ORIGINAL RESEARCH PAPER

Radio-Diagnosis

"ASSESSING THE EFFECTIVENESS OF OPTIMIZED CONTRAST AGENT USAGE IN CT SCANNING"

KEY WORDS: Contrast media, CT scan, liver scan

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ABSTRACT

Background: To assess individually optimized protocol of contrast medium injection in enhanced CT scan for liver imaging. **Materials & methods:** 50 patients who underwent liver CT scan were included in the present study. Random division of all the patients was done into two study groups as follows: Group A and group B (25 patients in each group). All the patients were scanned using CT machine. All patients underwent both unenhanced and enhanced CT scans during hepatic arterial phase (HAP) and portal venous phase (PVP). All the enhanced CT scans during HAP and PVP started at thirty-five seconds and sixty-five seconds respectively, after the contrast injection, from the level of diaphragm to inferior hepatic edge. Both groups received the same contrast medium. Group A adopted an individually optimized protocol of the platform, which automatically calculated the contrast medium dose. Patients of group B received a standard contrast medium injection protocol with a contrast medium to weight dose of 1.5 ml/kg. CT values of unenhanced liver parenchyma, CT values of liver parenchyma during HAP and PVP, and CT values of the portal vein during PVP were measured. CT examinations were performed in both group A and group B patients. Analysis of results was done using SPSS software. **Results:** Mean CT value of liver parenchyma during HAP (HU) among patients of group A and group B was 78.3 and 77.1 respectively. Mean CT value of liver parenchyma during PVP (HU) among patients of group A and group B was 103.1 and 108.3 respectively. Mean CT value of portal vein during PVP (HU) among patients of group A and group B was 145.3 and 158.7 respectively. Mean Contrast medium dose (ml) among patients of group A and group B was 79.2 and 95.3 respectively. Significant results were obtained while comparing the outcome variables among the two study groups. **Conclusion:** From the above results, the authors concluded that in enhanced CT scan for liver imaging, individualizing the contrast dose on the basis of body weight through contrast medium injection protocol could efficaciously decrease contrast medium dose.

INTRODUCTION

Computed tomography (CT) provides high-resolution anatomic diagnoses for a broad range of disease such that over 85 million CT scans are performed annually in the USA alone, and approximately half of these are performed using intravenous (IV) injected contrast agents. The development of safe radiopaque contrast materials for CT imaging revolutionized the value of this imaging modality for highlighting internal organ lesions and vascular anatomy.[1-3]

Patient body size is known to be a major determinant of parenchymal enhancement, and it has been shown that adjusting the contrast media (CM) dose to patient weight may be a more appropriate approach than administering a fixed dose of CM, allowing to reduce inter-patient variability and unnecessary healthcare costs related to CM over dosage. However, there are no general recommendations or established guidelines regarding the CM dosing method necessary to optimize parenchymal enhancement for abdominopelvic CT studies, and fixed-dose CM injection protocols are still commonly used for clinical practice in many institutions.[4-6] Hence; the present study was conducted for assessing individually optimized protocol of contrast medium injection in enhanced CT scan for liver imaging.

MATERIALS & METHODS

The present study was conducted for assessing individually optimized protocol of contrast medium injection in enhanced CT scan for liver imaging. 50 patients with hepatocellular carcinoma who underwent liver CT scan were included in the present study. Random division of all the patients was done into two study groups as follows: Group A and group B (25 patients in each group). All the patients were scanned using CT machine. All patients underwent both unenhanced and enhanced CT scans during hepatic arterial phase (HAP) and portal venous phase (PVP). All the enhanced CT scans during HAP and PVP started at thirty-five seconds and sixty-five seconds respectively, after the contrast injection, from the level of diaphragm to inferior hepatic edge. Both groups received the same contrast medium. Group A adopted an individually optimized protocol of the platform, which automatically calculated the contrast medium dose. Patients of group B received a standard contrast medium injection protocol with a contrast medium to weight dose of 1.5ml/kg. CT values of unenhanced liver parenchyma, CT values of liver parenchyma during HAP and PVP, and CT values of the portal vein during PVP were measured. CT examinations were performed in both group A and group B patients. Analysis of results was done using SPSS software.

RESULTS

Mean age of the patients of group A and group B was 52.3 years and 49.7 years respectively. Mean CT value of liver parenchyma during HAP (HU) among patients of group A and group B was 78.3 and 77.1 respectively. Mean CT value of liver parenchyma during PVP (HU) among patients of group A and group B was 103.1 and 108.3 respectively. Mean CT value of portal vein during PVP (HU) among patients of group A and group B was 145.3 and 158.7 respectively.

Mean Contrast medium dose (ml) among patients of group A and group B was 79.2 and 95.3 respectively. Significant results were obtained while comparing the outcome variables among the two study groups.

