Tomosynthesis for the detection of choledocholithiasis: diagnostic performance compared with radiography for Endoscopic retrograde cholangiography.

Poster No.: C-1448  
Congress: ECR 2015  
Type: Scientific Exhibit  
Authors: Y. Suyama¹, Y. Yamada¹, G. Someya², S. Otsuka², H. Yamaguchi², Y. Murayama², M. Jinzaki¹, K. Ogawa², ¹Tokyo/JP, ²Kanagawa/JP  
Keywords: Calcifications / Calculi, Technology assessment, Endoscopy, Digital radiography, Biliary Tract / Gallbladder  
DOI: 10.1594/ecr2015/C-1448

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR’s endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys’ fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Aims and objectives

Choledocholithiasis is a common disease and endoscopic retrograde cholangiography (ERC) with radiography is performed for the detection of choledocholithiasis as well as MRCP. However, endoscopic stone extraction sometimes shows the presence of choledocholithiasis, although choledocholithiasis is not detected by ERC with radiography[1-5].

Digital tomosynthesis is a type of limited-angle tomography that allows reconstruction of multiple image planes from a set of projection data acquired over a finite range of movements of the X-ray tube [6-8]. Its advantages are that it removes visual interference from overlying structures and provides depth information on structures [9-14].

When endoscopic stone extraction is performed, it needs endoscopic sphincterotomy which sometimes causes complications such as bile duct stone recurrence, acute cholecystitis, acute cholangitis, liver abscess, and biliary carcinoma [15-19]. If tomosynthesis for ERC improves the diagnostic performance for choledocholithiasis, it could avoid unnecessary endoscopic sphincterotomy. To the best of our knowledge, no clinical studies to date have evaluated the diagnostic performance of tomosynthesis for the detection of choledocholithiasis.

The purpose of this study was to compare the diagnostic performance between ERC with tomosynthesis and ERC with radiography for the detection of choledocholithiasis.
Methods and materials

The institutional review board approved this retrospective study and waived informed consent.

#Patients

We performed a retrospective review of tomosynthesis images in 102 consecutive patients with suspected choledocholithiasis who underwent radiography for ERC and tomosynthesis for ERC on the same day at our hospital between July 2009 and June 2014.

Of 102 patients, 57 patients (men/women, 34/23; age, 68±14.8) were with choledocholithiasis and 45 patients (men/women, 25/20; age, 72±13.1) were without choledocholithiasis.

#Imaging protocol

For radiography and tomosynthesis, the SONIALVISION safire radiography/fluoroscopy system (Shimadzu, Nakagyo-ku, Kyoto, Japan) equipped with a direct-conversion digital flat panel detector under the radiographic tilt table was used.

Radiography for ERC obtained at a tube voltage of 80-85 kVp, with automatic control of the patient exposure.

For tomosynthesis, the direct-conversion digital flat panel detector was used in the 15 frames-per-second mode and 24 cm × 24 cm field of view. The anatomical range and the imaging depth were adjusted to the patient characteristics up to 30 cm in the anteroposterior direction. Under these settings, the acquisition time for 36 frames over the tube movement range of ±20° was 2.5 s. The other acquisition parameters for tomosynthesis were 90 kVp, 160 mA and 16 ms. The tomosynthesis examination yielded approximately 20 reconstructed coronal images with a thickness of 5 mm.

#Detection study

Blinded gastroenterologist with 4 year of clinical experience in tomosynthesis for ERC independently evaluated the tomosynthesis images and radiographs of ERC for the presence of choledocholithiasis.

The reader was provided with no clinical information, including in respect of the ratio of the choledocholithiasis to non-choledocholithiasis cases. He was allowed to change the window width and window level and to use the pan/zoom functions and grey-scale
inversion at the workstation. He was asked to grade their degree of confidence with regard to the diagnosis of choledocholithiasis on a scale of 0-4, with the rating of 4 representing the highest degree of confidence (definitely choledocholithiasis), that of 1 representing the lowest degree of confidence (possible choledocholithiasis), and that of 0 representing definitely no-choledocholithiasis. The reader was also advised to ignore the gallstones. To eliminate systematic bias in the reading of the images, the order of reading the images from the two techniques was randomly classified into two sessions. Each case occurred only once in each session (i.e. if the tomosynthesis image was included in the first session, the radiograph was included in the second session). The interval between the two reading sessions was 1 month.

# Reference method

Reference standard for the existence of choledocholithiasis was confirmed by endoscopic stone extraction during ERC (n = 78), intraoperative cholangiography (n = 11) or follow-up by MRCP (n = 13).

The diagnoses made on the tomosynthesis images and radiographs by the reader were compared with the diagnosis made on the reference standard. The possible causes of the false-negative and false-positive diagnoses were evaluated retrospectively.

# Statistical analysis

Receiver-operating characteristic (ROC) analysis was used to compare the diagnostic performance of tomosynthesis with that of radiography. The area under the curve (AUC) and its 95 % confidence interval (CI) were calculated for each of the techniques and reader. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of tomosynthesis and radiography were estimated by treating a rating of greater than 0 as a positive test result. The significance level for all tests was two-sided, at 5 %. All data were analysed using a commercially available software program (SPSS version 21; IBM SPSS, Armonk, New York, USA).
Results

The ROC curves for each technique and reader are shown in Fig. 1 on page 7. Non-parametric AUC values for the techniques and reader is summarised in Table 1.

Table 1.

