Contribution of impactor misalignment to the neurofunctional variability in porcine spinal cord contusion models

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Traumatic spinal cord lesions studies are often carried out with animal models or numerical simulations. Unfortunately, animal models usually present a high variability in severity and type of neurofunctional impairments following impact surgery. We postulate that the variability of outcomes is strongly dependent on the positioning and alignment of the impactor during the contusion. A finite elements model of the spinal cord, predicting the action potential (AP) conduction alteration, was proposed and used to perform nine numerical simulations of a 50 g weight dropped from 200 mm on the exposed spinal cord in its spinal canal. Simulations followed a 32 factorial design with impactor eccentricity and spinal cord tilt angle as factors on two outcomes: injured spinal cord area (AP < 10 % of its baseline, 1h post-injury), and asymmetry of injury (ratio of right/left injured area of both half spinal cord). Eccentricity contributed highly and significantly on both outcomes, but not tilt angle. Damaged axons were found in conscious motor, sensory, and unconscious proprioception tracts. Variability in impactor alignment beyond ±6.2 % of the spinal canal width affects neurofunctional outcomes, and careful assessment of the impactor course is therefore key when producing or simulating spinal cord injury by contusion on pigs.