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Evaluation of iliac arteries involvement in abdominal aortic aneurysm using spiral computed tomography

Aortic aneurysm is a frequently encountered disorder in cardiovascular practice. Its incidence has increased multifold, likely due to increased life span and improved detection. The strict definition of an aneurysm is a localized, irreversible dilatation of the aorta. In the elderly, the radiographic definition is typically reserved for focal dilatation greater than 3 cm (6). Involvement of the iliac artery is very important for planning proper management. It is important for both open and endovascular procedures (1). The natural history of iliac artery aneurysm is expansion, with a risk of rupture in approximately one-third of the cases. The mean diameter of ruptured iliac artery aneurysms has been reported as 5.6 cm (9).

The aim of the study is evaluation of the use of spiral CT in assessing the iliac artery involvement in abdominal aortic aneurysm.

MATERIAL AND METHODS

Material comprises a group of 34 patients, 32 men and 2 women aged between 44 and 76 years, with abdominal aortic aneurysm. In each patient CT examination of the abdominal aorta and iliac contrast arteries was performed in vascular protocol with Siemens Somatom Emotion CT scanner. The scanning was performed before administering the contrast agents, and then enhanced examination was performed, using automatic syringe. 100–150 ml of contrast agent was injected in two phases: in the first phase which lasted 8 seconds 4 ml per sec, and the second phase – 2.5 ml per sec. The scanning was automatically started, when pick enhancement inside the lumen of the examined aorta was reached. After scanning the multiplanar reconstructions (MPR) were performed, and the arteries were assessed in maximum intensity projection (MIP). 3D images were created using Volume Rendering Technique (VRT), and evaluated before and after editing unnecessary bone structures.

RESULTS

In all patients dilatation of the abdominal aorta was found and in five of them the descending thoracic aorta was also involved. The thrombus inside the aorta was found in all patients. In 14 patients the iliac arteries were involved. In one of them the dilated left iliac artery was completely blocked with thrombus inside, which was seen on MPR images (Fig. 1A). On VRT images there was no blood flow visible within the blocked artery (Fig. 1B,C). In eight patients the involvement of right iliac artery was clearly seen on MPR images (Fig. 2A), but the VRT images presented the morphology of iliac artery more precisely (Fig. 2B). In two patients isolated involvement of the left iliac artery was found. Involvement of both iliac arteries was found in four patients. In one of them the morphology of iliac arteries dilatation was simple, and could be accurately assessed on maximum intensity projection (Fig. 3A), although VRT images provided additional information regarding vessel tortuosity (Fig. 3B). In one patient the small enlargement of the left iliac artery was accompanied by large aneurysm of the right one. The iliac artery was partially visualized on MPR image (Fig. 4A), while VRT image provide precise assessment of complex aorto-iliac morphology (Fig. 4B).

Fig. 1. Abdominal aortic aneurysm involving left iliac artery. The left iliac artery completely block with thrombus inside MPR – A. Lack of left iliac artery on VRT image (arrow) – B. VRT image after bone removing without left iliac artery (arrow) – C

Fig. 2. Abdominal aortic aneurysm involving the right iliac artery (arrow) on MPR image - A. Involvement of right iliac artery on VRT image (arrow) – B

Fig. 3. Abdominal aortic aneurysm involving both iliac arteries (arrows) on MIP projection -A. VRT images provide better visualization of complex aorto-iliac morphology – B

