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Diagnostic value of multiplanar CT reconstructions in the assessment of abdominal aortic aneurysms

The definitions of the abdominal aortic aneurysm based on the aortic diameter vary. It is defined as (i) a diameter of the aorta exceeding 3.0 cm; (ii) permanent localized dilation of an artery having at least a 50% increase in diameter compared with the expected normal diameter of the artery or of the diameter of the segment proximal to the dilation; or (iii) the diameter of the infrarenal aorta at least one and a half time larger than the diameter of the suprarenal segment of the abdominal aorta (9, 10, 16).

The increased use of ultrasonography and computed tomography result in the increased number of detected aneurysms, especially with relative small diameters so the prevalence of the abdominal aortic aneurysms (AAA) is increasing (1).

The aim of the study was the assessment of the usefulness of multiplanar (MPR) CT reconstructions in the evaluation of abdominal aortic aneurysms.

MATERIAL AND METHODS

Material comprises a group of 30 patients with abdominal aortic aneurysm. There were 22 men and eight women, aged between 54 and 78 years (mean age was 62 years). In all patients the CT examination of the abdominal aorta was performed. The scanning was performed from the level of the diaphragm to the level of the pubic bone. In cases of evident dilation of the suprarenal aorta, additional sections of the thoracic aorta were performed, to assess a possible coexistent thoracic aortic aneurysm. The thickness of the CT sections was 1 cm. The examination was performed before and after intravenous administering of 100 ml of contrast medium (Ultravist). Secondarily out of the digital data from axial sections multiplanar (MPR) reconstructions were performed in different planes.

RESULTS

The diameters of the aneurysms were from 4.6 to 7.6 cm (mean diameter was 5.8 ± 0.4 cm). MPR reconstructions in both sagittal and coronal plane along the axis of the aorta were assessed, to choose the section on which the maximum diameter of the aneurysms was performed. In five cases tortuous dilated aorta was not parallel to the axial sections, which was visible on MPR reconstructions (Fig. 1). Three patients have abdominal aortic aneurysm involving thoracic aorta as well. The mean length of the aneurysms was 12.1 ± 1.4 cm (range from 7 to 19 cm). The measurements of the maximal diameter were performed on axial sections, while measurements of length of both aneurysm and thrombus were performed on the MPR images (Fig. 2AB). The thrombus was present in all aneurysms, in 21 of them it was annular with excentric patent aortic lumen. The mean thickness of the thrombus was 2.7 ± 0.3 cm

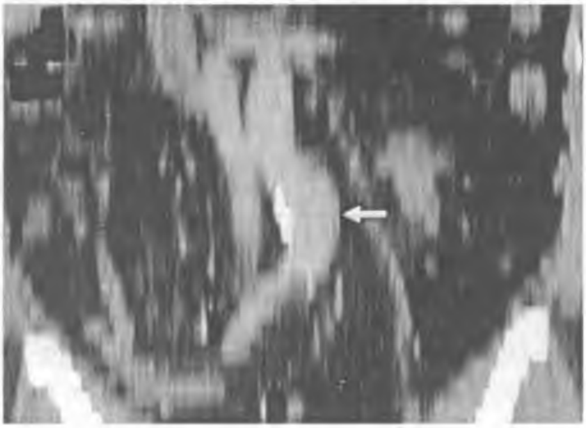

Fig. 1. Abdominal aortic aneurysm in MPR reconstruction. The tortuosity of the aneurysm is evident on MPR image (arrow)

