ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN-POLONIA
VOL. LX, N 1, 83 SECTIO D 2005

2nd Department of Radiology, Medical University of Lublin

MAREK PASŁAWSKI, EWA KURYS, JANUSZ ZŁOMANIEC

Abdominal aortic endograft in computed tomography – VRT and MIP images

An aneurysm is defined as a localized, irreversible dilatation of the aorta. In the elderly, the radiographic definition is typically reserved for focal dilatation greater than 3 cm (6). The mean diameter of ruptured iliac artery aneurysms has been reported as 5.6 cm (8).

Endovascular aneurysm repair of aortic aneurysms has swiftly moved beyond the confines of research protocols to become a popular treatment of abdominal aortic aneurysm (AAA) in patients with the appropriate arterial anatomy (1).

Exclusion of aneurysms with endovascular prostheses is developing rapidly and relies on expedient, precise imaging protocols to appropriately select patients for procedures and to assess performance after deployment. Development of an algorhythm to cost-effectively monitor aneurysms after exclusion is a priority for current development and consists in determining the natural history of the abdominal aortic aneurysm (AAA) at various intervals after treatment (2).

CT is the most frequently used imaging modality to control the result of endovascular procedure and to detect possible complications. Some of the phenomena are associated with the prosthesis such as migration, angulation, and increased incidence of rupture after implantation (7).

The aim of the study is to present the imaging possibility of helical computed tomography in evaluation of abdominal aortic endograft using VRT and MIP images and determining the optimal window settings for visualizing endografts on MIP images.

MATERIAL AND METHODS

Material comprises a group of nine patients, after endovascular treatment of abdominal aortic aneurysm with bifurcated endoprosthesis. 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 contrast agent, 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 sec 4 ml per sec, and in 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 arteries were assessed in maximum intensity projection (MIP) using different window settings. 3D images were created using Volume Rendering Technique (VRT) and evaluated before and after editing unnecessary bone structures.

RESULTS

The axial sections before administering the contrast agent reveal the presence of endografts inside the dilated aorta. In five patients star-like structures were seen (Fig. 1A), formed by the metal web. In four patients the endografts had smooth margins on unenhanced axial images (Fig. 1B). The location of the endograft bifurcation was clearly seen on axial images (Fig. 2AB).

The window level 500 HU and the window width 700 HU were optimal for assessing grafts on MIP images (Fig. 3AB). For assessment of the tubular metal web the higher window level is necessary, about 1200 HU with the window width 1500 HU (Fig. 4). Endografts were also visualized on VRT images, after adding additional blue color, covering density level of 300–2500 HU. The VRT images were evaluated both before (Fig. 5) and after removing unnecessary structures (Fig. 5B). VRT images of aorta and kidneys enable precise assessment of the endograft and renal arteries (Fig. 6). No evident complication of the endovascular procedure was found in the examined group of patients.

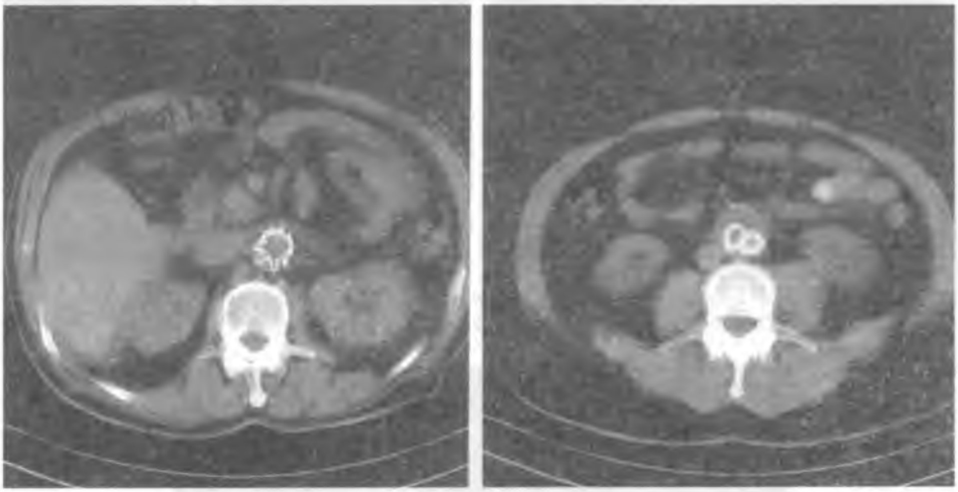

Fig. 1. Abdominal aortic aneurysm; A–axial section with annular thrombus and star-like endograft inside, B – smooth endograft inside the abdominal aortic aneurysm

