Assessment of inter-patient variability in hepatic enhancement at abdominal CT using lean body weight for intravenous contrast dosing.

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DISCLOSURES:

- Nothing to disclose.

BACKGROUND:

- A previous audit performed at our institution suggested an improvement in the quality of images when weight based contrast dosing was used, however variability in the average hepatic enhancement remained high. As well, total contrast doses increased, increasing the cost to the department.

"Weight based contrast dosing, faster injection rate, and late HAP timing result in better quality studies in cirrhotic patients"

Assessment of Cirrhotic Liver Enhancement with Multiphasic CT using a Faster Injection Rate, Late Arterial Phase, and Weight-based Contrast Dosing

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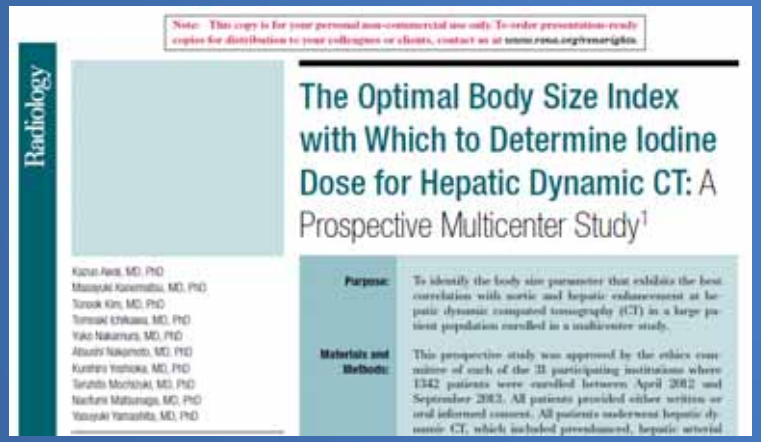
BACKGROUND:

While using weight based contrast dosing improved uniformity of enhancement, others have found Lean Body Mass to have a higher correlation with aortic and hepatic enhancement.

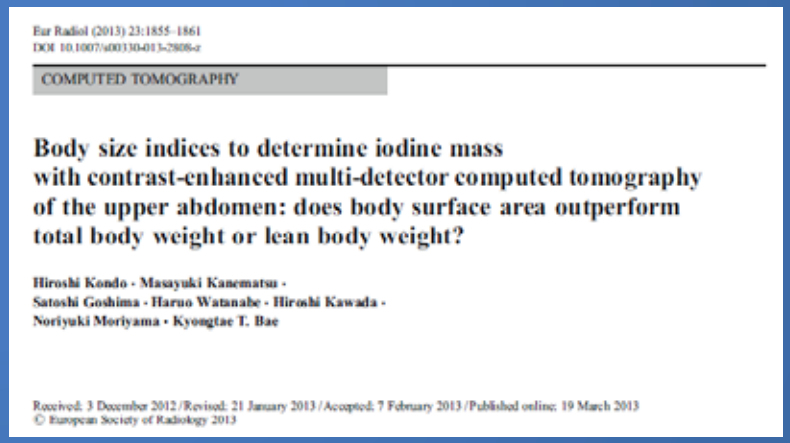


Radiology

The Optimal Body Size Index with Which to Determine Iodine Dose for Hepatic Dynamic CT: A Prospective Multicenter Study[1]

Purpose:

Materials and Methods:



Eur Radiol (2013) 23:1855–1861
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COMPUTED TOMOGRAPHY

Body size indices to determine iodine mass with contrast-enhanced multi-detector computed tomography of the upper abdomen: does body surface area outperform total body weight or lean body weight?

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AIM:

- Based on the expectation of less variability in enhancement when dosing with estimate Lean Body Weight, we hoped to be able to demonstrate an improvement in our variability, and allow consistently minimal contrast dosing.
- One limitation of applying the Awai study to our population was that the study patients were Japanese, and their group was composed of individuals with a much lower average lean body weight than would be typical of our region. A secondary aim of our audit would be to demonstrate that the principle is still applicable at higher percentages of body fat.