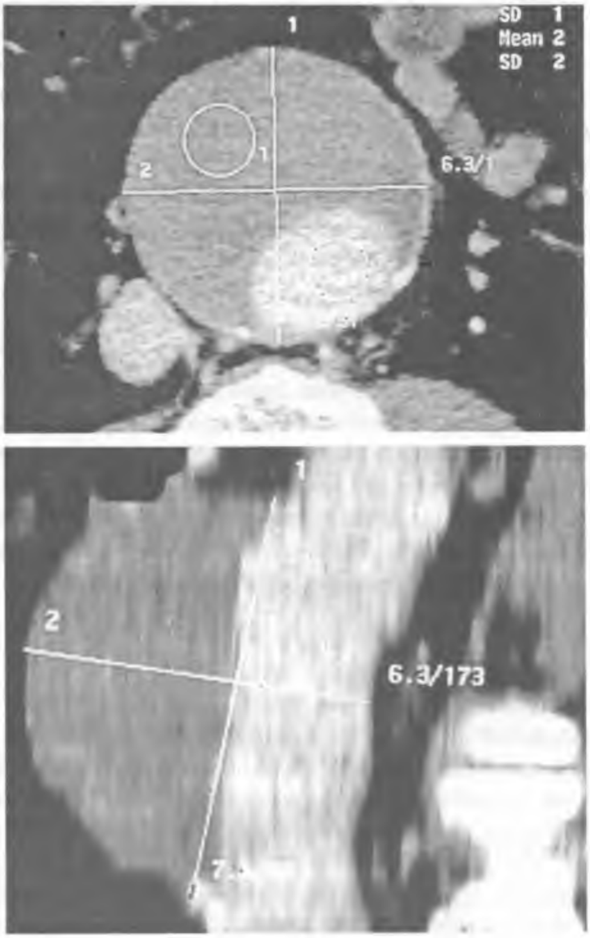

Fig. 2. Abdominal aortic aneurysm on axial CT section, with large thrombus inside (A). MPR reconstruction presents the exact length of both aneurysm and thrombus (B)

(range from 1.7 to 4 cm). There was a good correlation between the thickness of the thrombus and the maximal diameter of the aneurysm (r = 0.83). The mean length of the thrombus was 9.8 ± 1.1 cm (range from 6 to 15 cm). The mean patent lumen of the aorta was 2.1 ± 0.1 cm (range from 1.7 to 2.5 cm). MPR reconstructions enable the evaluation of the whole patent lumen of the aneurysm on one image (Fig. 3). In seven patients both iliac arteries were involved, and in two patients only one (right in both cases), that was clearly visible on MPR reconstructions (Fig. 4). There was one isolated aneurysm of iliac artery, very well visible on both axial section and MPR reconstructions (Fig. 5 ABC).

In one patient the beginning of the dissection was visible only on MPR reconstructions (Fig. 6).

Fig. 3. MPR reconstruction of the abdominal aortic aneurysm in sagittal section reveals the whole patent lumen of the aneurysm as well as the small parietal thrombus (arrowheads)

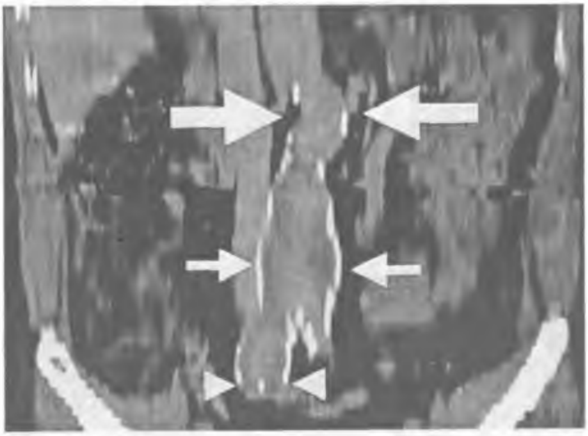

Fig. 4. MPR reconstruction of the aortic aneurysm in coronal plane. The tortuous (big arrows) aneurysm with the calcifications within its walls (small arrows), involving the right iliac artery (arrowheads)

