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Biomechanical study of porcine urinary bladder wall: matter of isotropy or anisotropy

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Regenerative medicine for reconstructive urogenital surgery has been widely studied during the last two decades[1]. One of the key factors affecting the quality of bladder regeneration is the mechanical properties of the bladder scaffold. Due to extensive similarity of porcine bladder to human bladder[2], and availability of this tissue from local slaughterhouses, we applied porcine bladder. The outcomes from this study can assist researchers with better solutions for design of scaffolds for bladder tissue engineering aiming to provide patients with high quality life in the future.

In most studies, test samples were preserved at -20ºC prior to testing. However, we applied fresh samples in all our experiments, as the effect of storage temperature on bladder's mechanical properties is not systematically investigated yet[3]. Bladder is understood to have anisotropic mechanical properties. In order to properly study the anisotropic properties of bladder wall, uniaxial tests were applied under loading conditions similar to physiologic filling of bladder (1–2 mL/min) to evaluate how circumferential and longitudinal cut-outs of lateral region of bladder behave under load. Uniaxial tensile tests under low strain rate of 10 mm/min (0.4%/s) were applied onto rectangular shaped samples. The different strain amplitudes for uniaxial tests are 2.5, 5, 10, 20, 50, 100, 200 and 300%. Samples were under cyclic loading-unloading for 11 rounds, and the data from 11th cycle were applied for further analysis. The first 10 cycles were considered for preconditioning.

Our results demonstrate that bladder behaves isotropic at strain amplitudes below 200%, while at strains above 200% becomes slightly stiffer in longitudinal direction. We conclude that commenting upon isotropy/anisotropy of bladder wall needs to be subjective. It behaves isotropic under physiologic conditions and low strain loads, but anisotropic under high strain amplitudes. We sum up that it is important to consider the study parameters, when referring to mechanical data from reports in literature.

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