STANDARDS:

- Our goal attenuation was an increase of 50 HU in average Hepatic Attenuation Difference (HAD) over three ROIs measured in normal liver when comparing unenhanced and enhanced phases. This was consistent with the practice in the literature.

- Our expectation from the literature was an overall decrease in the Coefficient of Variability (CV), but the what extent we should expect was not clear from the literature.

STANDARDS:

- Studies were performed at a busy tertiary care center.
- Modern Siemens scanners were used, with automated radiation dosing software (care dose, autokv).
- Only studies conducted at 100keV were considered.

METHODS: Patient Selection

PHASE I	PHASE II
Retrospective.	Prospective.
Patient consent was waived.	Patient consent was required.
June – Dec 2016	Jan – Mar 2017
100 patients included	108 patients included
1.3cc/kg TBW	1.9cc/kg LBW
kVp = 100	kVp = 100

METHODS: Patient Selection

Patients were EXCLUDED when:

- Height was not documented.
- They were scanned on a scanner other than one of our institution's two modern CT scanners.
- They were scanned at a kVp other than 100keV
- They weighed more than 115kg (the weight which would achieve our site's maximum contrast dose).
- There was confounding pathology affecting attenuation, ie:
  - Intrinsic to liver – i.e. liver neoplasm
  - Extrinsic to the liver – i.e. renal failure.
- Limitation were imposed by technical factors (such as artifact: respiratory motion, streak artifact etc.).

METHODS: Contrast Dosing

- In PHASE I of our audit, contrast was dosed by the usual weight-based method which is the standard of care at our institution (1.3ml/kg).
- In PHASE II of our audit, contrast was dosed by a, estimated-lean body weight method (1.9ml/kg *estimated lean body weight*).

- The regions of interest were marked on an unenhanced scout image, and matched regions of interest were marked on enhanced images in the portal venous phase.

METHODS: Measuring Attenuation

- Imaging was analyzed by a PGY-2 resident in the radiology department. The regions of interest were marked on an unenhanced scout image, and matched regions of interest were marked on enhanced images in the portal venous phase.

- The attenuation values were converted to a mean for each phase, and the difference in mean attenuation was calculated.

$$Hepatic\ Enhancement\ (HE) = \sum 1 \uparrow 3 \blacksquare postcontrast\ liver\ ROI\ /3 - \sum 1 \uparrow 3 \blacksquare precontrast\ liver\ ROI\ /3$$

METHODS: Statistical Analysis

- The Student T-test and Fischer exact test were used to compare means of continuous variables including patient age, TBW, LBW, contrast dose administered, HAD, and HAD per gram of iodine.

- We also performed linear regressions with r^2 correlation coefficients. Statistical analysis was performed with Prism (version 5.03, GraphPad Software Inc., La Jolla, CA).

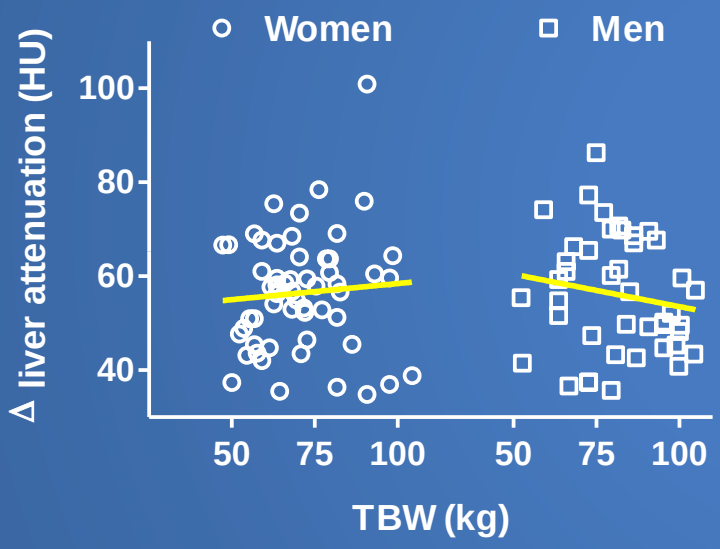
RESULTS: Phase I vs II – Population Data