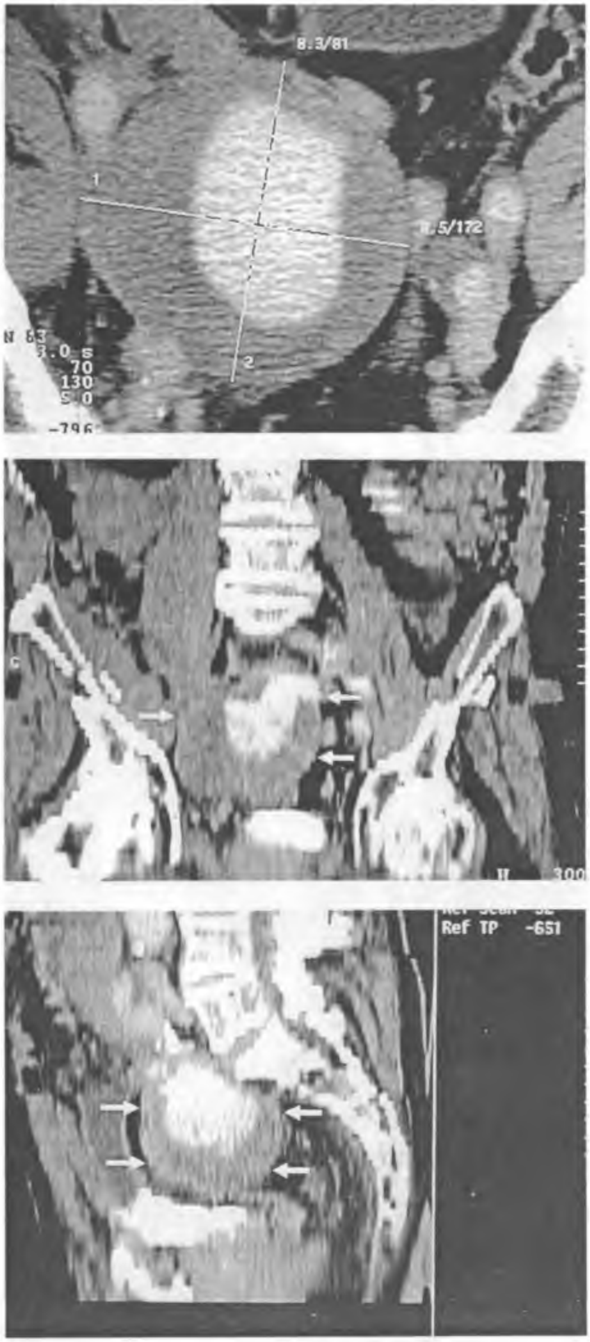

Fig. 5. Aneurysm of right iliac artery in axial section (A), and MPR reconstructions in coronal (B) and sagittal (C) planes

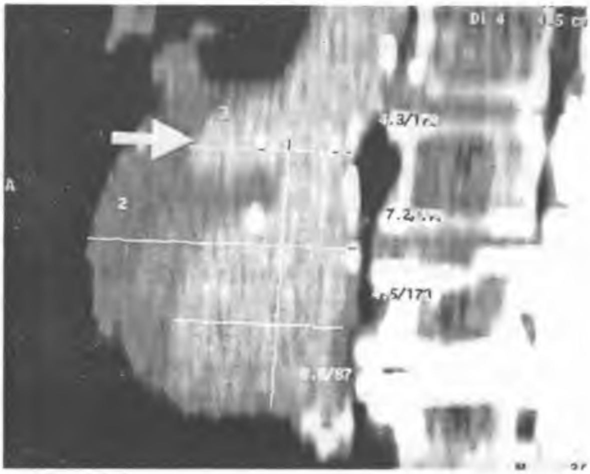

Fig. 6. Abdominal aortic aneurysm in MPR reconstruction. The beginning of the false lumen preceding dissection (arrow)

DISCUSSION

The reported prevalence of abdominal aortic aneurysms in subjects aged 50 years and older varies between 1.4 and 8.8%. It is estimated that AAA is fourfold as common and tenfold more fatal in men than in women, who are affected when 10 years older than their male counterparts. Arterial size, measured as a diameter related to the subject's size, is higher in men (1, 6, 10).

About 75% of AAAs are asymptomatic. They come to light as the chance findings of a lump with or without pulsation, noted on self-examination, a routine physical check-up, or during diagnostic investigations, such as a plain abdominal film, intravenous urography, barium, US, CT, or magnetic resonance-imaging study, undertaken for some other reason. The aneurysm may also be found at laparotomy or post-mortem examination (6, 8, 11).

Abdominal US and CT scan were the two most common investigations, responsible for the opportunistic detection of aneurysms found during radiological procedures (8, 11).

Because AAAs are very often asymptomatic before their rupture, the screening is suggested (9).

