On the role of water mobility for soft tissue biomechanics and mechanobiology

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Abstract

Soft biological tissues are multiphasic materials, and, in good approximation they may be considered as two-component systems consisting of a swollen solid network and a watery fluid phase [1]. While it is well accepted that tissues that are mainly subject to compressive loads *in vivo* change their volume by partial loss or gain of the fluid phase, tension-bearing tissues are typically considered incompressible, implicating independence between water content and the state of deformation. However, recent studies have shown that soft collagenous membranes can drastically reduce their volume with even moderate in-plane tensile loading, facilitated by substantial contractions perpendicular to the direction of the applied load, see e.g. [2, 3]. This does not only disprove the applicability of the incompressibility assumption, but also implies fluid efflux under hydrostatic tension, contrary to the expectations for a classical poroelastic medium [4]. In the present contribution, this behaviour is rationalized in terms of the network architecture of these soft tissues and chemomechanical coupling, established through osmotically active proteoglycans present in the solid phase [1]. It is shown that this coupling entails a direct mechanotransductive conversion between tensile loading and the osmotic pressure within the tissue. Consequences of the inversely poroelastic and chemoelastic behaviour on tissue and cell level are discussed.

References

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