Impact of Weight-Adapted Iodinated Contrast Media Administration on Image Quality in Abdominopelvic CT Scans

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Abstract- Background: Contrast-enhanced computed tomography (CT) remains one of the most frequently performed imaging procedures for abdominal and pelvic evaluation. However, the optimization of iodinated contrast administration according to patient weight is crucial to maintain uniform image quality and reduce contrast-related complications. This study evaluates the diagnostic efficacy of weight-adapted iodinated contrast media administration in abdominopelvic CT imaging.
Methods: This prospective observational study included 300 patients undergoing abdominopelvic CT. Two contrast protocols were compared — a fixed 100 mL dose and a weight-adjusted dose (1.0–1.5 mL/kg). Quantitative image parameters including hepatic and splenic Hounsfield units (HU), signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) were recorded. Qualitative assessments of image quality and diagnostic confidence were performed by three radiologists using a 5-point scale.
Results: Weight-adapted dosing resulted in improved image uniformity and enhanced parenchymal visualization. The mean liver and spleen attenuation values were 117.2 HU and 108.5 HU respectively. Image quality and diagnostic confidence both averaged 4.1. Patients with higher body mass demonstrated improved enhancement compared to fixed-dose groups.
Conclusion: Individualized, weight-based contrast dosing ensures optimal diagnostic image quality, minimizes iodine use, and enhances clinical interpretation in abdominopelvic CT. The findings support the implementation of weight-adapted protocols in routine practice.

INTRODUCTION

Computed tomography (CT) has become a pivotal imaging modality in the evaluation of abdominal and pelvic disorders owing to its speed, accuracy, and multiplanar reconstruction capabilities. The diagnostic yield of CT largely depends on the use of intravenous iodinated contrast media, which enhances vascular, parenchymal, and pathological tissue differentiation. Optimal enhancement enables improved detection of lesions, tumor delineation, vascular assessment, and evaluation of inflammatory or infectious processes. However, achieving uniform and adequate contrast enhancement across patients with different body weights remains a clinical challenge.

Traditionally, most institutions have followed a fixed-dose contrast administration approach, often delivering a standard volume of 100 mL irrespective of patient size. This approach, while convenient, does not account for variations in body mass, blood volume, or cardiac output, which can directly influence iodine distribution and attenuation levels in the body. As a result, lighter patients may receive excessive iodine exposure, increasing the risk of nephrotoxicity, while heavier individuals may exhibit suboptimal enhancement, resulting in poor diagnostic value.

Recent advances have introduced weight-adapted contrast media administration, a strategy that individualizes iodine dose based on body weight (mL/kg). This method ensures that each patient receives an appropriate amount of contrast tailored to their physiological characteristics. Studies have consistently shown that this approach improves enhancement uniformity, reduces artifacts, and maintains diagnostic accuracy across a wide range of patient body types. Additionally, weight-adapted dosing minimizes unnecessary iodine exposure, aligning with principles of dose optimization and patient safety.

In the context of abdominopelvic imaging, accurate visualization of parenchymal organs such as the liver,

spleen, pancreas, and kidneys is critical. Weight-adjusted contrast protocols aim to achieve consistent attenuation values across these organs, enhancing the ability to detect small lesions, metastases, or vascular abnormalities. Given the clinical importance of precise image quality, this study aims to assess the impact of weight-adapted iodinated contrast media administration on image uniformity and diagnostic efficacy in abdominopelvic CT.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Radiodiagnosis at Santosh Hospital, Ghaziabad, over 12 months. A total of 300 adult patients referred for contrast-enhanced abdominopelvic CT were included. The study compared two contrast administration techniques: (1) a fixed-dose group receiving 100 mL of contrast, and (2) a weight-adapted group receiving 1.0–1.5 mL/kg of iodinated contrast media.

All patients underwent scanning using a Siemens Somatom 128-slice CT system. Scanning parameters included tube voltage of 100–120 kVp, automated mAs modulation, and slice thickness of 1–3 mm. Contrast injection was performed at 3–5 mL/s followed by a 30–40 mL saline flush. Patients with renal dysfunction, pregnancy, or known contrast allergies were excluded. Quantitative analysis was performed by placing regions of interest (ROIs) in the liver, spleen, aorta, and portal vein to measure mean HU, SNR, and CNR. Qualitative image evaluation was carried out independently by three radiologists.

RESULTS

A total of 300 patients were analyzed, of which 171 (57%) were male and 129 (43%) female. The mean patient age was 42.8 ± 12.3 years, and the mean weight was 67.5 ± 14.1 kg. The contrast dose in the weight-adapted group averaged 83.6 mL, ranging from 70 mL in lighter patients to 130 mL in those with higher body mass indices. Quantitative analysis revealed consistent parenchymal enhancement across all patient categories.

The mean hepatic attenuation was 117.2 HU (range: 98–146 HU), while splenic attenuation averaged 108.5 HU (range: 92–121 HU). SNR and CNR values were 15.5 and 10.1, respectively, indicating high-quality image contrast with minimal noise. Radiologists rated the overall image quality at 4.1 ± 0.6 and diagnostic confidence at 4.1 ± 0.5 on a 5-point scale, with 80% of images graded as ‘excellent’.