The overall mortality due to aortic aneurysm rupture is between 66–95% with perioperative mortality about 50%. On the other hand, the mortality of the elective surgery is between 3–6%, or lower in specialistic vascular departments. Certainly, the detection of abdominal aortic aneurysms before rupture would be ideal. Symptomatic aortic aneurysm > 5 cm should be treated with surgery or intravascular procedures, and the growth rate of the small aneurysm should be evaluated in control ultrasound examinations (6, 9, 11, 16).

Early identification of AAAs may reduce the risk of death from rupture by providing the opportunity for elective repair (11).

Aneurysm size is the most important factor related to likelihood of rupture. Although rupture may occur with an aortic diameter of less than 4 cm, the risk is small. With an AAA diameter under 5 cm, the yearly chance of rupture is about 0–5%. For AAA of 5–6 cm, annual chance of rupture is 5%, increasing exponentially for larger aneurysms (7, 16).

The risk of rupture increases when growth exceeds the expected expansion rate. The normal rate of expansion increases with AAA diameter following an exponential curve with a median growth of 0.5 cm per year. An increased risk of rupture has been observed in patients with hypertension, chronic obstructive pulmonary disease, and familial AAA. The chance of rupture is also enhanced in cigarette smokers and in the absence of peripheral obstructive vascular disease. With few exceptions, AAA is diagnosed in patients over 55 years of age and rupture seldom occurs before the age of 65 (16).

According to Stenbaek et al., the presence of thrombus in general and growth of thrombus in particular is associated with an increased risk of rupture. The so-called crescent sign seen on CT examinations of AAA represents bleeding in the thrombus and this sign has been suggested to indicate an increased risk of rupture (15).

In view of the rising chance of rupture, many surgeons have a policy of proceeding to repair when the AAA diameter has reached 5 or 5.5 cm or when growth of more than 1 cm per year is recorded. The modern treatment involves insertion of vascular prosthesis within the lumen of the aneurysm, as well as less invasive endovascular treatment of selected aortic aneurysm with stentgrafts (1, 4, 16).

The cross-sectional diameter of the aortic aneurysm, measured using computed tomography (CT) scans is the most important determinant of the risk of rupture, and is the key index determining when elective repair is justified (13).

The maximum aortic diameter as assessed with CT is considered the gold standard for clinical decision-making. If an aneurysm is to be treated by stentgraft, the exact sizing of the graft is of great importance. The accuracy of the CT measurements of the abdominal aorta and common iliac arteries is important both for diagnosis, follow-up and in preoperative decision making for aneurysms (14).

With the introduction of the endovascular treatment of abdominal aortic aneurysm the more precise measurements are important, including measurements of iliac arteries (1).

Before endovascular procedure axial CT sections and MPR reconstructions are necessary to assess the aortic diameter, including the thrombus and patent lumen. The reconstructed images MPR images present the true aortic diameter (12).

The aorta is a three-dimensional structure and aneurysms may expand in all dimensions. Increasing aneurismal length leads to aortic convolution or unfolding and may confound interpretation of measurements based on simple two-dimensional images (13)..

Andrews et al. suggested scanning from the level of diaphragm to the level of the pubic bone, with 2.0 mm slices in the region of renal arteries and aortic bifurcation, and 10 mm slices in examining of other parts of the aorta (2).

Even if measurements are performed at pre-determined anatomical levels, the following two--dimension measurements at that level may not reflect the real increase in size, for aneurysms expand in three dimensions. CT scans in situations where the aorta does not lie perpendicularly to the plane of the scan produces an elliptical image. Measurements performed on those images do not reflect the real aortic diameters (13).

It is important to emphasize, however, that the diameter that we used to determine aneurysm size is not a casual measurement of a possibly elliptically distorted section of an aneurismal aorta on a CT scan, but is an estimate of the true diameter of the aorta in the area of maximal dilation, obtained as explained from a computer-generated three-dimensional aortic reconstruction (7).

