investigations.

Discussion
This work highlights the potential of ESWT for treating novel indications, demonstrating the utility of an integrative framework combining experimental, computational, and safety analyses. By understanding the interactions of physical fields with the eye's anatomy and physiology, we provide a pathway for safely and effectively extending these therapies to this sensitive and challenging target. This approach can further guide future developments in expanding therapies to other complex and sensitive indications.