<table>
<thead>
<tr>
<th>Technique</th>
<th>AUC (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomosynthesis</td>
<td>0.876 (0.808, 0.943)</td>
</tr>
<tr>
<td>Radiography</td>
<td>0.803 (0.717, 0.889)</td>
</tr>
</tbody>
</table>

There is no significant difference between the AUC for tomosynthesis (0.876 [95 % CI 0.808, 0.943]) and for radiography (0.803 [95 % CI 0.717, 0.889]. The sensitivity, specificity, accuracy, PPV and NPV are summarized by technique in Table 2. For tomosynthesis, the sensitivity, accuracy, specificity, accuracy, PPV and NPV were 0.965, 0.745, 0.467, 0.696 and 0.913, respectively, whereas, for radiography, the corresponding values were 0.825, 0.706, 0.556, 0.701 and 0.714, respectively.

Table 2. Sensitivity, specificity, accuracy, PPV and NPV by technique

<table>
<thead>
<tr>
<th>Technique</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomosynthesis</td>
<td>0.965</td>
<td>0.467</td>
<td>0.745</td>
<td>0.696</td>
<td>0.913</td>
</tr>
<tr>
<td>Radiography</td>
<td>0.825</td>
<td>0.556</td>
<td>0.706</td>
<td>0.701</td>
<td>0.714</td>
</tr>
</tbody>
</table>

In Fig. 1 on page 7, an example of choledocholithiasis correctly diagnosed on tomosynthesis images, but not on radiographs. Fig. 3 on page 8 illustrates a case of choledocholithiasis in which the diagnosis was missed on both the tomosynthesis images and radiographs.

In the retrospective assessment of 102 cases, there were 24 cases of false-positive diagnosis by tomosynthesis and were 20 cases of false-positive diagnosis by radiography. The most frequently cause of the false-positive diagnoses by both tomosynthesis and radiography was the presence of air that came into common bile duct when ERC was performed.

With respect to the false-negative, there were 2 cases of false-negative diagnosis by tomosynthesis and were 10 cases of false-negative diagnosis by radiography. The cause of the false-negative diagnoses by tomosynthesis was to fail to detect because the stones were small, but they could be found in tomosynthesis retrospectively. The cause of the
false-negative diagnoses by radiography was also the small stones, but they couldn't be found in radiography retrospectively.

The results of our study suggest that tomosynthesis has an advantage in the detection of choledocholithiasis compared with radiography, and that higher NPV in tomosynthesis may avoid unnecessary endoscopic sphincterotomy which sometimes causes complications.

#Limitation

Our study had several limitations. Firstly, the size of the patient group was relatively small and further studies on larger numbers of patients must be performed. Secondly, the number of observers was only one and the effect of the length of experience of the observers on the diagnostic performance was not evaluated. Thirdly, further study to compare combination of radiography and tomosynthesis with only radiography would be desirable.
Fig. 1: ROC curve for tomosynthesis and radiography in the detection study

© Department of Radiology, Nippon Koukan Hospital 2015
Fig. 2: A 34-year-old man with choledocholithiasis. a Tomosynthesis image; b radiography image. Choledocholithiasis was detected on the tomosynthesis, but was missed on the radiographs. Note that the choledocholithiasis (arrows) are much easier to recognise on the tomosynthesis image than on the radiograph.

© Department of Radiology, Nippon Koukan Hospital 2015
Fig. 3: A 62-year-old man without choledocholithiasis. a Tomosynthesis image; b radiography image. Airs (arrows) were detected as choledocholithiasis on both the tomosynthesis and radiographs. Note that airs were difficult to be distinguished from choledocholithiasis.

© Department of Radiology, Nippon Koukan Hospital 2015
Conclusion

The sensitivity and NPV of tomosynthesis for ERC were numerically higher than those of radiography for ERC for the detection of choledocholithiasis. Unnecessary endoscopic sphincterotomy may be avoided by using tomosynthesis with higher NPV.
Personal information

Y. Suyama
Department of Diagnostic Radiology, Keio University School of Medicine, 35 Shinanomachi, Shinjuku-ku,
Tokyo 160-8582, Japan
E-mail: yohsuke0710@rad.med.keio.ac.jp

Y. Yamada
Department of Diagnostic Radiology, Keio University School of Medicine, 35 Shinanomachi, Shinjuku-ku,
Tokyo 160-8582, Japan
E-mail: yamada@rad.med.keio.ac.jp

G. Someya
Department of Gastroenterology, Nippon Koukan Hospital, 1-2-1, Kokandori, Kawasaki-ku, Kawasaki-shi, Kanagawa 210-0852, Japan

S. Otsuka
Department of Gastroenterology, Nippon Koukan Hospital, 1-2-1, Kokandori, Kawasaki-ku, Kawasaki-shi, Kanagawa 210-0852, Japan

H. Yamaguchi, Y. Murayama, K. Ogawa
Department of Radiology, Nippon Koukan Hospital, 1-2-1, Kokandori, Kawasaki-ku, Kawasaki-shi, Kanagawa 210-0852, Japan

Y. Murayama
Department of Radiology, Nippon Koukan Hospital, 1-2-1, Kokandori, Kawasaki-ku, Kawasaki-shi, Kanagawa 210-0852, Japan

M. Jinzaki
Department of Diagnostic Radiology, Keio University School of Medicine, 35 Shinanomachi, Shinjuku-ku,
Tokyo 160-8582, Japan

K. Ogawa

Department of Radiology, Nippon Koukan Hospital, 1-2-1, Kokandori, Kawasaki-ku, Kawasaki-shi, Kanagawa 210-0852, Japan
References


