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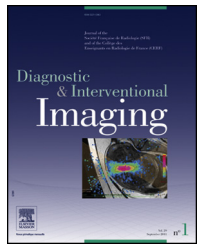

ORIGINAL ARTICLE / *Gastrointestinal imaging*

Quantification of the visceral and subcutaneous fat by computed tomography: Interobserver correlation of a single slice technique

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KEYWORDS
Computed tomography;
Subcutaneous fat;
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Area;
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Abstract
Purpose: To assess the interobserver reproducibility of the quantification of the visceral and subcutaneous fat by computed tomography from an umbilical slice and study the effect of the level of the slice (slice going through the navel versus a slice going through disc L3—L4).
Materials and methods: Forty-four breast cancer patients who had a CT-scan were included in this study. This is a double blind (junior versus senior) retrospective study to determine the interobserver reproducibility. A junior observer studied the variation between two levels of slice by selecting an image going through L3—L4 and the navel.
Results: The measurement of the fat obtained from an umbilical slice seemed to be well correlated and consistent with that obtained from a slice with a disc reference (L3—L4). The interobserver reproducibility is good for the quantification of the umbilical fat (Spearman and Lin at 0.9921 and 0.985 [$P < 0.001$] for the visceral fat).
Conclusion: The interobserver reproducibility of the single slice CT-scan measurement going through the navel (easily detected) is excellent and may therefore be used in oncology as a predictive tool to measure a characteristic of the host and not the tumor.

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Obesity, and more specifically the accumulation of visceral fat, is a factor of risk associated with a great many cancers [1,2]. It is also associated with a higher risk of recurrence after treatment [3] and death [4,5]. Visceral fat is even thought to be a factor of risk independent of the development of cancer of the colon and pancreas [6].

More recently, visceral fat has been shown to be the first predictive biomarker of the efficacy of antiangiogenics in cancer of the colon and kidney [7,8]. Its evaluation is therefore of major importance in the treatment.

Several studies have been carried out on the methodology to quantify and measure abdominal fat by computed tomography [9—15]. In particular, a calculation based on a single slice area has been shown to be sufficient [16]. In some studies, the naval was used as a point of reference [9,11,13—15] while in others, a bone or disc was used as point of reference [17,18]. As far as we are aware, the interobserver reproducibility of the calculation of the area of visceral fat by computed tomography has never been studied in the literature. However, it is a basic element in the reliability of a predictive marker.

The purpose of this study is to assess this interobserver reproducibility by computed tomography from an umbilical slice and study the effect of the level of the slice on the quantification of the fat by comparing this umbilical area with that of one going through disc L3—L4.

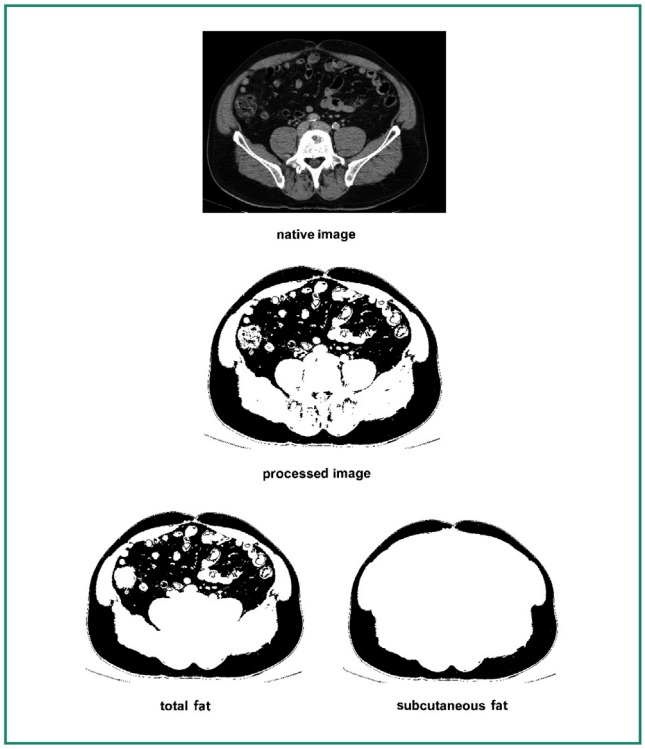

Figure 1. Computed tomography image in axial slice passing through the navel showing the different steps in the calculation of the total fat and subcutaneous fat after segmentation of the fat density pixels (−190 HU to −30 HU) with Image J software. The visceral fat is obtained by subtraction.

Materials and methods

Eligible patients

In a study on the antiangiogenic treatment of breast cancer, forty-four successive patients with histologically-proven breast cancer benefited from pre-therapeutic computed tomography imaging and were thereby included in this study. These patients provided their written consent to use the clinical data and imaging while respecting their anonymity.

This is a double blind retrospective study (junior versus senior) on interobserver reproducibility. The variation between two areas was studied by a single junior observer who selected an image going through L3—L4 and an image through the navel.

Measurement of the visceral and subcutaneous fat

The segmentation of the fat was determined by computer tomography (CT) before treatment on the entire abdomen in patients placed in decubitus dorsal. The two levels of slice were selected, at the umbilical level and at L3—L4, enabling single slice segmentation of the fat. The images acquired were then post processed with Image J software (http://rsb.info.nih.gov/ij/). With this software, it was possible to measure the pixels in densities between −190 and −30 Hounsfield units (HU) in order to define the fat compartments (subcutaneous, visceral) and define an area in mm^2 for each of them (Figs. 1 and 2).

Statistical analysis

The main purpose of this study was to show that a CT slice passing through the navel was a reproducible method in the determination of the area of visceral fat.

The slice passing through disc L3—L4 was chosen because it represents the limit of the upper abdomen, a fixed marker by definition (disc marker). The upper levels from T12—L2 were not selected because the liver is a too big part of the image, thereby limiting the study of the visceral fat. As to the lower levels, as of L5, this is the area of subcutaneous fat which is highly influenced by the fat from the buttocks.

The navel level has been validated in several studies [9,11,13—15] and is very easily found during the scrolling of the axial slices (as opposed to the inter-vertebral discs). For this reason, this level was used to study the visceral fat. For certain authors, the position of the navel may vary according to the patient's morphotype.

The mean, minimum and maximum values of the area of total, subcutaneous and visceral fat were compared. Their coefficient of correlation (Spearman's coefficient) and the concordance (Lin's coefficient) were also studied.

Results

Comparative study of two levels of slice with different markers

The total fat (Fig. 3), subcutaneous fat (Fig. 4) and visceral fat (Fig. 5) as well as their correlation (Spearman's coeffi-