Contrast-enhanced Magnetic Resonance Angiography for the Preoperative Evaluation of Hepatic Vascular Anatomy in Living Liver Donors:

A Meta-analysis

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Rationale and Objectives: The objective of this study was to determine the diagnostic accuracy of contrast-enhanced magnetic resonance angiography (MRA) when used in the preoperative evaluation of hepatic vascular anatomy in living liver donors.

Materials and Methods: A computer-assisted literature searching of EMBASE, PubMed (MEDLINE), and the Cochrane library databases was conducted to identify potentially relevant articles which primarily examined the utility of contrast-enhanced MRA in the preoperative evaluation of hepatic vascular anatomy in living liver donors. We used the Q statistic of chi-squared value test and inconsistency index (I-squared, I^2) to estimate the heterogeneity of the data extracted from all selected studies. Meta-Disc software (version 1.4) (ftp://ftp.hrc.es/pub/programas/metadisc/Metadisc_update.htm) was used to perform our analysis.

Results: Eight studies were included in the present meta-analysis. A total of 289 living liver donor candidates and 198 patients who underwent liver harvesting were included in the present study. The pooled sensitivities of hepatic artery (HA), portal vein (PV), and hepatic vein (HV) in this meta-analysis were 0.84, 0.97, and 0.94, respectively. The pooled specificities of HA, PV, and HV were 1.00, 1.00, and 1.00, respectively. The pooled diagnostic odds ratios of HA, PV, and HV were 127.28, 302.80, and 256.59, respectively. The area under the summary receiver-operating characteristic curves of HA, PV, and HV were 0.9917, 0.9960, and 0.9813, respectively.

Conclusions: The high sensitivity and specificity demonstrated in this meta-analysis suggest that contrast-enhanced MRA was a promising test for the preoperative evaluation of hepatic vascular anatomy in living liver donors.

Key Words: Magnetic resonance imaging; magnetic resonance angiography; liver; transplantation; meta-analysis.

Living donors liver transplantation (LDLT) is becoming more and more common recently because of the shortage of donor livers (1,2). One of the main clinical issues of this procedure is the risk to the donors who are healthy until the date of transplantation. To reduce the morbidity and mortality and to ensure a successful LDLT, careful preoperative evaluations of the hepatic vascular and biliary anatomy, as well as the parenchyma, are essential for us to get useful information and help us in the surgical planning for vascular and biliary anastomoses (3,4).

Digital subtraction angiography (DSA) is considered as the diagnostic criterion standard for the preoperative evaluation of hepatic vascular anatomy in living liver donors. However, DSA is not an ideal screening test. One of the most important reasons is because DSA is not only associated with high cost but also have an invasive nature. Because of this, DSA is associated with some potential complications (5). Computed tomographic (CT) angiography has also been used recently in the preoperative evaluation of the hepatic vasculature of living liver donors (6–8). In particular, multidetector CT can now provide detailed images of the arterial system in a short breath-hold. However, because CT requires using ionizing radiation and potentially nephrotoxic iodinated contrast material, it could also potentially lead to nephrotoxicity, thus contraindicated in those patients with decreased renal function.

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Three-dimensional contrast-enhanced magnetic resonance angiography (MRA) is another alternative noninvasive technique for evaluating vascular anatomy. Recently, thanks to the development of technique, high-resolution near-isotropic imaging of the abdomen could be acquired in a breath-hold by using three-dimensional interpolated gradient echo sequence. MRA image quality has also greatly improved by means of thinner sections and faster scanning (9,10).

So far several studies using contrast-enhanced MRA for preoperative evaluation of the hepatic vascular anatomy have been published, but sample sizes are relatively small (11–18). Given the growing concerns about the risks of diagnostic DSA and uncertainty regarding the accuracy of MRA in evaluating hepatic vascular anatomy; here, we performed a meta-analysis to determine the overall sensitivity, specificity, and diagnostic accuracy of contrast-enhanced MRA for the preoperative evaluation of the hepatic vascular anatomy.

MATERIALS AND METHODS

Literature Searching Strategy

A computer-assisted literature searching of EMBASE (from 1966 to July 1, 2013), PubMed (MEDLINE; from 1974 to July 1, 2013), and the Cochrane library databases (up to July 1, 2013) was conducted to identify potentially relevant articles using the medical subject heading (MeSH) term liver transplantation OR free-text term liver transplantation AND MeSH term angiography, magnetic resonance OR free-text term magnetic resonance angiography OR MRA. The literature was restricted by language in English and Chinese. Manual searching of the most relevant reference from potentially relevant articles was performed to identify any additional study that may have been missed. In addition, for each potentially relevant article found on PubMed, the "relevant article" option was used to identify similar articles.

Study Selection

Two investigators (X.T.M. and Q.Z.M.) independently reviewed titles and abstracts of all citations identified by the literature searching described previously. Potentially relevant studies were retrieved and selection criteria were applied. Eligible articles were reviewed and data were extracted in a duplicate and independent manner by the two investigators. Disagreement was resolved by consensus.

Inclusion and Exclusion Criteria

The selection criteria for inclusion into the present meta-analysis were as follows: (1) studies that primarily examined the use of contrast-enhanced MRA in preoperative evaluation of the hepatic vascular anatomy, (2) studies that contained living liver donors who underwent MRA, (3) studies that explicitly defined the reference standard as conventional angiography or surgery and (4) studies from which the raw numbers (true positive, false positive, true negative, and false negative) necessary for meta-analysis were reported or could be calculated based on information given in the articles. Exclusion criteria were as follows: (1) data were duplicated from another article, (2) review articles, letters, comments, and case reports.

Data Extraction and Quality Assessment

Two independent reviewers (X.T.M. and Q.Z.M.) extracted the following data from the selected studies: first author's name, year of publication, journal of publication, patient characteristics, MRA technique, indication for MRA, reference standard used, timing between MRA and reference standard, blinding of radiologists, and outcomes (true positive, false positive, true negative, and false negative). The quality of methods used in selected studies was assessed independently by other independent reviewers (H.W. and C.N.W.) by doing quality assessment of diagnostic studies (quality assessment of diagnostic studies [QUADAS]) instrument, a quality assessment tool specifically developed for the systematic reviewing of diagnostic accuracy studies (19).

Meta-analysis

We used the Q statistic of chi-squared value test and inconsistency index (I-squared, I^2) to estimate the heterogeneity of the data extracted from all selected studies. The homogeneity was used to evaluate if the differences across all selected studies were greater than expected by chance alone. P value $< .05$ suggests presence of heterogeneity beyond what could be expected by chance alone. I-squared (I^2) was used to describe the percentage of total variation across all selected studies due to heterogeneity rather than chance. It was also used as a measure to quantify the amount of heterogeneity. $I^2 > 50\%$ suggests there is heterogeneity across our selected studies (20).

The primary outcome of interest is the sensitivity and specificity of MRA for the preoperative evaluation of hepatic vascular anatomy in living liver donors. Pooled sensitivities, specificities, positive likelihood ratio, negative likelihood ratio forest plots, pooled diagnostic odds ratio, and summary receiver-operating characteristic (sROC) curves were analyzed using a bivariate mixed effects model. We used the Meta-Disc software (version 1.4) (ftp://ftp.hrc.es/pub/programas/metadisc/Metadisc_update.htm) to perform our analysis (21).

RESULTS

Literature Search

A total of 804 articles were retrieved using the search criteria described previously. A further detailed title and abstract reviewing identified 14 studies eligible for our study. Eight studies were included in the present meta-analysis (11–18). There was 100% agreement between reviewers regarding the study selection.