BACKGROUND AND PURPOSE: Preoperative localization of the artery of Adamkiewicz (AKA) may be useful in selected children in prevention of ischemic spinal complications of spinal or thoracoabdominal aortic surgery. The aim of our study was to investigate the ability of 64-section CT for assessing the AKA in children.

MATERIALS AND METHODS: Forty children (mean age, 7.5 ± 5 years) underwent thoracic imaging with a 64-section CT scanner after intravenous injection of 1.5 mL/kg of contrast agent. Volumetric reconstructions were obtained for every patient. Identification of the AKA was performed on the basis of continuity from the aorta to the anterior spinal artery with a characteristic hairpin turn. Identification of the AKA and determination of its origin and course were analyzed by 2 independent radiologists.

RESULTS: The AKA was successfully visualized in 38 patients (95%). Twenty-seven (71.1%) AKAs originated on the left side, whereas 11 (28.9%) originated on the right side. It was seen to originate at the level of the left 5th intercostal artery in 1 patient, the left 8th in 4, the left 9th in 15, the left 10th in 5, the left 11th in 2, the right 8th in 2, the right 9th in 6, the right 10th in 2, and the right 12th in 1.

CONCLUSION: Sixty-four-section CT angiography depicted the AKA in a very high percentage (95%) of children. The results of this study suggest that 64-section CT angiography is a viable noninvasive technique that could be an alternate to selective angiography for delineating the AKA.

Materials and Methods

The study included 40 consecutive patients (23 male and 17 female; mean age, 7.5 ± 5 years; age median, 7 years; age range, 5–14 years) who underwent cardiac and/or thoracic CT between June and September 2005. Twenty-five of these patients had undergone an arterial switch operation for transposition of the great arteries in the neonatal period, 10 had mild coarctation, and 5 had kinking of the thoracic aorta. All patients were clinically well without any medication.

Our institutional review board did not require its approval for this study. Informed written consent was obtained from all patients’ parents or guardians before patients underwent cardiac or thoracic CT examination.

All CT scans were obtained with a 64-section CT scanner with a 0.35- to 0.4-second rotation time. Scanning parameters were as follows: x-ray tube potential, 80–100 kV; section thickness, 0.625 mm; and effective pitch, 0.984. All CT scans were obtained by using an implemented fully automated real-time anatomy-based dose regulation, modulating the effective tube current from 100 to 200 mA. The overall scanning time was shorter than 4 seconds (median, 3.2 seconds; range, 3–3.9 seconds).

Patients were requested to hold their breath during scanning. When patients could not hold their breath for the entire scanning time, they were instructed to breathe shallowly after holding their breath for as long as possible.

A 22-gauge plastic intravenous catheter was placed in an antecubital vein in the right or left arm. The line was then connected to a power injector. A total of 1.5 mL/kg of body weight of contrast material containing 300 mg of iodine per milliliter (Omnipaque; GE Healthcare) was administered at a flow rate of 2.5–3 mL/s. The scanning delay was set by means of an implemented triggering system. Under these conditions, continuous low-dose fluoroscopy (70 kV, 20 mA) at the level of the ascending aorta was initiated 6 seconds after the start of the injection of the contrast. A circular region of interest in the ascending aorta was measured every second. As previously described, when the attenuation value reached a preset threshold (an absolute attenuation value of 85 HU) in 2 consecutive sampling points, scanning began. CT imaging started 2 cm above the pulmonary artery bifurcation and stopped at the lower edge of the liver (location was determined on a scout digital radiograph). The triggering system was used to perform acquisition during the pure arterial phase. The criteria for identifying the arterial phase during the acquisition were based on the differential enhancement of both ventricles, with a higher enhancement of the left ventricle compared with the right ventricle.
Reconstruction FOV was Set to the Area Around the Aorta and Spine for Evaluation of the AKA

Images were transferred to a workstation (Advantage Windows 4.2, GE Healthcare). We used multiplanar reconstruction (MPR) images, including oblique coronal images and maximum intensity projection (MIP) images. We also used a cine-mode display, in which original transverse sections and MPR images can be analyzed by scrolling the images on the workstation as if the pages were being turned over.

The AKA was identified as an enhanced vessel oriented toward the anterior spinal cord and joining the anterior spinal artery at the tip of a typical hairpin turn (Fig 1A).3-5 The origin and course of the AKA were evaluated by 2 independent radiologists (P.O. and P.S.).

Analyses of cine-mode display and postprocessing of images took less than 8 minutes (median, 7 minutes; range, 5–8 minutes) on the workstation.

