Comparison between post processing techniques in the analysis of hepatic arteries by using MDCTA

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Purpose

The patterns of hepatic arterial supply are not constant; in fact the usual anatomy in which the common hepatic artery arises from the celiac axis is found in 25% to 75% of the population. Precise knowledge of the configuration of hepatic arteries is important in hepatic surgery, as well as in the planning of interventional radiological treatments, because many anatomic variations may necessitate modifications to the surgical approach.

In the analysis of MDCTA, it is possible to use several post-processing methods to visualize the arteries. The most frequently used are Maximum Intensity Projection (MIP), Multi Planar Reconstruction (CPR), Curved Planar Reconstruction (CPR) and Volume Rendering (VR). With the more recent workstations, these post-processing images are obtained in real-time, such that the processing time, which was a problem some years ago, is no longer an issue. However, the time taken for the radiologist to visualize datasets using all the different post-processing techniques may be important. For this reason it is important to determine the most reliable post-processing technique(s) for visualizing the vessels.

The purpose of this paper was to compare four different post-processing techniques (MPR, MIP, CPR, VR) for the study of hepatic arteries.

Methods and Materials

Material and methods

Patients. A total of 137 patients (84 men; mean age, 69.2 years) who underwent MDCTA between August 2009 and January 2010 were retrospectively analyzed. Informed consent for the contrast agent administration protocols was obtained from all patients before the MDCT examination. Exams were performed within the routine clinical standards of our Institution. Each MDCTA was performed using a 16-detector-row scanner (Philips Brilliance, Rotterdam, The Netherlands). Written consent to perform MDCTA was obtained from the patients after discussion about the associated risks of contrast enhanced MDCTA and the potential benefits deriving from this examination. The scanning parameters were a voltage of 120 kV, a tube current of 280-330 mA, collimation 16 x 0.625 mm, field of view of 32-36 cm, 80-110 mL of a contrast medium (Iomeron 400; Bracco, Milan, Italy) were injected into a cubital vein, using a power injector at a flow rate of 5 mL/s and an 18-gauge intravenous catheter in order to obtain a constant iodine delivery rate (2 gI/sec). A bolus tracking technique was used to determine the correct timing of the scan. Dynamic monitoring scanning began 6 seconds after the beginning of
the intravenous injection of contrast material. The trigger threshold inside the ROI was set at +60 HU above the baseline. The delay between the acquisition of each monitoring scan was 1 second. When the threshold was reached, the patient was instructed not to breathe and after an interval of 4 seconds the scan started in the cranio-caudal direction. The flow rate was variable from 3 to 6 mL/sec.

Assessment of image quality and exclusion criteria. The image quality of the CT angiograms was classified as technically adequate or inadequate. CT angiograms were considered technically adequate when there was no substantial respiratory motion artifact and when adequate enhancement of the hepatic artery was achieved. Otherwise, CT angiograms were considered technically inadequate.

Image analysis and post-processing techniques. Each MDCTA dataset was post-processed in our workstations using four post-processing techniques: Multi-Planar-Reconstruction (MPR), Maximum-Intensity-Projection (MIP), Curved-Planar-Reconstruction (CPR) and Volume-Rendering (VR). Image quality was categorized as grade 1 (poor with sub-optimal arterial opacification), grade 2 (fair), grade 3 (good) and grade 4 (excellent: all of the sub-segmental hepatic artery branches were clearly visualized to the sub-sub-segmental level with no opacified venous superimposition). To study the hepatic arteries we used the MIP (Maximum Intensity Projection), MPR (Multi Planar Reconstruction), CPR (Curved Planar Reconstruction) and VR (Volume Rendering) post-processing.

Statistical analysis. The image-quality scores for the three algorithms were ranked as mean ± Standard Deviation (SD). The significance of the differences was tested using the Wilcoxon signed rank test. The Cohen kappa statistic was used to assess the level of observer agreement on image quality achieved by the four post-processing techniques. A value of < 0.20 implied poor agreement; 0.21-0.40, fair agreement; 0.41-0.60, moderate agreement; 0.61-0.80, substantial agreement; and 0.81-1.0, almost perfect agreement. The Pearson coefficient moment was calculated to assess the measurement of HU values by the two observers in the common hepatic artery. Receiver Operating Characteristic (ROC) curve analysis was also performed for each method and the area under each ROC (Az) was determined to evaluate which HU values determine good/optimal visualization parameters (grade 3 and grade 4).

Results

Of the 137 examined patients, 9 (6.56%) were excluded because of technically inadequate images. For the remaining 128 patients (78 men; mean age, 68.5 years ± 9 [SD]; age range, 23-84 years), the Pearson $r$ between the observers for the common hepatic artery was good ($r = 0.88$). The highest agreement between the two observers was detected using the volume rendering protocol with a Cohen kappa value of 0.78;
analysis of the inter-technique agreement for each observer showed the best agreement between the VR and MIP techniques (with a Cohen kappa of 0.69 and 0.62 for observer 1 and 2 respectively).

The highest image quality score was obtained using MIP (total value 384, mean value 3.01) for observer 1 and using VR and MIP for observer 2 (both with a total value of 376 and a mean value of 2.94).

In the ROC analysis the best value was obtained using the MIP technique with an Az of 0.861, indicating that the effect of HU is extremely important in this image post-processing procedure, allowing it to achieve the best image visualization.

**Conclusion**

The purpose of this paper was to compare four different post-processing techniques (MPR, MIP, CPR, VR) for the study of hepatic arteries. An accurate, reproducible, method for evaluating hepatic arteries is fundamental in order to give the information necessary to plan the correct therapies. The introduction and widespread availability of 16-section multi-detector row CT technology and, more recently, 64/128/256-section and dual source scanners, has greatly advanced the role of MDCTA in clinical practice. The success of CT angiography depends on a number of critical steps, including the correct timing of data acquisition, the timed delivery of iodinated contrast material and the selection of appropriate scanning parameters. Results of our study suggest that the MIP and VR methods showed optimal inter- and intra-observer agreement and the highest quality scores and therefore should be used preferentially as post-processing techniques to study the hepatic arteries when using MDCTA.

**References**


**Personal Information**