European Radiology (2018) 28:3719–3720
https://doi.org/10.1007/s00330-018-5550-8

EDITORIAL COMMENT

# Breath-holding 3D MRCP: the time is now?

Marc Zins [1]

Received: 7 May 2018 / Revised: 11 May 2018 / Accepted: 18 May 2018 / Published online: 21 June 2018


For more than 25 years, magnetic resonance cholangiopancreatography (MRCP) has been part of the standard protocol of abdominal MR imaging when a pancreatic or a biliary disease was suspected [1]. Different and complementary approaches, all using two-dimensional (2D) sequences, were initially developed for the assessment of the pancreatic duct and biliary tract with MRCP [1]: a thick slab single-shot fast spin-echo (SSFSE) T2-weighted sequence and a multisection thin-slab, single-shot TSE T2-weighted sequence [1]. Both sequences have many advantages since they provide an excellent selective display of the whole extrahepatic biliary tract and pancreatic duct with few respiratory artefacts, few susceptibility effects and good in-plane resolution and are still in use in many reference centres [1]. However, these sequences have also some drawbacks: motion artefacts, including respiratory, may produce misregistration of thin-slice MRCP images, which may result in areas of missed anatomy. Thick-slab MR imaging is operator-dependent and even when examinations are technically relevant, inherent in-plane volume averaging effect may obscure small stones or anatomic variants [2]. For these reasons, many authors have advocated the use of three-dimensional (3D) MRCP sequences [2]. The theoretical main advantages of 3D MRCP compared to 2D MRCP sequences include: (1) acquisition of contiguous sections that may be used to reconstruct images in any projection, yielding the anatomical overview normally provided with thick-slab 2D images, (2) better spatial resolution with thinner imaging section and better signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) and (3) acquisition of all slices with a single coronal volume placed over the biliary tree and pancreatic ducts without need to obtain rotating oblique 2D SSFSE thick-slab planes [2, 3].

Interestingly, most initial publications focusing on 3D MRCP technique used breath-holding acquisition sequences [2, 4]. However, these initial sequences suffered from decreased spatial resolution and acquired non-isotropic voxel datasets [2]. Consequently, for the last 10 years, 3D MRCP sequences have been performed principally with a respiratory-triggered technique for the purpose of obtaining high-resolution isotropic images. However, the acquisition time of the respiratory-triggered 3D MRCP sequence has been a clinical burden with a mean time often superior to 5 min despite the use of parallel acquisition technique [5]. Such a long acquisition time is often associated with poor image quality due to motion artefacts. For these reasons, there was a clinical need to decrease the acquisition time of the 3D MRCP sequence while keeping high spatial resolution. The works of Nam et al [6] and Yoshida et al [7] are opening new perspectives in the field of 3D-MRCP. Both studies evaluated the clinical feasibility and clinical usefulness of the gradient and spin-echo (GRASE) sequence with a single breath-hold in 3-T MRCP in comparison to the conventional 3D respiratory-triggered (RT) MRCP using TSE sequence. The GRASE sequence is a combination of the spin-echo and gradient-echo sequences, where several spin echoes are replaced with gradient-echoes. Fewer refocusing radiofrequency (RF) pulses coming from alteration between the RF refocusing pulse and the gradient within echo train allow improved temporal resolution compared with TSE sequence [6]. Improving temporal resolution allows a breath-hold acquisition. Both studies have interesting results including: (1) shorter acquisition time (15-20 s for GRASE technique), (2) better overall image quality, (3) less blurring artefacts and most importantly, (4) fewer non-diagnostic examinations.

Moreover, Nam et al advocate that this technique, initially developed in the 1990s, is widely available and does not necessitate high hardware and software performance, in contrast to the recently developed 3D breath-holding MRCP with compressed sensing technique [6, 8]. However, the sequences

This comment refers to the article available at https://doi.org/10.1007/s00330-017-5275-0.

✉ Marc Zins
mzins@hpsj.fr

[1] From the Department of Radiology and Medical Imaging, Saint Joseph Hospital, 185 rue Raymond Losserand, 75014 Paris, France

using the new compressed sensing technique will become more and more available and can be combined to respiratory-triggered technique and then applicable to patients with short breath-holding capacity. Future studies will have to compare 3D breath-holding MRCP using GRASE and 3D breath-holding MRCP using compressed sensing techniques to find out which is the better option in clinical practice. Finally, comparison of these new breath-holding 3D techniques with the standard 2D SSFSE sequences using thin and thick sections will be needed. If confirmed, these encouraging results will open a new era in the clinical evaluation of the biliary and pancreatic diseases with MRCP.

**Acknowledgements** The author would like to thank Ines Mannes for her help in the preparation of the manuscript.

**Funding** The authors state that this work has not received any funding.

## Compliance with ethical standards

**Guarantor** The scientific guarantor of this publication is **Marc Zins** (mzins@hpsj.fr)

**Conflict of interest** The authors of this manuscript declare no relationships with any companies, whose products or services may be related to the subject matter of the article.

**Statistics and biometry** No complex statistical methods were necessary for this paper.

**Informed consent** Written informed consent was not required for this study because this is an editorial without any study subjects.

**Ethical approval** Institutional Review Board approval was not required because this is an editorial without any study subjects.

## References

1. Matos C, Cappeliez O, Winant C et al (2002) MR imaging of the pancreas: a pictorial tour. Radiographics 22:e2
2. Sodickson A, Mortele KJ, Barish MA (2006) Three-dimensional fast-recovery fast spin-echo MRCP: comparison with two-dimensional single-shot fast spin-echo techniques. Radiology 238:549–559
3. Nandalur KR, Hussain HK, Weadock WJ et al (2008) Possible biliary disease: diagnostic performance of high-spatial-resolution isotropic 3D T2-weighted MRCP. Radiology 249:883–890
4. Wielopolski PA, Gaa J, Wielopolski DR, Oudkerk M (1999) Breath-hold MR cholangiopancreatography with three-dimensional, segmented, echo-planar imaging and volume rendering. Radiology 210:247–252
5. Nakaura T, Kidoh M, Maruyama N et al (2013) Usefulness of the SPACE pulse sequence at 1.5 T MR cholangiography: Comparison of image quality and image acquisition time with conventional 3D-TSE sequence. J Magn Reson Imaging 38:1014–1019
6. Nam JG, Lee JM, Kang HJ et al (2018) GRASE Revisited: breath-hold three-dimensional (3D) magnetic resonance cholangiopancreatography using a Gradient and Spin Echo (GRASE) technique at 3 T. Eur Radiol. https://doi.org/10.1007/s00330-017-5275-0
7. Yoshida M, Nakaura T, Inoue T et al (2018) Magnetic resonance cholangiopancreatography with GRASE sequence at 3.0 T: does it improve image quality and acquisition time as compared with 3D TSE? Eur Radiol. https://doi.org/10.1007/s00330-017-5240-y
8. Chandarana H, Doshi AM, Shanbhogue A et al (2016) Three-dimensional MR cholangiopancreatography in a breath hold with sparsity-based reconstruction of highly undersampled data. Radiology 280:585–594