Fig. 2. Bifurcation of the endograft inside the abdominal aortic aneurysms (arrows); A – star-like graft margins, B – smooth graft margins

Fig. 3. MIP images of the graft. Window level 500 HU, window width 700 HU; A – the tubular metal web clearly seen, B – graft with smooth margins

Fig. 4. MIP images of the graft. Window level 1200 HU, window width 1500 HU. Tubular metal web visualized in details

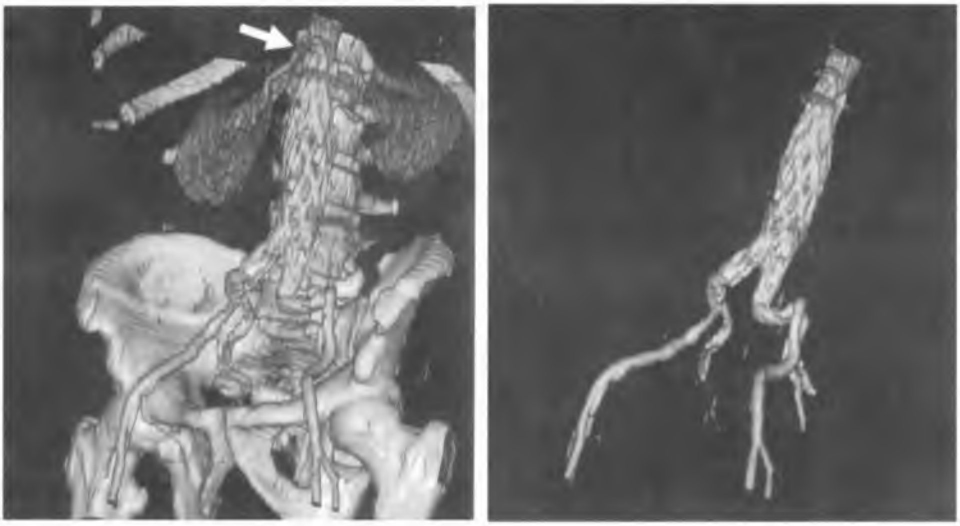

Fig. 5. VRT images of the abdominal aortic endograft – A (arrow indicates renal artery), B – the endograft after removing unnecessary structures

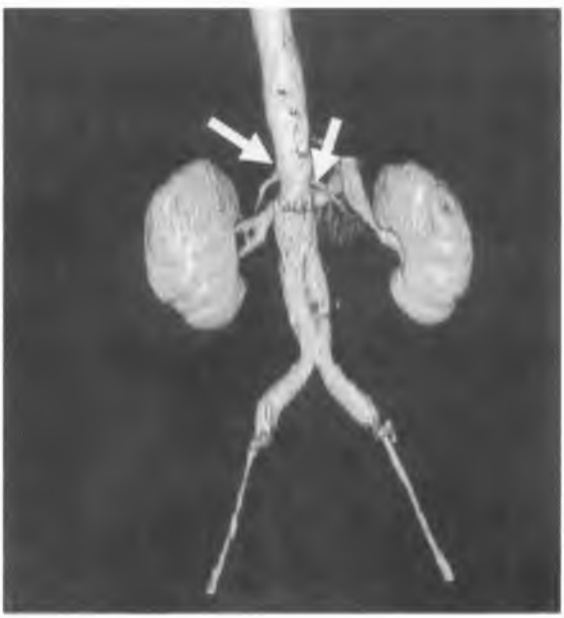

Fig. 6. VRT image of the abdominal aortic endograft with kidneys enabling precise assessment of the graft origin and renal arteries (arrows)

DISCUSSION

Many patients are nowadays followed up even several years following endovascular aortic aneurysms repair. Most patients appropriately chosen for treatment with endografts demonstrate a slow progressive decrease in aneurysm size and require therefore only periodic imaging to a slow progressive decrease in aneurysm size and require therefore only periodic imaging to ensure proper positioning of the device and maintenance of decompression of the aneurysm sac (7).

