

## Abdominal Aortic Aneurysm Diameters: A Study on the Discrepancy between Inner to Inner and Outer to Outer Measurements

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### WHAT THIS PAPER ADDS

Aortic aneurysm screening is in a transition period, in which implementation has occurred and now it is being refined. This article adds to the growing body of evidence detailing the differences between the two main methods of aortic sizing; it also adds weight to the idea of including sub-aneurysmal aortas into the screening programme.

**Introduction:** The NHS Abdominal Aortic Aneurysm Screening Programme (NAAASP) uses the maximal anterior to posterior (AP) inner-to-inner (ITI) wall diameter in sizing aortic dimensions when screening with ultrasound. It is recognised that ITI measurements are smaller than outer-to-outer (OTO) measurements, and the primary aim was to calculate the absolute difference in AP ITI and OTO measurements across varying aortic diameters. The secondary aim was to estimate the potential number of patients lost from the screening programme.

**Methods:** Since April 2012, patients outside the screening programme that undergo ultrasound of abdominal aortas have their ITI and OTO measurements recorded. These measurements were compared retrospectively and analysed for variability at threshold sizes of AAAs.

**Results:** From May 2012 to October 2013, 452 abdominal aortic ultrasound scans recorded both ITI and OTO measurements. The majority (81%) were performed on men with the mean age of 78 years. The mean difference between ITI and OTO measurements was 4.21 mm ( $p < .001$ ). There was no difference between the genders. Thresholds were created for analysis between different ITI and OTO aortic diameters; these were <3 cm, 3.1–4 cm, 4.1–5 cm, and >5 cm. There was no significant difference between the means at each threshold size for ITI diameter ( $p = .758$ ). In the first 2 years from April 2012, 15,447 men underwent screening. Of these, 177 (1.14%) had sub-threshold ITI aortic diameters between 2.6 cm and 2.9 cm. This would upscale to 5,316 men nationally.

**Conclusion:** We have demonstrated a consistent and significant 4 mm difference between ITI and OTO diameters in live scanning. Lowering the threshold for entry into a surveillance AAAs to an ITI diameter of 26 mm rather than the current 30 mm is advocated. An alternative cost-effective way is to rescreen this small sub-group at 5 or 7 years.

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### INTRODUCTION

Abdominal aortic aneurysms (AAAs) predominantly occur in 1.5–3% of men aged over 65.<sup>1–3</sup> Ultrasound (US) can reliably visualise the aorta in 99% of individuals, allowing detection of AAAs before rupture.<sup>4</sup> US has also been shown to accurately size AAAs when compared to reconstructed three-dimensional (3D) computed tomography (CT).<sup>5</sup> The UK Small Aneurysm (UKSAT) and Aneurysm Detection and

Management Veterans Affairs Cooperative Study (ADAM) trials concluded the risk of mortality from rupture of small aneurysms (4.0–5.5 cm) was less than for operative intervention or from another unrelated cause,<sup>6,7</sup> thus allowing a window of opportunity for detection, surveillance, and medical optimisation. As the majority of aneurysms are asymptomatic until rupture, it was postulated that screening for AAAs would decrease deaths from ruptured AAA and be cost-effective. This was confirmed by the Multicentre Aneurysm Screening Study (MASS).<sup>8</sup> In the pre-abdominal aortic aneurysm screening era, ruptured AAAs accounted for between 6,000 and 8,000 deaths each year in the UK.<sup>2</sup>

The NHS AAA Screening Program (NAAASP) was announced by the Department of Health in 2008. The phased implementation began in 2009 with coverage

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throughout England being completed in spring 2013.<sup>9</sup> US was the modality of choice for screening as it is reliable, non-invasive, and relatively inexpensive.<sup>10</sup> Traditionally US anterior to posterior (AP) diameter is used to size AAAs; this was proven to be an accurate reproducible measurement with low inter-observer variability.<sup>11,12</sup> With time, two techniques for measurement of the aortic wall have been developed: inner to inner (ITI) and outer to outer (OTO) diameter. Recently, a third measurement has been described: leading edge to leading edge (LTL).<sup>13</sup>