Results

CT was performed without complication in all patients and during the pure arterial phase in 38 patients. In the 2 other patients, CT acquisition was premature because images were acquired when enhancement was maximal in the right ventricle. The AKA was successfully visualized in the 38 patients (95%) in whom images were acquired during the arterial phase. In this phase, the AKA constantly presented with its characteristic hairpin turn within the bony spinal canal. In these 38 patients, the course of the AKA from the intervertebral foramen to the anterior spinal artery was traceable on continuous transverse images and/or on multiple oblique coronal MPR and MIP images (Fig 1).

The concordance of interpretation between the 2 radiologists with regard to the identification of the AKA and its level of origin in the 38 patients was 100%.

Discussion

To our knowledge, no previous study has evaluated the ability of CT angiography to assess the AKA in pediatric patients. In this first study, we have shown that the 64-section CT angiography can easily delineate the AKA with a simple scanning protocol and rapid postprocessing analyses.

Identification of the AKA may be important in planning surgical treatment and/or interventional radiologic procedures to prevent the risk of ischemic spinal complications or paraplegia.1 This preoperative information is of importance because different techniques have been shown efficient in preventing spinal ischemia, including drainage of CSF from the spinal cord,7 motor-evoked potential of the spinal cord,7 spinal somatosensory-evoked potential,8 and hypothermic bypass.9 Although preoperative selective spinal angiography is...
the reference standard, complications from this procedure are well known and have a relatively high incidence.2,5,10 Indeed, selective spinal angiography may expose the patient to the risk of retroperitoneal bleeding, temporary cerebral ischemia, and transient paresis of the lower extremities from spinal ischemia in up to 4.6% of patients.7 Furthermore, localizing the origin of the AKA with selective spinal angiography is time-consuming and may be hazardous, with a low success rate between 59%–75%.11,12 These difficulties are related to the unusual anatomic presentations of the artery, in particular its various branching levels, as have been shown in previous anatomic studies13,14 and in our present study.

Alternative diagnostic tools for assessment of the AKA include noninvasive techniques with CT and MR imaging. Multisector CT has been performed with a 4-sector CT scanner in adults. However, the sensitivity of detection of the AKA was quite poor because the success rate for visualizing the artery ranged from only 68% to 90% and localization of the origin was worse.3,5 To become a clinically accepted tool, CT angiography has been performed with a 4-section CT scanner but also with the triggering system that is currently handicapped by a complicated protocol, low spatial resolution, and long scanning time compared with CT angiography.16 Furthermore, this technique is currently handicapped by a complicated protocol, low spatial resolution, and long scanning time compared with CT angiography.17 These may limit routine clinical application of this technique. New techniques improving MR imaging are being developed, such as higher magnetic field strength, new coils, contrast agents, and acquisition methodology. These technical parameters must continue to improve for MR imaging to be considered as a noninvasive, non-x-ray technique that offers an alternative to the new generation of CT scanners for the detection of the AKA.

Study Limitations

We acknowledge the following limitations of the present study: First, there was no standard reference to confirm that we had, indeed, identified the AKA. For ethical and also practical reasons, we did not compare 64-sector CT findings to selective spinal angiography. Indeed, there is now a large body of literature that verifies the characteristic appearance of the AKA, which presents with a typical hairpin turn aspect that is easily identified on CT angiography.3,5 Second, the radiation dose is a real problem in our pediatric patients. However, as done previously in other institutions, we systematically use an implemented fully automated real-time anatomy-based dose regulation, modulating the effective tube current, allowing a reduction of up to 40% of the radiation dose.18 We also apply individual adaptation according to the patient’s morphology. Because of these adaptations, the radiation doses used are 4–7 mSv, in the same range as those in pediatric cardiac catheterization with prolonged use of fluoroscopy.19 Third, we acknowledge that although CT angiography may be useful to identify the AKA preoperatively in adults before thoracic aortic stent-grafting or aneurysmal repair, it is more rarely imperative in children. However, our study may have clinical implications in dedicated pediatric hospitals such as our institution. In our practice, we may need CT angiography of the AKA preoperatively in some very selected situations, such as pial spinal cord arteriovenous malformations, aneurysms of the descending or thoracoabdominal aorta encountered in severe forms of Marfan disease, Takayasu arteritis, or other chronic inflammatory diseases involving the aorta.

Conclusion

Sixty-four-sector CT angiography depicted the AKA in a very high percentage (95%) of children. The results of this study suggest that 64-sector CT angiography is a viable noninvasive technique that could be an alternate to selective angiography for delineating the AKA.
References