The CT examination is perfect for assessing patients after endovascular procedures. Axial sections enable precise measurements, MIP and VRT reconstructions enable choosing the level suitable for precise measurements. 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 minimally less 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).

In as many as 5% to 15% of patients, endoleaks at follow-up intervals of 1 to 3 years present a challenging diagnostic problem and in a small percentage require a secondary intervention to retard progressive aneurysm enlargement and prevent rupture. The presence of endoleaks is easily seen on enhanced CT images (7).

Aneurysm enlargement has also been observed in patients without endoleak, suggesting the pressurization of the sac can be sustained by transmission through thrombus even where there is no evidence of flow on imaging studies. In most patients in whom the aneurysm slowly decreases in size after successful exclusion, surveillance is required to ensure that realignment of the device related to aneurysm morphology changes does not adversely affect function. Three-dimensional spiral (helical) computed tomography (CT) scans have been found to be particularly useful in addressing the phenomenon and were used in this study to assess the effect of morphologic changes on aneurysm exclusion and device function (7).

The study reports the analysis of patients treated with the bifurcated endoprosthesis who underwent post implantation helical contrast CT examination.

As regards conventional aortobifemoral bypass in patients with aneurysms, there are known complications that limit the long-term success such as device thrombosis, infection, ongoing atherosclerotic change, aneurysmal dilatation of adjacent arterial segments, and a significant attrition in patient populations caused by comorbid conditions. Syndromes that were thought to be associated only with endoluminal grafts such as endoleaks have also recently been reported to occur after conventional open AAA repair. For these reasons it has become increasingly apparent that a carefully designed analysis of our current understanding of aneurysmal and atherosclerotic disease and the implications of endoluminal graft deployment on altering the course of these pathologic conditions is providing relevant new information that is significantly enhancing our understanding of the utility and limitations of these technologies (7).

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).

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 invasive procedures (4,5).

The three-dimensional CT reconstructions not only displayed important information regarding the initial efficacy of the device as it was deployed but also showed how device modifications could improve the function of the prosthesis. 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 (7).

CONCLUSIONS

CT assessment of the abdominal aortic aneurysm after endovascular procedure is valuable. CT enables precise assessment of the graft extent and location, its relations to the renal and iliac arteries. The presence of possible complication is also easily detected using CT examination, especially with MIP and VRT reformations. They enable direct visualization of the tubular metal web of the endograft and global morphologic assessment of both, aneurysm and the endograft. The window level of 500 HU and the window width of 700 are optimal for endograft assessment on MIP images.

REFERENCES

1. Aarts N. J. M. et al.: Abdominal aortic aneurysm measurements for endovascular repair: intra - and interobserver variability of CT measurements. Eur. J. Vasc. Endovasc. Surg., 18, 475, 1999.
2. Cayne N. S. et al.: Variability of maximal aortic aneurysm diameter measurements on CT scan: Significance and methods to minimize. J. Vasc. Surg., 39, 811, 2004.
3. Fillinger M. F. et al.: Anatomic characteristics of ruptured abdominal aortic aneurysm on conventional CT scans: Implications for rupture risk. J. Vasc. Surg., 39, 1243, 2004.
4. Lookstein R. A.: Impact of CT angiography on endovascular therapy. The Mount Sinai J. Med., 70, 367, 2003.
5. Parra J. R. et al.: Conformational changes associated with proximal seal zone failure in abdominal aortic endografts. J. Vasc. Surg., 37, 106, 2003.
6. Sharmaa U. et al.: Helical CT evaluation of aortic aneurysms and dissection. A pictorial essay. J. Clin. Imaging, 27, 273, 2003.
7. White R. A.: Computed tomography assessment of abdominal aortic aneurysm morphology after endograft exclusion. J. Vasc. Surg., 33, S1, 2001.
8. Yasui K. et al.: Recanalization 24 months after endovascular repair of a large internal iliac artery aneurysm with use of stent-graft. Acta Med. Okayama, 55, 315, 2001.