CONCLUSIONS

The diameter of the aortic aneurysm, measured using computed tomography scans and the rate of growth are the most important determinants of risk of rupture, and in determining when elective repair is justified. The exact measurements of the aortic aneurysm are required. The tortuous aorta is clearly visible on MPR reconstruction, which enables choosing the proper axial section to measure the true diameter of the aneurysm. The exact measurement of the aneurysm length, possible on MPR sections is essential in determining the rate of the aneurysm growth. The presence and size of thrombus correlate with the risk of aneurysm rupture. The MPR reconstructions enable exact measurements of the thrombus length. The visualization of aortic bifurcation is better on MPR reconstructions in coronal plane. The beginning of the dissection in some patients is visible only on MPR images.

MPR reconstructions provide additional information in CT examination of the abdominal aortic aneurysm and should be performed in each CT examination of aortic aneurysms.

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SUMMARY

The increased use of ultrasonography and computed tomography result in the increased number of detected aneurysms, especially with relatively small diameters so the prevalence of the abdominal aortic aneurysms (AAA) is increasing. The aim of the study was to assess the usefulness of multiplanar (MPR) CT reconstructions in the evaluation of abdominal aortic aneurysms. Material comprises a group of 30 patients with the abdominal aortic aneurysm. There were 22 men and eight women, aged between 54 and 78 years (mean age was 62 years). In all the patients the CT examination of the abdominal aorta was performed. The diameter of the aortic aneurysm, measured using computed tomography scans and the rate of growth are the most important determinants of the risk of rupture, and in determining when elective repair is justified. The exact measurements of the aortic aneurysm are required. The tortuous aorta is clearly visible on MPR reconstruction, which enables choosing the proper axial section to measure the true diameter of the aneurysm. The exact measurement of the aneurysm length, possible on MPR sections is essential in determining the rate of aneurysm growth. The presence and size of thrombus correlate with the risk of aneurysm rupture. The MPR reconstructions enable exact measurements of the thrombus length. The visualization of aortic bifurcation is better on MPR reconstructions in coronal plane. The beginning of the dissection in some patients is visible only on MPR images. An MPR reconstruction provides additional information in CT examination of abdominal aortic aneurysm and should be performed in each CT examination of aortic aneurysms.

Wartość diagnostyczna rekonstrukcji płaszczyznowych TK w ocenie tętniaków aorty brzusznej

Wzrastająca częstość stosowania ultrasonografii i tomografii komputerowej powoduje wzrost liczby wykrytych tętniaków, szczególnie tych o małych rozmiarach, tak więc częstość tętniaków aorty brzusznej wzrasta. Celem pracy była ocena użyteczności rekonstrukcji płaszczyznowych (MPR) TK w ocenie tętniaków aorty brzusznej. Materiał stanowiła grupa 30 pacjentów z tętniakiem aorty brzusznej. Było to 22 mężczyzn i 8 kobiet w wieku od 54 do 78 lat (średni wiek 62 lata). U wszystkich pacjentów wykonano badanie TK aorty brzusznej. Średnica tętniaka aorty, mierzona w tomografii komputerowej oraz tempo wzrostu są najważniejszymi czynnikami wpływającymi na ryzyko pęknięcia oraz stanowią podstawę do decyzji o operacji. Dokładne pomiary aorty są więc konieczne. Kręty przebieg aorty jest dobrze widoczny na rekonstrukcjach MPR, co umożliwia wybór odpowiedniego przekroju osiowego do dokonania dokładnych pomiarów średnicy. Dokładne pomiary długości tętniaka, możliwe na rekonstrukcjach MPR, są bardzo ważne w ocenie tempa wzrostu tętniaka. Obecność zakrzepu koreluje z ryzykiem pęknięcia. Rekonstrukcje MPR umożliwiają dokładne pomiary długości zakrzepu. Uwidocznienie rozdwojenia aorty jest również bardzo dobre na obrazach rekonstruowanych w płaszczyźnie wieńcowej. Cechy rozpoczynającego się rozwarstwienia u niektórych pacjentów są widoczne jedynie na rekonstrukcjach MPR. Rekonstrukcje MPR dostarczają dodatkowych informacji w badaniu TK tętniaka aorty brzusznej i powinny stanowić integralną część badania TK tętniaka aorty brzusznej.