Visualization of Bile Movement using Magnetic Resonance Arterial Spin-Labeling Technique : Preliminary Results
［大会長賞受賞記録］

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目　　的

従来の胆管描出方法では，胆汁の“to-and-fro”を含む動態をリアルタイムにとらえることは難しい．MRI で脈管の血流描出に用いられる arterial spin labeling 法の一つである time-spatial labeling inversion pulse（time-SLIP）[1)~5)] を応用し，総胆管内の胆汁の動態をリアルタイムに描出することに挑戦した．

方　　法

対象は健常者 6 人(26～33 歳，男女 3 人ずつ)で，各検査前 6 時間絶飲食指示した．

1.5T MR（EXCELART Vantage, Toshiba）および 8ch 腹部コイル(QD Torso SPEEDER)．撮像プロトコール（計 70 分，負荷物を変えて 3 回）：⑴ 負荷前，2D-MRCP・T_2WI・脂肪抑制 T_1WI・Time-SLIP；⑵ 経口負荷：水 300 ml，高脂肪乳 300 ml（脂肪 13.2 g 含），経口陰性造影剤ボースデル 250 ml のいずれか；⑶ 負荷 5 分後，T_2WI；⑷ 負荷後 10・20・30・40・50 分後，Time-SLIP；⑸ 負荷後 50 分後，2D-MRCP・T_2WI・脂肪抑制 T_1WI．Time-SLIP 撮像条件：⑴ ROI，総胆管と主膵管の両方が見える斜冠状断像；⑵ Labeling pulse，胆管開口部から約 3 cm 上流の位置に 2 cm の幅で送信；⑶ パラメータ，SE single-shot 2D-T_2WI（TR/TE, 3000/80 ms ; ETL, 80 ms ; FA，90° ; ST，10 mm ; NEX，1 ; matrix, 256×256 ; FOV，40×40 cm）；⑷ 撮像タイミング，labeling pulse の 1500 ms 後，これを 22 秒ごとに 15 回繰返す．評価項目は，Time-SLIP 画像上の移動胆汁量を円錐モデル近似，シーケンスごとの平均流出速度（mm^3/ms）を算出．Gallbladder ejection fraction（GBEF）導出．2D-MRCP の胆道系描出能変化．下部総胆管内胆汁の T_1/T_2 短縮の有無．

結　　果

Time-SLIP 像で to-and-fro を含む総胆管内胆汁の動態描出に成功した（Fig. 1）（膵液も描出できた）．胆汁排泄動態と負荷物質の関係

キーワード　arterial spin-labeling, magnetic resonance cholangiopancreatography, pancreaticobiliary disease

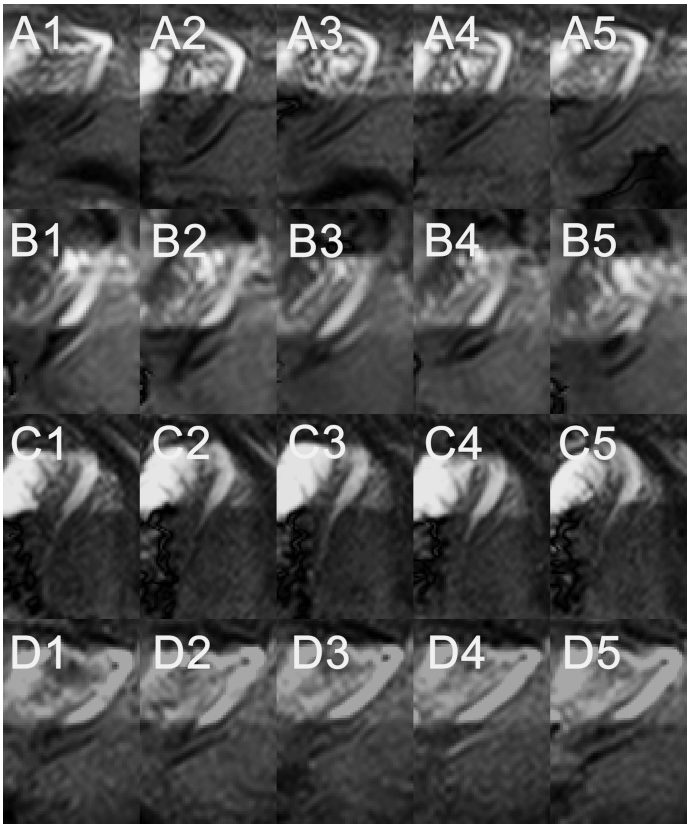

Fig. 1. On oblique-coronal spin-echo single-shot 2-dimensional T_2-weighted images (TR/TE, 3000/80 ms ; slice thickness, 10 mm) acquired at inversion times of 1500 ms after labeling pulse (slice thickness, 2 cm) before (A1–A5) and 20 min after oral administration (water, B1–B5 ; high-fat milk, C1–C5 ; negative contrast material, D1–D5). Prominent bile movement was observed after high-fat milk administration (C1–C5), whereas much less movement was observed on water (B1–B5) and negative contrast material studies (D1–D5). Retrograde bile movement, which indicates the existence of to-and-fro movement, was observed (A3, A5, and B5). The flow of pancreatic juice was also observed to be irrelevant to bile movement (B1, B3, C4, and D4).

