Can computed tomography identify patients with anaemia?

A J Collins, S Gillespie, B E Kelly

Thirty-three in-patients attended for non-contrast enhanced computed tomography (CT) of chest and/or abdomen within a six-week period (11 M, 21 F). All had measurement of their full blood profile within the previous 72 hours. Patients with a blood dyscrasia or known history of active bleeding were excluded.

All patients were imaged using a Siemens Somatom Plus S scanner. The scanning parameters were standardised at 210mA, 120kV, 10mm slice thickness, pitch of 1. Following image review, circular regions of interest (ROI) were defined within the lumina of the aorta and inferior vena cava (IVC) at the level of the superior mesenteric artery origin. The mean attenuation value was calculated using on-board computer software, and recorded.

The mean patient age was 59.6 years (range 18-85 years). A non-parametric correlation analysis was performed and a linear regression plot obtained. A significant correlation was demonstrated between haemoglobin measurement and the aortic and IVC attenuation value. The correlation was stronger ($r=0.64$) for the aortic attenuation value than for the IVC attenuation values ($r=0.57$).

In addition, if anaemia is defined as less than 14g/l for a male and less than 12g/l for a female, then, in our study group, no male with an aortic attenuation value greater than 50HU and no female with an aortic attenuation greater than 45HU was found to be anaemic.

The results demonstrate a significant correlation between patients' haemoglobin measurement and the derived aortic attenuation value. We do not propose this as a method of accurately measuring the patient's haemoglobin; however, we feel that it may be possible for a radiologist at non-contrast enhanced CT examination to note the probable presence of anaemia.

INTRODUCTION

The measurement of an attenuation value of an anatomical region at CT examination is commonplace. The study aims to demonstrate a correlation between routine haematological assay of haemoglobin level and the attenuation value measured within the aorta or inferior vena cava (IVC) lumina at routine unenhanced CT examination.

The measured attenuation value is a reproducible physical density measurement, readily obtainable from a standard CT examination. A correlation between attenuation value and plasma haemoglobin may permit the identification of anaemia at CT examination.

MATERIALS AND METHODS

Thirty-three patients who attended for routine unenhanced CT of the chest and abdomen within a six-week period were evaluated. There were 12 male and 21 female patients. Patient age ranged from 18-85 years. Each patient had had a full blood profile performed within 72 hours of his or her CT examination. Haemoglobin was calculated using the standard hospital laboratory assay.

The CT examination was performed using a Siemens Somatom Plus S CT scanner (Siemens, Erhiangen, Germany). Ten millimetre axial sections were acquired at standardised imaging parameters (210mA and 12kV) and reviewed at a window width of 200HU and a window centre of 50HU Regions of interest (ROI) were then defined within the lumina of the aorta and IVC at the level of the superior mesenteric artery origin using the integrated software package on the scanner

Department of Radiology, Royal Victoria Hospital, Grosvenor Road, Belfast BT12, Northern Ireland.

Anthony J Collins, MB, FRCSI, FRCR.

Scott Gillespie, MB, MRCP, FRCR.

Barry E Kelly, MD, FRCS, FFRRCSI.

Correspondence to A J Collins.

workstation. (Fig.1) Simple circular regions of interest were designated and interrogated.

The mean attenuation value, standard deviation, and region of interest area were recorded for both the aortic and IVC regions.

STATISTICAL METHODS

Correlation was calculated using the Spearman correlation coefficient.

RESULTS

The mean patient age was 59.6 years. Assayed haemoglobin values ranged from 8-16.6 g/dl with a mean of 12.8 g/dl. The ROI data set for the cohort was then subjected to statistical analysis using a non-parametric correlation analysis and a linear regression plot was also derived.

The Spearman correlation coefficient for the aortic attenuation value to haemoglobin level was 0.64. This compared to a value of 0.57 for IVC attenuation value to haemoglobin level and 0.33 for aortic attenuation to white blood cell count, which was measured as a control. These correlations for the aortic and IVC attenuations to haemoglobin level are significant, with the aortic correlation stronger. The linear regression plot obtained is displayed in Fig.2.