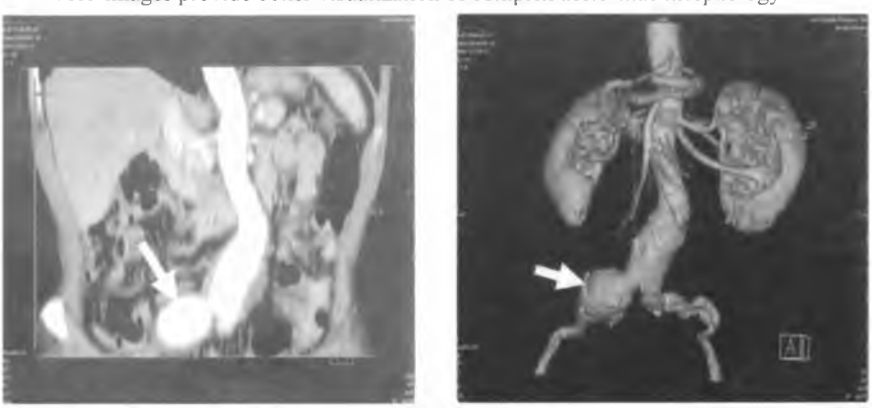

Fig. 4. Abdominal aortic aneurysm involving both iliac arteries on MPR reconstruction reveal only proximal part of large right iliac aneurysm (arrow) – A. VRT image provide precise visualization of large aneurysm of right iliac artery (arrow) and smaller dilatation of the left one – B

DISCUSSION

Conventional angiography has long been the preferred technique for evaluating aortic aneurysms. While it is invasive, it is rarely associated with complications such as puncture site hematomas and arterial dissection. However, it is only able to indirectly detect mural thrombi within an aneurysm (4).

Conventional CT is useful for aneurysm detection and overall measurement of the lesion, but cannot be used in detecting all accessory renal arteries or in grading stenoses of the aorta and of the renal, mesenteric, and celiac arteries. Spiral CT can detect a greater number of renal artery orifices and accessory renal arteries and in many patients can better define the relationships of these vessels to aortic aneurysms (5).

Computed tomography (CT) angiography has become the preferred screening tool for vascular disease since it was first described in 1992. This study tool is faster and more minimally invasive than previous tools, making it the imaging modality of choice when planning endovascular procedures as well as when performing routine follow-ups of these patients(4). The most important step in CT angiography is determining the area of the patient to be imaged. With current commercially available systems, a reasonable area to be covered is the chest and abdomen down to the patient's knees, or the abdomen and pelvis down to the patients' feet. It is important to realize that most endovascular procedures are performed from the common femoral artery approach (4).

The imaging requirements for endovascular procedures are much more complex than those previously required for open vascular procedures. Many details must be evaluated before the physicians can select those procedure(s) and devices that will optimize the outcome. Poor planning usually results in a technical failure, with the need for repeat procedures or (ultimately) conversion to an open surgery. As a result, post-procedure imaging is essential for monitoring the success of the procedure and planning any further interventions. The endovascular specialist must be well versed in the latest imaging technology, in order to achieve technical success and adequately follow up patients who have undergone these minimally invasive procedures (1,4). Successful endovascular aortic aneurysm repair (EVAR) depends largely on accurate patient selection. Beyond the routine preoperative evaluation, a detailed anatomic assessment of the aneurysm is required to determine whether the patient is an appropriate candidate for endografting. This has traditionally been accomplished with axial computed tomography (CT) with selective use of digital subtraction angiography (5,7).

Significant variation in the quantitation of aneurysm size occurs depending on the technique of CT assessment used. In most patients diameter assessment is adequate, particularly if diameters are measured on centerline CT images. Volumetric analysis appears to be very helpful in certain patients who do not show aneurysm regression, or in whom the diameter increases or where endoleaks persist. Three-dimensional reconstruction and volumetric analysis are also useful to assess the mechanism by which the endovascular device accommodates to morphology changes and to determine criteria for reintervention (8).

