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## Human gallbladder mucosal function: Effect of concentration and acidification of bile on cholesterol and calcium solubility

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## Abstract

The most recognized function of the human gallbladder is to store bile. However, this organ is not a static reservoir. It actively modifies bile by two processes: concentration and acidification. This study was designed to simultaneously evaluate the relationship between these two physiological processes in the normal human gallbladder and to define their effects on biliary cholesterol and calcium solubility. Bile was sampled directly from the gallbladder of 78 morbidly obese patients undergoing elective gastric bypass procedures. All had negative results of intraoperative ultrasound examinations for sludge and gallstones, normal liver function tests, and no history of hepatobiliary disease. Bile salt concentrations, an indirect index of concentration by the gallbladder, ranged from 15.1–272.8 mmol/L. As [bile salt] increased, [Na<sup>+</sup>], [K<sup>+</sup>], free [Ca<sup>2+</sup>], [cholesterol], [phospholipid], and [total lipid] increased linearly; [Cl<sup>-</sup>] decreased linearly. Molar percent cholesterol decreased from 17.2% in dilute bile to 10.1% in fully concentrated bile, suggesting that cholesterol was absorbed by the gallbladder. As bile was concentrated, cholesterol saturation index decreased curvilinearly from a maximum of 3.7 in dilute bile to 1.0–1.5 in concentrated bile. Concentration of gallbladder bile was accompanied by progressive acidification. Bile pH decreased linearly with increasing [bile salt]; [CO<sub>3</sub><sup>2-</sup>] decreased curvilinearly. Despite increasing [Ca<sup>2+</sup>], CaCO<sub>3</sub> saturation index decreased curvilinearly with increasing [bile salt] from a maximum of 3.62 in dilute bile to a minimum of 0.12 in concentrated and acidified bile. CaCO<sub>3</sub> saturation index also decreased exponentially with decreasing pH. This study concludes that concentration of bile enhances cholesterol solubility while acidification enhances calcium salt solubility. By increasing the solubilities of these two species, gallbladder mucosal function may play a key role in preventing gallstone formation.

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## Abbreviations

BS, bile salt; PL, phospholipid; TL, total lipid; XOL, cholesterol

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