Anaemia was then defined as a haemoglobin value of less than 14 g/dl in a male and less than
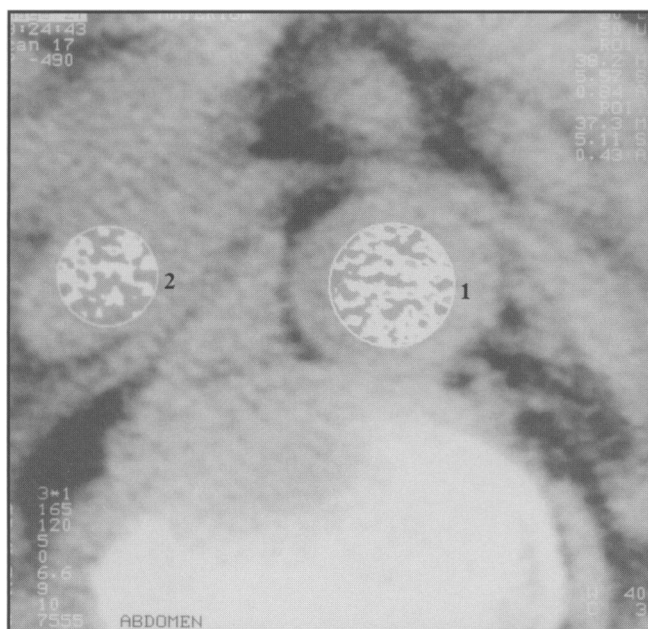

Fig 1. CT of the abdomen at the level of the superior mesenteric artery (SMA): Regions of Interest (ROI) defined within the lumina of the aorta (1) and the inferior vena cava (2).
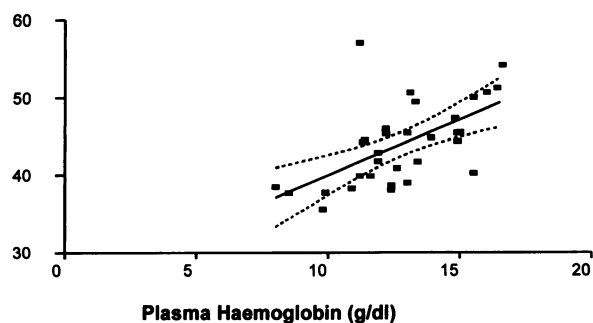
CT attenuation value (HU)

Fig 2. Regression plot of haemoglobin (g/dl) versus CT attenuation value (HU). (broken line reprsents 95% confidence limits).

12 g/dl in a female patient. Our study group was then divided into anaemic and non-anaemic sub-groups on the basis of this haemoglobin measurement. We found that no male patient with an aortic attenuation value greater than 50HU and no female patient with an aortic attenuation greater than 45HU was anaemic.

DISCUSSION

A correlation between plasma haemoglobin and the attenuation of ionising radiation has been shown in vitro and indeed is the basis for a previous method of measuring the haemoglobin level. However the use of abdominal CT examination to primarily measure haemoglobin is absurd.[1]

The data we have used to reach our conclusions is however freely available from the routine CT examinations performed in imaging centres. No additional radiation dose is incurred. There is a small time penalty in accessing and extracting the data but this is negligible.

Modern CT scanning systems are equipped with software to allow the extraction of highly accurate reproducible physical measurements from the routinely acquired data. This information has been used to assess and characterise lesions in many clinical settings. [2-3]

This study aimed to investigate the possibility of deriving a haemoglobin level from this readily available data. The degree of correlation we have demonstrated is not strong enough to give a highly accurate measurement of the plasma haemoglobin but is capable of providing a reliable indicator of the presence of anaemia. We have

shown that an averaged aortic attenuation value in excess of 50HU in a male and 45HU in a female is consistent with the absence of anaemia.

The amount of clinical information available to the radiologist at the time of reporting is variable and usually sparse. In this context the ability to note the presence of anaemia[4] may be a helpful adjunct in the process of interpreting the study – possibly altering or further limiting the differential diagnosis.

CONCLUSION

The results demonstrate a significant correlation between the haematological haemoglobin assay and the aortic attenuation value. In addition we have defined subgroups of anaemic and non-anaemic patients, and shown that measuring the averaged aortic attenuation value can differentiate these groups. This allows the accurate pin-pointing of anaemia at unenhanced CT examination, and we conclude that this readily available information may provide a valuable adjunct in the interpretation of such examinations.

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