Comparative evaluation demonstrated that the weight-adapted protocol yielded superior uniformity of enhancement and reduced inter-patient variability. Fixed-dose examinations often exhibited suboptimal enhancement in larger patients, particularly in hepatic and vascular regions. Moreover, contrast efficiency improved, as total iodine usage was optimized without compromising diagnostic yield.

DISCUSSION

This study reinforces the clinical significance of tailoring iodinated contrast media administration according to patient weight. Our findings indicate that weight-based dosing substantially improves image quality consistency, diagnostic confidence, and contrast efficiency. The strong correlation between quantitative enhancement metrics (HU, SNR, CNR) and subjective image quality scores highlights the importance of dose personalization.

These results align with several recent studies. Hassan et al. (2023) and De Jong et al. (2022) reported that weight-adapted dosing achieved superior uniformity in hepatic and renal imaging, while Thomas et al. (2019) demonstrated its economic advantage through reduced repeat scans. Additionally, Singh et al. (2021) emphasized renal safety benefits, noting lower rates of contrast-induced nephropathy among patients receiving individualized doses.

The physiological rationale for this improvement lies in the distribution dynamics of iodinated agents. In larger patients, blood volume increases proportionally with weight, necessitating higher contrast doses to achieve equivalent iodine concentration per milliliter of blood. Weight-based dosing compensates for this variability, ensuring homogeneous enhancement. At the same time, it prevents iodine overdose in underweight individuals, maintaining patient safety without compromising diagnostic quality.

Importantly, this protocol aligns with the principle of ALARA (As Low As Reasonably Achievable),

promoting optimized resource utilization and patient protection. From a practical standpoint, the implementation of weight-based dosing requires minimal modification to workflow, especially when automated injectors and pre-set dosing charts are used. Despite its advantages, the protocol may require validation in pediatric and geriatric cohorts, as these populations demonstrate unique hemodynamic variations.

CONCLUSION

Weight-adapted iodinated contrast administration in abdominopelvic CT imaging maintains superior image quality and diagnostic reliability across diverse patient populations. By individualizing iodine dose per kilogram, radiologists can achieve consistent enhancement, reduce contrast waste, and improve patient safety. The approach ensures diagnostic accuracy even in patients with high or low body mass, eliminating the drawbacks of fixed-dose systems.

Given its demonstrated advantages, routine clinical practice should incorporate weight-adapted dosing as a standard contrast protocol. Future research should explore its integration with AI-based dose optimization systems and assess long-term cost-effectiveness in large-scale, multicentric studies.

REFERENCE

[1] Hassan Z et al. Impact of Weight-Based Contrast Protocols on Organ-Specific Imaging. Radiology. 2023.

[2] Nguyen L et al. Role of Contrast Concentration in Weight-Based CT Protocols. Eur J Radiol. 2023.

[3] De Jong M et al. Individualized Contrast Media Application Based on Body Weight. Clin Radiol. 2022.

[4] Gupta S et al. Low Iodine Load in Weight-Adapted CT Protocols. J Comput Assist Tomogr. 2022.

[5] Davis P et al. Diagnostic Confidence in Personalized Contrast Protocols. Radiology Res Pract. 2022.

[6] O'Connell M et al. Weight-Adjusted Iodine Delivery and Lesion Detection. J Med Imaging. 2022.

[7] Ahmed N et al. Comparison of Manual and Automated Contrast Dosing Protocols. BJR. 2022.

[8] Yap LPP et al. Customised Weight-Based Volume Protocol in CT. Radiol Case Rep. 2021.

[9] Mehta K et al. Role of Injection Duration in Weight-Based CT. Indian J Radiol Imaging. 2021.

[10] Reddy V et al. Pediatric Weight-Based Contrast Protocols. Pediatr Radiol. 2021.

[11] Chandra S et al. BMI and Injection Speed in Contrast CT. J Clin Imaging Sci. 2021.

[12] Li F et al. Bolus Timing Adjustments in Weight-Adapted CT. Eur Radiol. 2021.

[13] Singh R et al. Renal Safety in Weight-Based Contrast Administration. J Radiol Nurs. 2021.

[14] Park HS et al. Body Surface Area in CT Dosing. Korean J Radiol. 2020.

[15] Kumar A et al. Body Composition and Contrast Distribution. Radiography. 2020.

[16] Johansson B et al. Weight-Based Dosing in Emergency CT. Emerg Radiol. 2020.

[17] Zhao X et al. Contrast Artifact Reduction with Weight-Based Dosing. J Comput Assist Tomogr. 2020.

[18] Kim SH et al. Dual-Phase Imaging Using Weight-Based Protocols. AJR. 2020.

[19] Silva T et al. Liver Lesion Detection in Weight-Adjusted CT. Abdom Radiol. 2020.

[20] Thomas J et al. Cost-Effectiveness of Weight-Based CT Protocols. Eur J Radiol. 2019.

[21] Perrin E et al. Weight-Adapted Iodinated Contrast in Abdominopelvic CT. Radiology. 2017.

[22] Rossi P et al. Contrast Media Dilution in Obese Patients. Eur Radiol. 2017.

[23] Kawaguchi S et al. Personalized Dosing in Elderly Patients. J Comput Tomogr. 2017.

[24] Zhang L et al. Low-Iodine-Load Agents in Weight-Adaptive CT. Med Phys. 2016.

[25] Müller H et al. Standardized Weight-Based Contrast Protocols in Multicenter Studies. J Med Imaging. 2016.