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Integrated Experimental Platforms to Study Blast Injuries: a Bottom-Up Approach[1]

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Developing a cellular and molecular understanding of the nature of traumatic and post-traumatic effects of blast events on live biological samples is critical for improving clinical outcomes[1]. To investigate the consequences of pressure waves upon cellular structures and the underlying physiological and biochemical changes, we are using an integrated approach to study the material and biological properties of cells, tissues and organs when subjected to extreme conditions. In particular we have developed a confined Split Hopkinson Pressure Bar (SHPB) system, which allows us to subject cells in suspension or in a monolayer to compression waves of the order of few MPa and duration of hundreds of microseconds[2]. The chamber design also enables recovery of the biological samples for cellular and molecular analysis. Specifically, cell survivability, viability, proliferation and morphological changes are investigated post compression for different cell populations. The SHPB platform, coupled with Quasi-Static experiments, is also used to determine stress-strain curves of soft biological tissues under compression at low, medium and high strain rates. Samples are also examined using histological techniques to study macro- and microscopical changes induced by compression waves. Finally, a shock tube has been developed to replicate primary blast damage on organs (i.e. mice lungs) and cell monolayers by generating single or multiple air blast of the order of kPa and few milliseconds duration. This platform allows us to visualize post-traumatic morphological changes at the cellular level as a function of the stimulus pressure and duration as well as biomarker signatures of blast injuries. Adapting and integrating a variety of approaches with different experimental platforms allows us to sample a vast pressure-time space in terms of biological and structural damage that mimic blast injuries and also to determine which physical parameters (peak pressure, stimulus duration, impulse) are contributing to the injury process. Moreover, understanding biological damage following blast events is crucial to developing novel clinical approaches to detect and treat traumatic injury pathologies.

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[2] Eur. Phys. J. Appl. Phys. 55, 31201 (2011).

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