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TECHNICAL NOTE / *Vascular imaging*

Arm elevation during computed tomography does not significantly alter abdominal aortic aneurysm anatomy

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Typical positioning during computed tomography (CT) for abdominal aortic aneurysms (AAAs) involves arm elevation above the head [1]. This removes the arms from the field of view and improves visualization and image quality. Patients undergoing CT scan for symptomatic AAAs occasionally become hemodynamically unstable during their CT scan. This hemodynamic instability could be due to AAA rupture. Rupture of an AAA occurs when the local wall stress exceeds the local tensile strength of the wall [2]. Something about the way the patient is scanned may be causing this increase in wall stress. One possible explanation is an increase in patient blood pressure due to a decrease in their body temperature [3] during the scan. However, in this study, it is hypothesized that patient arm elevation while in the CT scanner could cause anterior movement of the lumbar spine, and consequently, changes in the AAA position or shape, which would increase the AAA wall stress, and in certain cases, could lead to AAA free rupture.

The goal of this study was to investigate the impact of arm elevation on the anatomy of AAA during CT examination.

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Materials and methods

Two fluoroscopic images of the spine of a healthy 38-year-old male volunteer were obtained, one with his arms elevated (Fig. 1a) and one with his arms by his side (Fig. 1b). The distances between the most anterior point of the lumbar spine and the table on which our volunteer was lying were measured and the difference in the two cases was found to be 41.0 mm. This difference was deemed to be substantial enough to warrant further study on actual AAA patients. To do so, approval was obtained from our hospital's Research Ethics Board to perform a CT scan on a maximum of 10 AAA patients with their arms by their sides in addition to the standard CT scan with their arms elevated. These additional CT scans were to be done with no additional contrast added following the standard contrast-enhanced CT scans performed with the patient's arms elevated as per standard CT scan protocol.

Six men, with a mean age of 77 years $\pm$ 7 (standard deviation [SD]) (range: 64 to 84 years) participated in this study. All six patients had an intraluminal thrombus and five of the six patients had no family history of aneurysms. Patient recruitment was stopped after six patients based on the results described below.

64-section multi-detector CT (Aquilon® 64, Toshiba Medical, Otawara, Japan) and Visipaque® 270 iodinated contrast (Genaral Electric HealthCare, USA) were used for this study with bolus tracking at the L1 vertebral body with the region of interest in the infra-renal abdominal aorta. A total volume of 100 mL of iodinated contrast material was administered intravenously at a rate of 4 mL/s with a saline bolus chase (4 mL/s for 10 s). Image acquisition was obtained in the expiratory phase of respiration in cranial caudal direction when the contrast threshold reached 70 Hounsfield unit in the region of interest. Immediately following this phase, the patient's arms were placed in the neutral position (arms by their side) and a repeat scan was performed with no additional contrast administration. Post processing consisted of 1 mm reconstructions in the transverse plane with a standard algorithm and 2.5 mm coronal and sagittal reconstructions.

Patient CT scans were imported into RadiAnt DICOM Viewer v. 2.29 (Medixant, Poznan, Poland) for analysis. Two perpendicular measurements of AAA diameter were made from axial views in both patient positions. The distance between the most anterior part of the lumbar spine and the CT table was measured from sagittal center-plane views at the same vertical location in the two patient positions. The distance between the most posterior part of the abdominal aorta and the CT table was measured from axial views at the same vertical location in the two patient configurations. All measurements were made by a single observer.

Absolute differences in AAA diameters (in two perpendicular planes), lumbar spine position, and AAA position were calculated for each patient. Wilcoxon rank sum test were performed to determine if there were statistically significant differences between the two patient positions for any of these parameters.

Results

Fig. 2a and b show axial CT images for a representative patient with his arms elevated and by his side, respectively, along with the corresponding measurements of AAA diameter in two perpendicular directions. Fig. 2c and d show sagittal CT images for a representative patient with his arms elevated and by his side, respectively, along with the corresponding measurements of the lumbar spine position. Fig. 2e and f show axial CT images for a representative patient with his arms elevated and by his side, respectively, along with the corresponding measurements of the abdominal aorta position. Table 1 summarizes the measurements of AAA diameters, lumbar spine displacements, and abdominal aorta displacements for the six patients, and includes absolute differences in these parameters between the arm elevated patient position and the arms by the side patient position and *P*-values from the statistical analysis.

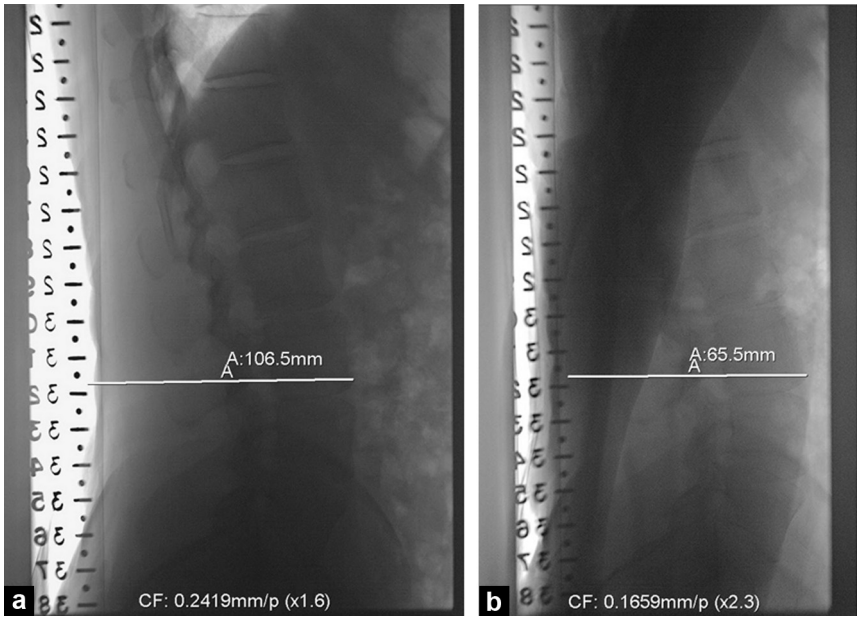

Figure 1. Radiographs of the spine of a healthy 38-year-old volunteer with his arms elevated (a) and with his arms by his side (b).