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EDITORIAL

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The cardiothoracic ratio—an inaccurate and outdated measurement: new data from CT

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Abstract Cardiomegaly (and left ventricular size in particular) is well recognized to have cardiovascular prognostic significance. Cardiac assessment should be routinely performed when evaluating imaging studies encompassing the thorax, whether cross sectional or projectional. However, such measurements should be robust, readily available and practical. In this issue of *European Radiology*, Schlett et al. describe such a technique based on single level area and transverse diameter measurements on transverse CT and projection digitally acquired radiographs. This paper is significant as it makes a simple tool for left ventricular assessment readily available to all cross-sectional imagers and highlights the established limitation of cardiothoracic ratio on the chest radiograph.

In this issue of *European Radiology*, Schlett et al. [1] elegantly describe simple methods for assessment of left ventricular (LV) size based on single level area and transverse diameter measurements using readily recognisable anatomical landmarks on transverse CT and projection digitally acquired radiographs (CT scout images). This evaluation can be performed on both unenhanced and contrast medium-enhanced examinations, is reproducible, practical (taking 1 min to perform) and correlates closely with three-dimensional assessment of LV volume, muscle mass and size. Although it can occasionally be difficult to identify the position of the interventricular septum on unenhanced cardiac CT (e.g. obtained for calcium scoring examinations), the authors experienced no real difficulty on volumetric unenhanced studies. Perhaps not surprisingly, the authors found that left ventricular area measurements on transverse images correlated closely with left ventricular size, end diastolic volume and left ventricular muscle mass. They also demonstrated significant correlation of left ventricular area measurements with transverse cardiac diameter on scout images, but, significantly, *not* with the cardiothoracic ratio.

The left ventricular area measurements they used do not require multiplanar reformats and provide a simple and objective method of communication of LV data with our clinical colleagues and may have a role in cardiovascular risk stratification. Since both cardiac and thoracic CT examinations involve ionising radiation it is incumbent on the interpreting imager to glean all the available diagnostic information, whether that be in the form of identification of extra-cardiac abnormalities (pulmonary emboli, lung nodules etc.) or the identification and quantification of extra-coronary cardiac abnormalities.

The applicability of left ventricular area measurements to non-cardiac gated CT requires further exploration. However the explosion of cardiac CT workload, which seems set to accelerate in coming years with increasing use both in the emergency room and chronic chest pain settings, provides a substantial substrate on which to apply this novel measurement.

Although retrospective gating of contrast-enhanced cardiac CT permits evaluation of dynamic cardiac function in order to achieve dose reduction, technological developments have led to an increased utilisation of prospectively gated CT. The functional information is, by definition, lost but Schlett et al. have indicated that the mean differences between static measurement of left ventricular area and calculated left ventricular volume were not influenced by the presence or absence of left ventricular dysfunction, implying that this should be a robust measurement. Clearly there will be limitations in that both beta-blockers used for rate control during the examination may influence the parameters measured and the important feature of regional wall motion abnormalities can not be assessed on a single phase image. Nevertheless one has to accept that even a limited assessment of left ventricular morphology is better than none. The presence and pattern of chamber dilatation either in patients with no coronary calcification or with normal coronaries on CT coronary angiography will alert the clinician to alternative diagnoses such as dilated cardiomyopathy and may direct further investigation and therapeutic intervention. Although the impact of this on mortality, morbidity and long-term healthcare costs are indirect, it seems intuitive that early risk stratification based on left ventricular dilatation could have positive beneficial effects.

An even more readily assessable parameter by which to evaluate cardiac size, namely transverse cardiac diameter, has been demonstrated to correlate closely with left ventricular volume, mass and size. Of critical importance is the finding that *no such* correlation applied to the cardiothoracic ratio (CTR). Although CTR on the chest radiograph is widely utilised and advocated in many textbooks [2, 3] its accuracy in assessment of left ventricular size and its role as a predictor of mortality is questionable at best [4]. Indeed a CTR greater than 50% has a specificity in the detection of left ventricular dilatation of only 41% [5]. The extrapolation of the lack of association between CTR and LV volume measurements on a scout CT image to the findings on chest x-ray (CXR) requires some caution because scout images are typically acquired supine and antero-posterior (AP) on CT; thus the geometric enlargement of the heart is maximised both by the projection and geometry of the acquisition system.

Although echocardiography provides a comprehensive evaluation of cardiac structure and function in most patients, there may be issues in relation to body habitus which may prevent full assessment. The gold standard technique for the assessment of left ventricular volume and mass is MRI but access is limited, examination time and cost relatively high, and claustrophobia may prove problematic. As modern healthcare pursues efficient pathways for the imaging workup of patients with non-specific cardio-respiratory symptoms based on symptom complex and pre-test likelihood, it will be increasingly important to prevent unnecessary duplication of tests. Comprehensive evaluation of CT studies, including cardiac dimensions, may form a key assessment on this diagnostic decision tree.

The paper by Schlett et al. is an important contribution to the literature which highlights readily assessable parameters on both transverse CT and projectional images which show excellent correlation with left ventricular volume and mass. Given the prognostic significance of left ventricular size it should be the duty of the radiologist, whether specialist cardiac or general imager, to consider, identify, quantify and communicate cardiac enlargement to their clinicians routinely on both cardiac and non-cardiac CT studies of the thorax.

The concept of trying to relate the size of the heart, let alone the size of the left ventricle, to that of the thoracic cage always seemed fundamentally flawed. First come the exceptions at the extremes of life: the cardiothymic shadow is large in infancy and the thoracic cage shrinks in later life, especially in the elderly kyphotic female patient. Congenital variations (e.g. pectus excavatum) compound these problems. So too does disease of the lung (e.g. emphysema).

Finally comes the all-important question of radiographic technique. We appreciate that the heart is accentuated in the AP and in the lordotic position. Obviously if the patient is supine it becomes larger in relation to the thoracic cage. In modern times obesity also compounds the difficulties of accurate assessment of cardiac size, let alone thoracic size, on the plain radiograph.

This new paper seems to throw yet further doubt on the long practice of 'eyeballing' the size of the heart in relation to the size of the chest. It would be better just to advise the simple measure of cardiac diameter.

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