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Kinking and tortuosity of iliac arteries in 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. Most common cause of aortic aneurysm formation is atherosclerosis. 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 (6). The evaluation of morphology of iliac arteries and their tortuosity may be critical for planning endovascular procedure.

The aim of the study is to present the assessment of the iliac artery tortuosity and kinking with spiral computed tomography.

MATERIAL AND METHODS

The material comprises a group of 34 patients, 32 men and two women aged between 44 and 76 years, with abdominal aortic aneurysm. In each patient CT examination of the abdominal aorta and iliac 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 an automatic syringe. 100–150 ml of contrast agent was injected in two phases: in the first phase which last of 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. In case of iliac arteries tortuosity the angles measurements were performed.

RESULTS

In all patients dilatation of the abdominal aorta was found and in 5 of them the descending thoracic aorta was also involved. The thrombus inside the aorta was found in all the patients. In 14 patients the iliac arteries were involved. In 4 four patients kinking of the iliac arteries on VRT images was seen. In one patient with involvement of the right common iliac artery double angulations were seen, the angle between the common and external iliac artery was 58.26° (Fig. 1A), and tortuous external iliac artery form the second kinking of 87° below (Fig. 1B). In one patient the angle between the dilated common iliac artery and external iliac artery was 71.32° (Fig. 2). In one patient with large widening of the right iliac artery heavy angulations of 32.86° were seen (Fig. 3). In one patient with involvement of both iliac arteries the left common iliac artery was tortuous, forming kinking of 41, 83° (Fig. 4).

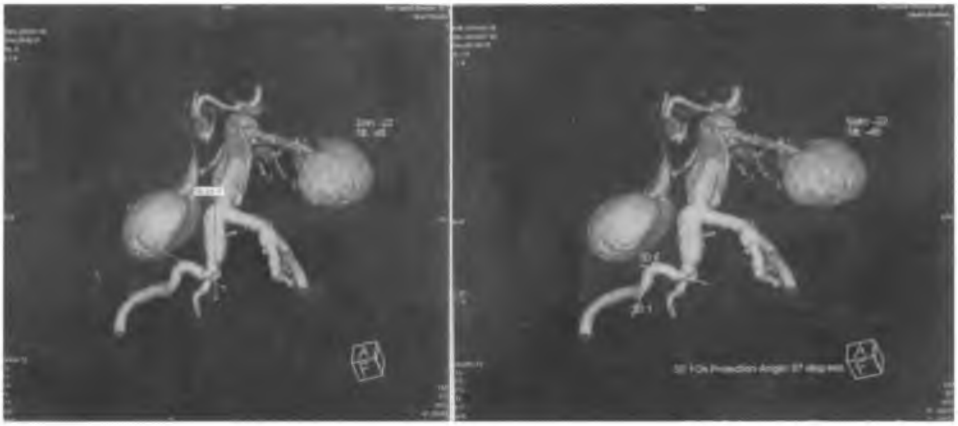

Fig. 1. Abdominal aortic aneurysm with involvement of right iliac artery, VRT images; A – double angulations on external iliac artery of 58.26°; B – and below 87°

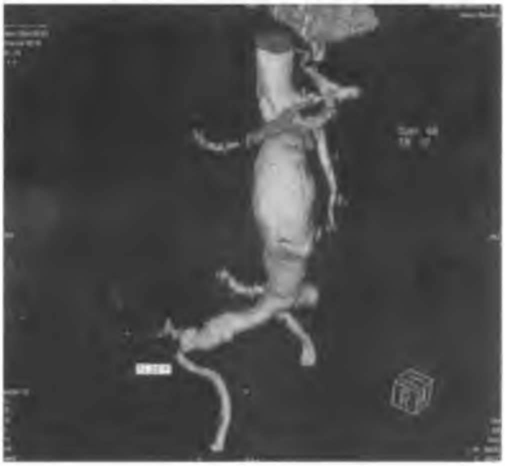

Fig. 2. VRT image of abdominal aortic aneurysm with involvement of right iliac artery, with angle between common and external iliac artery of 71.32°

Fig. 3. VRT image of abdominal aortic aneurysm with involvement of right iliac artery.

Fig. 4. Abdominal aortic aneurysm with involvement of both iliac arteries. Tortuous left external iliac artery forms angulations of 41.83°

DISCUSSION

Until recently, open surgical repair was the only treatment option available for patients with abdominal aortic aneurysms. But, with the introduction and now widespread use of endovascular stent-grafts, patients once considered poor surgical candidates are undergoing successful endovascular repair. The key to a successful outcome when using endovascular techniques is the ability to measure the maximum aneurysm diameter, the length of the abdominal aorta, and the degree of tortuosity of the aorta. These factors must be taken into consideration in the planning of these stent-graft procedures, since each stent-graft must conform to the patient's anatomy if complications are to be avoided (1,4).

These measurements can greatly overestimate the true diameter because of obliquity. Similarly, craniocaudal measurements can substantially underestimate the true aortic length by not accounting for tortuosity. One method of obtaining an accurate crosssectional measurement is the creation of oblique multiplanar reformats perpendicular to the longitudinal axis of the aorta. This mean centerline can accurately determine the length of the aortic lumen that the endovascular device must cover, which is typically from the lowest renal artery to the origin of the internal iliac arteries bilaterally (4,8).

Diameters of critical importance are those at the proximal attachment site at the lowest renal artery, the maximal diameter of the aorta, the diameter at the aortic bifurcation, and the diameter of the iliac arteries at the origin of the hypogastric artery. Another parameter that can be determined using CT is the degree of tortuosity of the aneurysm. This variable can be critical in predicting the complexity of the procedure preoperatively and in choosing the site of primary access of the device (2,4).

