Hepatocyte apical bulkheads provide a mechanical means to oppose bile pressure

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Abstract

Hepatocytes grow their apical surfaces anisotropically to generate a 3D network of bile canaliculi (BC). BC elongation is ensured by apical bulkheads, membrane extensions that traverse the lumen and connect juxtaposed hepatocytes. We hypothesize that apical bulkheads are mechanical elements that shape the BC lumen in liver development but also counteract elevated biliary pressure. Here, by resolving their structure using STED microscopy, we found that they are sealed by tight junction loops, connected by adherens junctions, and contain contractile actomyosin, characteristics of mechanical function. Apical bulkheads persist at high pressure upon microinjection of fluid into the BC lumen, and laser ablation demonstrated that they are under tension. A mechanical model based on ablation results revealed that apical bulkheads double the pressure BC can hold. Apical bulkhead frequency anticorrelates with BC connectivity during mouse liver development, consistent with predicted changes in biliary pressure. Our findings demonstrate that apical bulkheads are load-bearing mechanical elements that could protect the BC network against elevated pressure.