The UKSAT made their recommendations based on AP OTO measurements,<sup>6</sup> which are accepted thresholds for considering surgical intervention. MASS used the ITI to assess mortality benefit and cost-effectiveness.<sup>8</sup> Despite the treatment threshold being formulated using the OTO measurement, NAAASP uses the ITI measurement in their screening assessments. This was based on the MASS trial and a more recent study, which found better repeatability of AP ITI measurement as opposed to a greater variability in the OTO measurements when performed by screening technicians.<sup>14</sup>

Despite the better reproducibility of the ITI method, it naturally gives a smaller diameter than OTO measurement. This has been shown to be as high as 6 mm, which would have an influence on those who are screened.<sup>15</sup> A more recent paper shows a 4-mm difference between the OTO and ITI measurements in a small sample of static images.<sup>16</sup>

NAAASP recommend inclusion into a surveillance programme for AAAs that measure 30 mm or over in AP ITI diameter. AAAs that are 55 mm or greater are referred for surgical intervention.<sup>6,17,18</sup>

It is postulated that using the AP ITI measurement results in patients with small sub-threshold aortic diameters being excluded from the screening programme. Besides the falling rates for incidence of AAAs,<sup>19</sup> this could also account for the lower detection rates seen in NAAASP than MASS. This may also affect those with larger AAAs over 55 mm, potentially downscaling them and delaying surgical intervention.

To coincide with the implementation of the Staffordshire & South Cheshire AAA Screening Programme in April 2012, the vascular sonographers and radiologists at the Vascular Hub Centre were asked to provide AP ITI and OTO measurements on all patients attending the University Teaching Hospital for abdominal aortic scans. The primary aim of this retrospective study was to establish the absolute difference between AP ITI and OTO measurements. Since it is recognised that the ITI measurements are generally smaller than OTO measurements, the secondary aim was to estimate the potential number of patients lost from the screening programme.

## METHODS

In preparation for the local screening programme, the Vascular Laboratory at the University Teaching Hospital Vascular Hub centre were asked to provide the AP ITI and OTO US measurements on patients where AAAs were suspected, or on patients with a known AAA entered into the

local hospital-based surveillance programme. These were live measurements. Data were collected between May 2012 and October 2013. Seven qualified vascular sonographers or radiologists performed all scans via the trans-abdominal technique. Scans were performed using a Philips IU22 scanner with a C5-1 transducer. Formal radiology reports were used to retrospectively gather the AP ITI and OTO diameters. Only one measurement was provided for non-aneurysmal aortas measuring 25 mm or less.

### Measurement technique

A normal aorta is measured in the AP projection in the sagittal plane (LS) OTO during systolic expansion as this gives the most accurate and reproducible measurement. Measuring the aorta in the transverse plane (TS) leads to errors if the vessel is tortuous/ectatic and the vessel walls lie parallel to the ultrasound beam giving poor edge detail.

For AAAs, NAAASP requests that the AP diameter of the aorta is measured in both the LS and the TS planes at peak systole, placing the horizontal component of the calliper on the inner most aspect of the aortic wall anteriorly and posteriorly. However, it is important that the inner wall calliper is not placed on the inner border of any mural thrombus.

Similarly, to perform an OTO measurement the horizontal component of the calliper is placed on the outermost surface of the aortic wall anteriorly and posteriorly.

Aortic measurements were performed live in real time using the calliper software installed with the Philips IU22 scanner and recorded in the official report.

### Sonographer training

The vascular sonographers have received training through a NAAASP-approved training centre in Salford. All participated in validation of the local screening programme, and the senior sonographer is a NAAASP trainer.

### NAAASP data

NAAASP provided 2-year AAA screening data for the Staffordshire & South Cheshire Programme for the period April 11, 2012, to the March 31, 2014.

### Statistical analysis

Data were entered onto a database and the ITI and OTO variables were compared using the paired sample *t* test and the independent samples *t* test. Comparison of intravariability means was performed by analysis of variance (ANOVA). A *p*-value <.05 was considered statistically significant. All statistical analyses were performed with SPSS statistical software version 20 (SPSS, Inc., Chicago IL).

## RESULTS

From May 2012 to October 2013, of the 822 abdominal aortic scans coded, 806 aortic scans were performed. Of these, 452 had both AP ITI and OTO measurements recorded. The majority, 364 (80%), of the scans were performed

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