CT scan accurately defines the size of aneurysm. CTA (axial images) have the advantage of demonstrating the aortic wall thickening, calcification and luminal thrombus, thus, displaying the true axial extent of the aneurysm, as the aortography or 3D MIP and SSD images display only the enhancing lumen of the vessel. The wall calcification can also be well seen on MIP images, but is impossible to identify or difficult to interpret on SSD images. These wall parameters are also important features in establishing the etiology of aneurysm and in decision making for further management (6). It should however be noted that measurement based purely on the basis of axial images can be potentially misleading. Tortuosity of the aorta can lead to false estimation of aneurysm size or extent (3,6). Tortuosity can be easily assessed on 3D SSD images. MIP images, on the other hand, can be confusing in this regard. They do not give a sense of depth or perspective to the image. The site of origin of aortic branches and their relation to the aneurysm and presence of branch stenosis is crucial from the management point of view. CTA is able to display clearly the branch vessels in relation to the aneurysm. The axial and SSD images are particularly useful while

MIP can be confusing in this regard. The involvement of renal arteries and the effect on the kidneys can also be evaluated at the same time (6). DSA has the disadvantage of limited view angle, single lumen opacification and can be quite confusing to interpret, especially in the situation of complex dissections (6).

CTA is an excellent imaging modality for comprehensive evaluation of aortic aneurysm and dissection, combining the advantage of conventional contrast enhanced CT axial images and those of angiography in the form of 3D reformatted images. The marked reduction in examination time, increased contrast resolution, its minimally invasive technique, fewer potential complications and reduction in cost makes CTA the single best investigation for evaluation of aortic aneurysm and dissection (6).

Because of its decreased scan time, CTA is the imaging study of choice in suspected leaking aneurysm and rapid evaluation is imperative in such circumstances. The evaluation of the location of the aneurysm and its extent is important for its management and CTA exactly delineates the site and extent of the lesion. The longitudinal extent can be particularly well seen on 3D images. The extension of aneurysm into common, external or internal iliac arteries is also accurately demonstrated. This helps determine the type and length of prosthetic graft. CTA clearly displays the different shapes of aneurysm, whether saccular or fusiform (2,6).

CONCLUSIONS

Iliac artery involvement is important in planning proper management of aortic aneurysm. Iliac artery widening may be assessed on axial CT section. MPR reconstruction may reveal the extent of iliac artery involvement. In plain involvement the MIP images in spiral CT may be of great value, but in complex aorto-iliac morphology, 3D images gained in volume rendered technique (VRT) provide the most global visualization of iliac arteries involvement, and are the most informative CT reformations. Computed tomographic (CT) angiography has become an important technique in the evaluation of the vascular system. Volumetric data permit three-dimensional visualization from any angle of view and permit quantification that is unattainable with projection techniques such as conventional arteriography. CT angiographic examination is less invasive, less expensive, and capable of depicting important nonvascular abnormalities that otherwise would be missed with conventional angiography.

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SUMMARY

The aim of the study was evaluation of the use of spiral CT in assessing the iliac artery involvement in abdominal aortic aneurysm. The material comprised a group of 34 patients, 32 men and 2 women aged between 44 and 76 years, with abdominal aortic aneurysm. In each patient CT examination of abdominal aorta and iliac arteries was performed in vascular protocol with Siemens Somatom Emotion CT scanner. The scanning was performed before administering the contras agents, and then enhanced examination was performed, using automatic syringe. 100–150 ml of contrast agent was injected in two phases: in the first phase which lasted 8 seconds 4 ml per sec, and the second phase – 2.5 ml per sec. The scanning was automatically started, when pick enhancement inside the lumen of examined aorta was reached. After scanning the multiplanar reconstructions (MPR) were performed, and the arteries were assessed in maximum intensity projection (MIP). 3D images were created using Volume Rendering Technique (VRT), and evaluated before and after editing unnecessary bone structures. In all patients dilatation of the abdominal aorta was found and in five of them the descending thoracic aorta was also involved. The thrombus inside the aorta was found in all patients. In 14 patients the iliac arteries were involved. In one of them the dilated left iliac artery was completely blocked with thrombus inside, which was seen on MPR images. On VRT images there was no blood flow visible within the blocked artery. In eight patients the involvement of right iliac artery was clearly seen on MPR images, but the VRT images presented the morphology of iliac artery more precisely. In two patients isolated involvement of the left iliac artery was found. Involvement of both iliac arteries was found in four patients. In one of them the morphology of iliac arteries dilatation was simple, and could be accurately assessed on maximum intensity projection, although VRT images provided additional information regarding vessel tortuosity. In one patient the small enlargement of the left iliac artery was accompanied by large aneurysm of the right one. The iliac artery was partially visualized on MPR image, while VRT image provided precise assessment of complex aorto-iliac morphology. Iliac artery involvement is important in planning proper management of aortic aneurysm. Iliac artery widening may be assessed on axial CT section. MPR reconstruction may reveal the extent of iliac artery involvement. In plain involvement the MIP images in spiral CT may be of great value, but in complex aorto-iliac morphology, 3D images gained in Volume Rendered Technique (VRT) provide the most global visualization of iliac arteries involvement, and are the most informative CT reformations.