を Fig. 2 に示す．水，陰性造影剤，高脂肪乳による 50 分後 GBEF は，それぞれ約－20%，－15%，90%であった．Time-SLIP 像上の排泄胆汁体積と胆嚢容積変化は強く相関した（P＝0.003）．負荷 10 分後の胆汁排泄速度と GBEF50 min が有意に相関した（P＝0.049）．Time-SLIP 上の総胆管内・主膵管内相互の液体逆流は認めず．2D-MRCP の胆道系描出能変化は，陰性造影剤で主膵管のみ描出能向上が見られた（P＝0.012）．下部総胆管内胆汁の T_1

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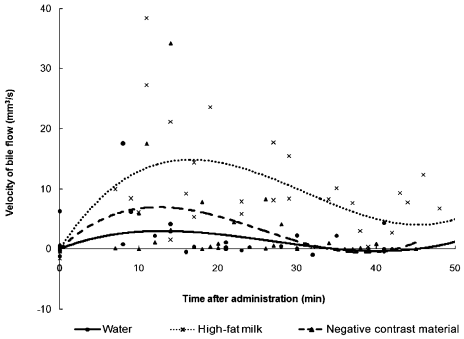

Fig. 2. Scatter plots of the bile flow rate in the common bile duct and the time after oral administration. Third-order approximation curves are depicted to promote better comprehension. Oral administration of high-fat milk induced extensive bile excretion, which lasted for approximately 50 min, whereas water and negative contrast material lasted a shorter time.

短縮を，陰性造影剤投与後に認めた（P＝0.004）．

考　　察

Arterial spin-labeling の手法の一つである time-SLIP 法を用いて，総胆管内の胆汁排泄の動的な描出に成功した．胆汁の胆管内移動は，順行性・逆行性の胆汁の流れに加えて，to-and-fro，逆行性の流れも見られ，これらの組み合わせによると考えられた．高脂肪乳で十分な GBEF が得られ，cholecystokinin の代替と成り得た（10 g 以上の脂肪が必要）[6)~8)]．経口負荷 10 分後の胆汁排泄速度から，50 分後の胆嚢体積変化の予測可能性が示唆された．陰性経口造影剤では，胆汁 T_1 短縮が示唆された．胆汁分泌刺激の際に，径乳頭的逆流が生じるかどうかは，議論の余地が残った．

結　　語

Arterial spin-labeling 法を用いて，総胆管内の胆汁排泄の準リアルタイムな可視化に成功した．今後の臨床応用が期待される．

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Visualization of Bile Movement using Magnetic Resonance Arterial Spin-Labeling Technique : Preliminary Results［Presidential Award Proceedings］

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Purpose : We aimed to visualize intrabiliary bile movement noninvasively using a magnetic resonance（MR）arterial spin–labeling technique.

Methods : Our institutional review board approved this prospective study, and we obtained informed consent from each subject. Six healthy subjects approximately 30 years of age underwent 3 pancreaticobiliary MR imaging studies. We acquired T_2-weighted images of the common bile duct（CBD）at inversion times of 1500 ms after pulse labeling using a time-spatial labeling inversion pulse（SLIP）technique. This was repeated every 22 s and continued from before to 50 min after oral administration of water, high-fat milk, or negative contrast material.

Results : We observed the to-and-fro bile movement in the CBD and flow of pancreatic juice. The total volume of excreted bile by time-SLIP imaging and changes in gallbladder volume correlated significantly（$P=0.003$）. Bile excretion was prominent and lasted approximately 50 min in milk studies but was inconspicuous in water and negative contrast material studies. The rate of bile flow 10 min after and gallbladder ejection fraction 50 min after administration of milk correlated significantly（$P=0.049$）. Negative contrast material shortened T_1 relaxation times in the CBD（$P=0.004$）.

Conclusion : We visualized intrabiliary bile movement using this MR technique. The pattern of bile excretion in the early phase was suggested to predict the final state of gallbladder contraction. Negative contrast material may have caused retrograde flow from the major papilla into the CBD. This technique could be used clinically to evaluate biliary diseases.