SUMMARY

The aim of the study is to present the imaging possibility of helical computed tomography in evaluation of abdominal aortic endograft using VRT and MIP images and determining the optimal window settings for visualizing endografts on MIP images. Material comprises a group of nine patients, after endovascular treatment of abdominal aortic aneurysm with bifurcated endoprosthesis. 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 contrast agent, 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 sec 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 arteries were assessed in maximum intensity projection (MIP) using different window settings. 3D images were created using Volume Rendering Technique (VRT) and evaluated before and after editing unnecessary bone structures. The axial sections before administering the contrast agent reveal the presence of endografts inside the dilated aorta. In five patients star-like structures were seen, formed by the metal web. In four patients the endografts had smooth margins on unenhanced axial images. The location of the endograft bifurcation was clearly seen on axial images. The window level 500 HU and the window width 700 HU were optimal for assessing grafts on MIP images. For assessment of the tubular metal web the higher window level is necessary, about 1200 HU with the window width 1500 HU. Endografts were also visualized on VRT images, after adding additional blue color, covering density level of 300–2500 HU. The VRT images were evaluated both before and after removing unnecessary structures. VRT images of aorta and kidneys enable precise assessment of the endograft and renal arteries. No evident complication of the endovascular procedure was found in the examined group of patients. CT assessment of the abdominal aortic aneurysm after endovascular procedure is valuable. CT enables precise assessment of the graft extent and location, its relations to the renal and iliac arteries. The presence of possible complication is also easily detected using CT examination, especially with MIP and VRT reformations. They enable direct visualization of the tubular metal web of the endograft and global mor-

phologic assessment of both, aneurysm and the endograft. The window level of 500 HU and the window width of 700 are optimal for endograft assessment on MIP images.

Endoproteza tętniaka aorty brzusznej w tomografii komputerowej – rekonstrukcje VRT i MIP

Celem pracy jest przedstawienie możliwości uwidocznienia endoprotezy aorty brzusznej na obrazach VRT i MIP oraz określenie optymalnych ustawień okna do oceny endoprotezy na obrazach MIP. Materiał stanowi grupa dziewięciu pacjentów po śródnaczyniowym leczeniu tętniaka aorty brzusznej protezą rozdwojoną. U każdego pacjenta wykonano badanie TK aorty i tętnic biodrowych, stosując protokół naczyniowy skanerem Somatom Emotion firmy Siemens. Badanie wykonywano przed podaniem środka kontrastowego oraz po podaniu strzykawką automatyczną 140 ml Ultravistu z szybkością 2,5-3,5 ml/sek,, oceniano przekroje osiowe oraz rekonstrukcje VRT i MIP przy różnych ustawieniach okna. Obecność protezy w świetle aorty byłą dobrze widoczna na skanach osiowych przed podaniem kontrastu. U pięciu pacjentów była widoczna gwiaździsta struktura, u czterech zarysy protezy były gładkie. Lokalizacja i kształt protezy był dokładnie widoczne na obrazach VRT oraz w projekcjach MIP przy ustawieniach poziomu okna na 500 JH oraz szerokości okna na 700 JH. Metalowa siatka endoprotezy była najlepiej widoczna przy ustawieniach środka okna na 1200 JH oraz szerokości okna na 1500 JH. Nie stwierdzono obecności żadnych powikłań leczenia śródnaczyniowego u badanych pacjentów. Badanie TK endoprotezy aorty brzusznej jest wartościowe w ocenie morfologii i lokalizacji protezy, jak również w poszukiwaniu potencjalnych powikłań. Ocena objętościowa na obrazach VRT oraz MIP umożliwia dokładną ocenę protezy i jej stosunku do tętnic nerkowych i biodrowych. Uwidocznienie metalowej siatki protezy na obrazach MIP jest najlepsze przy ustawieniach środka okna na poziomie 1200 JH oraz szerokości okna na 1500 JH. Ocena protezy i jej lokalizacji na obrazach MIP jest natomiast najlepsza przy ustawieniach środka okna na poziomie 500 JH oraz szerokości na 700 JH.