Ocena zajęcia tętnic biodrowych w tętniaku aorty brzusznej z wykorzystaniem spiralnej tomografii komputerowej

Celem pracy jest zastosowanie spiralnej tomografii komputerowej w ocenie zajęcia tętnic biodrowych u pacjentów z tętniakiem aorty brzusznej. Materiał stanowi grupa 34 pacjentów, 32 mężczyzn i 3 kobiety w wieku 44–76 lat, z tętniakiem aorty brzusznej. U każdego pacjenta wykonano badanie TK aorty brzusznej i tętnic biodrowych spiralnym tomografem komputerowym Somatom Emotion firmy Siemens. Badanie wykonywano przed i po podaniu środka kontrastowego strzykawką automatyczną w ilości ok. 100–150 ml, z prędkością 4 ml / sek. w fazie pierwszej i 2,5 ml / sek. w fazie drugiej. Po akwizycji wykonano wtórnie rekonstrukcje MPR, MIP i VRT. U wszystkich pacjentów stwierdzono tętniaka aorty brzusznej, a u pięciu z nich zajęcie

również zstępującej aorty piersiowej. Zakrzep stwierdzono w świetle aorty u każdego pacjenta. U 14 pacjentów stwierdzono zajęcie tętnic biodrowych. U dwu pacjentów stwierdzono izolowane zajęcie lewej tętnicy biodrowej. U jednego z nich poszerzona lewa tętnica nerkowa była niedrożna, co uwidoczniono na rekonstrukcjach MPR. Obrazy VRT uwidoczniły brak przepływu krwi w jej obrębie. U ośmiu pacjentów stwierdzono zajęcie jedynie prawej tętnicy biodrowej, wyraźnie widoczne na przekrojach MPR, ale rekonstrukcje VRT ukazały morfologie tętnicy biodrowej znacznie dokładniej. Zajęcie obu tętnic biodrowych stwierdzono u czterech pacjentów. U jednego z nich prosta morfologia tętniaka umożliwiła dokładne przedstawienie tętnic biodrowych na obrazach MIP, ale nie informując o krętym przebiegu naczyń. U jednego pacjenta niewielkiemu poszerzeniu lewej tętnicy biodrowej towarzyszyło znaczne poszerzenie prawej tętnicy biodrowej, częściowo uwidocznione na obrazie MPR. Rekonstrukcja VRT umożliwiła precyzyjną ocenę złożonej morfologii aortalno-biodrowej. Zajęcie tętnic biodrowych jest ważne w planowaniu właściwego podejścia terapeutycznego u pacjentów z tętniakiem aorty brzusznej. Poszerzenie tętnic biodrowych może być oceniane na przekrojach osiowych CT. Rekonstrukcje MPR mogą być przydatne w ocenie rozległości zajęcia tętnicy biodrowej. Rekonstrukcje MIP są przydatne w tętniakach o prostej morfologii. W przypadkach złożonych jedynie rekonstrukcje VRT umożliwiają precyzyjną ocenę złożonej morfologii patologii aortalno-biodrowej.