Table 1: Outcome variables

Groups	CT value of liver parenchyma during HAP (HU)	CT value of liver parenchyma during PVP (HU)	CT value of portal vein during PVP (HU)	Contrast medium dose (ml)
Group A	78.3	103.1	145.3	79.2
Groupe B	77.1	108.3	158.7	95.3
p-value	0.12	0.001*	0.000*	0.000*

*: Significant

DISCUSSION

Respiration motion can cause significant volumetric deformation of tumor images in conventional three-dimensional computed tomography (3DCT), which leads to inaccurate target volume delineation and may possibly impact the following treatment course and outcome. To explicitly include organ/target motion in treatment planning and delivery, respiration-correlated four-dimensional computed tomography (4D-CT) is needed, which has the ability to record tumor motion and can be used to obtain respiration artifact-free CT images of thorax tumors, thereby allowing tumor motion assessments for individual patients. In most radiotherapy departments, 4D-CT scanning has become the mainstream technology for CT simulation in patients with thorax tumors.[6-10] Hence; the present study was conducted for assessing individually optimized protocol of contrast medium injection in enhanced CT scan for liver imaging.

Mean age of the patients of group A and group B was 52.3 years and 49.7 years respectively. Mean CT value of liver parenchyma during HAP (HU) among patients of group A and group B was 78.3 and 77.1 respectively. Mean CT value of liver parenchyma during PVP (HU) among patients of group A and group B was 103.1 and 108.3 respectively. Damiano Caruso et al compared the performance of fixed-dose and lean body weight (LBW)-adapted contrast media dosing protocols, in terms of image quality and parenchymal enhancement. One-hundred cancer patients undergoing multiphasic abdominal CT were prospectively enrolled in this multicentric study and randomly divided in two groups: patients in fixed-dose group (n=50) received 120 mL of CM while in LBW group (n=50) the amount of CM was computed according to the patient's LBW. LBW protocol group received a significantly lower amount of CM (103.47±17.65 mL vs. 120.00±0.00 mL, $p<0.001$). Arterial kidney signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) and pancreatic CNR were significantly higher in LBW group (all $p\leq0.004$). LBW group provided significantly higher arterial liver, kidney, and pancreatic contrast enhancement index (CEI) and portal venous phase kidney CEI (all $p\leq0.002$). Significantly lower portal vein SNR and CNR were observed in LBW-Group (all $p \leq 0.020$). LBW-adapted CM administration for abdominal CT reduces the volume of injected CM and improves both image quality and parenchymal enhancement.[11]

Mean CT value of portal vein during PVP (HU) among patients of group A and group B was 145.3 and 158.7 respectively. Mean Contrast medium dose (ml) among patients of group A and group B was 79.2 and 95.3 respectively. Significant results were obtained while comparing the outcome variables among the two study groups. In another previous study conducted by Hua L et al, authors investigated the feasibility of using optimized protocol of iodine contrast agent with fixed injection time in triple-rule-out CT examination of acute chest pain patients. Protocol 1 was performed with 55 mL of total iodinated contrast media: iodinated contrast media was first injected at 5.0 mL/s for 8 s, followed by the same contrast media injection at 2.5 mL/s for 6 s, finally followed by injection of 40 mL of saline at a rate of 2.5 mL/s. Protocol 2 with 60 mL of total iodinated contrast media: iodinated contrast media was first injected at 5.0 mL/s for 10 s, followed by the same contrast media injection at 2.5 mL/s for 4 s, finally followed by injection of 40 mL of saline at a rate of 2.5 mL/s. The primary and objective evaluation was conducted on the image quality of the patients' blood vessels in different segments. The primary score, CT value and contrast-to-noise ratio (CNR) of the pulmonary artery, coronary artery, aorta and total effective radiation dose for the examination were recorded. A total of 92 patients were enrolled in the analysis. In BMI ≤ 23 kg/m2 group, the CT value, CNR and primary scores of pulmonary artery images in patients receiving protocol 2 were significantly higher than those receiving protocol 1 [CT value (HU): 584±110 vs. 472±86 for main pulmonary artery, 561±93 vs. 467±78 for left pulmonary artery, 555±91 vs. 472±83 for right pulmonary artery; CNR: 24.2±7.5 vs. 18.7±4.6 for main pulmonary artery, 23.2±6.8 vs. 18.6±4.8 for left pulmonary artery, 22.9±6.7 vs. 18.8±4.7 for right pulmonary artery; primary score: 4.0 (4.0, 4.0) vs. 3.5 (3.0, 4.0), all $P < 0.05$]; and there was no statistically significant difference in the primary or objective evaluation of coronary artery or aortic image quality between the two protocols. The effective radiation dose of triple-rule-out CT examination of acute chest pain is relatively low.[12]

CONCLUSION

From the above results, the authors concluded that in enhanced CT scan for liver imaging, individualizing the contrast dose on the basis of body weight through contrast medium injection protocol could efficaciously decrease contrast medium dose.

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