The structure and mechanical properties of articular cartilage are highly resilient towards transient dehydration. Articular cartilage is a mechanically highly challenged material with very limited regenerative ability. In contrast to elastic cartilage, articular cartilage is exposed to recurring partial dehydration owing to ongoing compression but maintains its functionality over decades. To extend our current understanding of the material properties of articular cartilage, specifically the interaction between the fluid and solid phase, we here analyze the reversibility of tissue dehydration. We perform an artificial dehydration that extends beyond naturally occurring levels and quantify material recovery as a function of the ionic strength of the rehydration buffer. Mechanical (indentation, compression, shear, and friction) measurements are used to evaluate the influence of de- and rehydration on the viscoelastic properties of cartilage. The structure and composition of native and de/rehydrated cartilage are analyzed using histology, scanning electron microscopy, and atomic force microscopy along with a 1,9-dimethylmethylene blue (DMMB) assay. A broad range of mechanical and structural properties of cartilage can be restored after de- and
rehydration provided that a physiological salt solution is used for rehydration. We detect only
minor alterations in the microarchitecture of rehydrated cartilage in the superficial zone and find
that these alterations do not interfere with the viscoelastic and tribological properties of the
tissue.

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