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 (4).

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. Tortuosity can be easily assessed on 3D SSD images. MIP images, on the other hand, can be confusing in this regard, which 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 the 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. Additionally, the presence of anatomical variants such as accessory renal arteries can also be evaluated. CTA also has the advantage of demonstrating the adjacent structures and can provide information about coexistent nonvascular abdominal disease that may be of relevance to the surgeon. Pleural effusion, ascitis, associated lung collapse and displacement of adjacent blood vessels, bowel loops, etc. can be confidently detected. SSD has the advantage to demonstrate the irregularity of aortic wall and extent of the lesion. Tortuosity is also better seen in SSD. SSD images are more easily understood by the vascular surgeon. Caution is, however, required in selecting the range of threshold attenuation values. Calcification and differentiation of the true and false lumina cannot be identified. Both CT and MRI accurately demonstrate intimal dissections, with CT having the advantage of shorter scan times (especially with multislice scanners) and easy availability. Unlike MRI, CTA is, however, unable to demonstrate aortic regurgitation precisely. Spiral CT provides excellent evaluation of intimal flaps within the aortic branches, restriction of flow into the branches from compression by the false lumen, and intimal flap fenestration (3,6).

Compared to this, DSA has the disadvantage of a limited view angle, single lumen opacification and can be quite confusing to interpret especially in the situation of complex dissections. 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 (6,7).

Generally, surgeons can plan their operative strategies in accordance with the findings of conventional CT. Because the proximal extent of the AAA usually determines the site of the proximal aortic clamp, it is important to predict the clamping level before the operation. Suprarenal clamping has a greater potential for damage to the kidneys or other visceral organs, and for temporary coagulation defects. Spiral CT, spiral CT angiography, and digital subtraction angiography have been introduced more recently and are more sensitive techniques in the evaluation of AAAs. 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. There is also clear evidence that spiral CT's use of contiguous images at thicknesses of less than 5 mm is extremely effective in detecting renal artery origins (5).

Significant variation in the quantization 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 (9).

CONCLUSIONS

Assessment of iliac arteries tortuosity is essential in planning of intravascular abdominal aortic repair. 3D CT images using VRT are very valuable in evaluation of the iliac arteries morphology. The possibility of rotation in any desired angle enables precisely assessment of the arteries and measurements of angles. The presence of tortuosity is also precisely visualized on VRT images, due to rotation of spatial images. VRT reconstruction should be an integrated part of CT examination of abdominal aortic aneurysm and iliac arteries.

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SUMMARY

The aim of the study is to present the assessment of the iliac artery tortuosity and kinking with spiral computed tomography. The material comprises a group of 34 patients, 32 men and two 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 case of iliac arteries tortuosity the angles measurements were performed. In all the 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 the patients. In 14 patients the iliac arteries were involved. In four patients kinking of the iliac arteries on VRT images was seen. In one patient with involvement of the right common iliac artery double angulations was seen, the angle between the common and external iliac artery was 58.26°, and tortuous external iliac artery formed second kinking of 87° below. In one patient the angle between the dilated common iliac artery and external iliac artery was 71.32°. In one patient with large widening of the right iliac artery heavy angulations of 32.86° were seen. In one patient with involvement of both iliac arteries the left common iliac artery was tortuous, forming kinking of 41.83°. Conclusions: Assessment of iliac arteries tortuosity is essential in planning intravascular abdominal aortic repair. 3D CT images using VRT are very valuable in evaluation of the iliac arteries morphology. The possibilities of rotation in any desired angle enable precise assessment of the arteries and measurements of angles. The presence of tortuosity is also precisely visualized on VRT images, due to rotation of spatial images. VRT reconstruction should be an integrated part of CT examination of abdominal aortic aneurysm and iliac arteries.

Ocena krętości przebiegu i obecności zagięć kątowych tętnic biodrowych w spiralnej tomografii komputerowej

Celem pracy jest analiza wartości diagnostycznej spiralnej tomografii komputerowej w ocenie przebiegu tętnic biodrowych. 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 czterech pacjentów stwierdzono kręty przebieg lub zagięcia kątowe tętnic biodrowych. U jednego z nich stwierdzono podwójne zagięcie kątowe, tworzące kąt 58,26° między tętnicą biodrową wspólną i biodrową zewnętrzną; kręta tętnica biodrowa zewnętrzna tworzyła drugie zagięcie o kącie 87°. U jednego pacjenta kąt między tętnicą biodrową wspólną a tętnicą biodrową zewnętrzną wynosił 71,32°. U jednego pacjenta ze znacznie poszerzoną tętnicą biodrową kąt między tętnicą biodrową wspólną a tętnicą biodrową zewnętrzną wynosił jedynie 32,86°. U jednego pacjenta z zajęciem obu tętnic biodrowych kręta lewa tętnica biodrowa zewnętrzna tworzyła kąt 41,83°. Wnioski: Ocena przebiegu tętnic biodrowych ma kluczowe znaczenie w planowaniu procedur śródnaczyniowych. Obrazy trójwymiarowe tomografii komputerowej są bardzo wartościowe w ocenie morfologii tętnic biodrowych. Możliwość rotacji obrazu o dowolny kąt umożliwia precyzyjną ocenę oraz pomiary zagięć kątowych w przebiegu tętnic. Kręty przebieg jest również wyraźnie uwidoczniany na obrazach VRT. Wykonanie rekonstrukcji VRT powinno być integralną częścią badania TK tętniaków aorty brzusznej i oceny tętnic biodrowych.