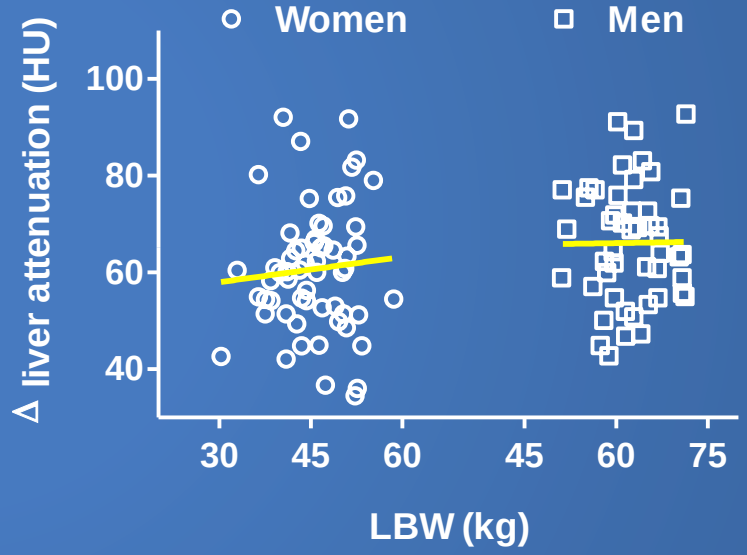
	Part 1	Part 2	p value
Number of Patients	**n = 100**	**n = 108**	-
Mean age in years (range)	59.6 ± 16 (20 - 91)	57.5 ± 16 (17 - 85)	0.33
Sex			
Female (%)	57 (57)	60 (56)	0.74
Male (%)	43 (43)	48 (44)	
Mean Total Body Weight in kg (range)	75 ± 15 (47 - 105)	75 ± 15 (40 - 111)	0.73
Female	71 ± 14	67 ± 14	0.13
Male	81 ± 14	84 ± 12	0.32
Mean Lean Body Weight in kg (range)	52 ± 9 (35 - 71)	53 ± 10 (30 - 71)	0.65
Female	46 ± 6	45 ± 6	0.5
Male	61 ± 7	62 ± 5	0.16

RESULTS: Phase I vs II – Attenuation Data

	Part 1	Part 2	p value
Mean hepatic attenuation difference in HU (range)	56.3 ± 12 (35 - 101)	63.1 ± 13 (34 - 93)	0.0001
Female	56.4 ± 12	60.7 ± 13	0.07
Male	56.1 ± 13	66.1 ± 12	0.0002
Coefficient of variation	22.00%	20.40%	-
Female	21.90%	21.40%	
Male	22.30%	18.50%	
Regression analysis (r^2)			
Female	0.006	0.006	-
Male	0.025	0.0001	-
Mean hepatic attenuation difference (in HU) per gram of iodine (range)	1.62 ± 0.47 (0.77 – 3.05)	1.74 ± 0.44 (0.94 –3.23)	0.045
Female	1.72 ± 0.46	1.92 ± 0.45	0.01
Male	1.49 ± 0.46	1.52 ± 0.31	0.72

RESULTS: Variability of Enhancement





DISCUSSION: Variance in Hepatic Enhancement

- Unable to demonstrate the expected result from the literature: we did not find any difference in the variability in the degree of enhancement when comparing the groups dosed by TBW vs LBW.

- The mean HAD was increased when dosing by LBW over TBW, especially in women. Further, women had a higher HAD per gram of iodine overall than did men. This suggests that overall dosing could still be reduced when LBW is used.

DISCUSSION: Variance in Hepatic Enhancement

- Patients for whom contrast was dosed by LBW demonstrated a mean HAD of 63HU. Given the original goal of 50HU of attenuation increase, patients received more contrast than necessary. The next phase in our project will be to reduce the dose per LBW, and attempt to achieve the target of 50HU of enhancement with a lower overall contrast dose.
- An addition further phase would entail scanning at a lower kVp which carries several advantages (reducing the dose of ionizing radiation, improving contrast between iodinated contrast and soft tissue). Our expectation would be that scanning at a lower kVp could facilitate a reduction in total contrast dose.

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