High resolution MRCP with adaptive average: image quality and diagnostic performance

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Introduction

MR cholangio-pancreatography (MRCP) is now a routine MR examination used for the diagnosis of biliary pathology. Different views of the bile ducts are obtained by a combination of projection and thin section images acquired in different planes [1]. The operator plans these locations on initial localiser images and performs a separate breath-hold image acquisition at each location. In general MRCP has limited spatial resolution as each image has a relatively low signal-to-noise ratio (SNR). This can be improved by averaging several images[2] but typically this results in mis-registration problems owing to multiple breath-holds, or respiratory motion.

An interactive MRCP method [3] based on a single shot fast spin echo sequence (SSFSE) that permits continuous and interactive acquisition of the required projection images has recently been developed. This has been combined with an ‘adaptive averaging’ (a method of re-registering multiple images acquired in the same location) technique to improve the SNR thereby potentially allowing an increase in the spatial resolution [4]. This could be particularly helpful for diagnosing subtle intra-hepatic duct strictures and duct irregularities such as in primary sclerosing cholangitis (PSC).

This study aims to provide an initial evaluation of image quality and diagnostic performance of this technique by prospective comparison of the conventional technique and the interactive approach with adaptive averaging in patients referred for routine MRCP examination.

Material and Methods

Ten patients (5F : 5M, age range 17-85 years) referred for routine MRCP investigation underwent high-resolution projection imaging using both the conventional and the adaptive interactive sequences. The examination was conducted using a 1.5T whole body MR system (LX, GEMS Milwaukee) and a torso phased array coil. The study was approved by the local ethics committee and informed patient consent obtained. The interactive SSFSE technique involved the acquisition of 20 images using respiratory triggering, which were subsequently ‘adaptively averaged’ by means of a cross-correlation method implemented in IDL (RSI, Boulder, Co). The adaptively averaged image was compared with a location-matched image obtained using the standard MRCP sequence in a breath-hold. Acquisition parameters were the same for both techniques; matrix 256x256, section thickness 40mm, FOV 20cm.

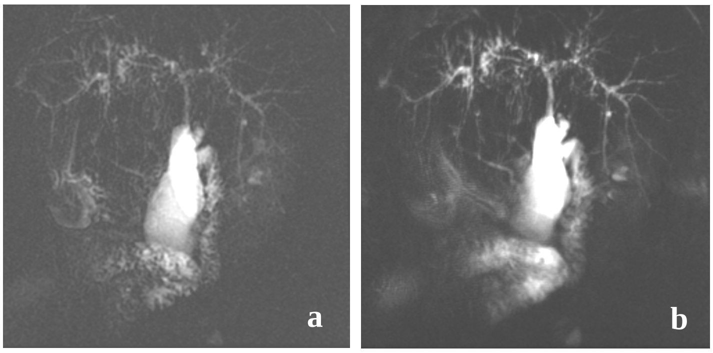

Figure 1. a) Standard high resolution MRCP image and **b)** adaptive averaged interactive image in a patient with PSC. Note improved delineation of the peripheral bile ducts in image **b**.

Qualitative visual analysis was performed by two experienced observers in consensus, blinded to the acquisition details for:

1. The ability to see the common bile duct, main left and right hepatic ducts and peripheral ducts for each acquisition method separately.
2. Direct comparison between the two acquisition methods for demonstration of the peripheral bile ducts.
3. Presence of artefacts that impaired diagnostic quality.

In addition, diagnosis was made by consensus and diagnostic confidence recorded using visual analogue scales. Signtest and non-parametric paired data Wilcoxon signed rank tests was used.

Results

There was no difference in both techniques ability to demonstrate the common and main intra-hepatic duct branches. In seven of the ten studies the adaptive technique provided better delineation than the standard method for the visualisation of the peripheral bile duct system (p=0.035, one-sided; p=0.07, two-sided; signtest). Artefact was present in one adaptive study, whilst there were no artefacts in the standard acquisition images. A diagnosis of PSC was made in 3 patients, intrahepatic bile duct strictures in two, and choledocholithiasis in one. The remaining 4 studies were normal. There was no difference in the diagnostic confidence between the two techniques (p=0.32, Wilcoxon signed rank test). The mean scan time for the acquisition of 20 respiratory-triggered interactive images was 92.2±26.3s (range 57-150s).

Conclusion

Adaptive averaging produced a significant improvement in image quality of the peripheral bile ducts compared with the standard technique. This can be attributed to the improved SNR in the adaptive images. Although this could be implemented in a standard 2D sequence the use of an interactive approach allows the integration of this technique within a complete interactive MRCP examination allowing rapid selection of the optimal locations for demonstration of biliary ductal anatomy. The adaptive averaging processing technique is being further developed and optimised to provide “on the fly” processing of the images during their acquisition. A larger patient study to evaluate this technique is in progress.

References

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