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Abdominal aorta morphometric study for endovascular treatment of aortic aneurysms: comparison between spiral CT and angiography

Estudo morfométrico da aorta abdominal para tratamento endovascular dos aneurismas aórticos: comparação entre tomografia helicoidal e angiografia

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Abstract

Purpose: **To compare the computed tomography and angiography study of abdominal aortic aneurysms for posterior endograft implant.**

Method**: From June 1997 to March 2001, 113 patients with abdominal aortic aneurysm were submitted to study of the aorto-iliac axis with abdominal spiral computed tomography and angiography with calibrated catheter. The patient's ages ranged from 51 and 88 years (mean: 69). There were 104 males and nine females.**

Results**: When comparing the mean computed tomography and angiography diameters, we observed that there was a statistical difference for the infra-renal neck (p<0.05) and for the aortic aneurysm diameters (p<0.001). There was no statistical difference for the iliac artery diameters (p>0.05). When comparing the mean lengths, we observed that there was a statistical difference for the aortic infra-renal neck (p<0.05), for the distance between the renal artery and the aortic bifurcation (p<0.05) and for the common iliac artery lengths (p<0.05). There was also a statistical difference for the length between the renal artery and the internal iliac artery (p<0.05).**

Conclusions**: In the AAA pre-procedure imaging study there were statistical differences between the computed tomography and angiographic measurement studies. We believe that computed tomography is a superior method for the evaluation of diameters and the angiography with a calibrated catheter for the length evaluation. We conclude, that both methods are complementary and must be undertaken for accurate evaluation of all candidates for aortic endograft implant.**

Descriptors: **Abdominal Aortic Aneurysm. Blood vessel prosthesis. X-ray Computed Tomography. Angiography.**

Resumo

Objetivos: **Este trabalho visa comparar a acurácia da tomografia computadorizada e da angiografia para avaliar os**

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aneurismas de aorta abdominal (AAA) para posterior implante de endoprótese vascular.

***Método:* De junho de 1997 até março de 2001, foram atendidos 113 pacientes portadores de AAA, tendo sido submetidos a estudo por tomografia helicoidal computadorizada de abdome e pelve e angiografia com cateter centimetrado do eixo arterial aorto-ilíaco. A idade dos pacientes variou entre 51 e 88 anos (S:69a.), sendo 104 do sexo masculino e nove do feminino.**

***Resultados:* Quando comparadas as médias dos diâmetros aferidas pela tomografia computadorizada e pela angiografia, notou-se que a diferença do diâmetro foi significativa para o colo aórtico infra-renal (r < 0,05) e muito significativa para o diâmetro máximo dos aneurismas aórticos (r < 0,001). Não existiu diferença estatística entre a medida do diâmetro das artérias ilíacas (r > 0,05). Quando comparadas as médias das extensões aferidas pela tomografia computadorizada e pela angiografia, notou-se que a diferença das extensões foi significativa para o colo aórtico infra-renal (r < 0,05), para a distância entre a artéria renal e a bifurcação aórtica (r < 0,05) e para as artérias ilíacas comuns (r < 0,05). A comparação entre as médias também foi significativa para a extensão entre a artéria renal e a artéria ilíaca interna (r < 0,05).**

***Conclusões:* Na avaliação por imagem dos AAA houve diferenças estatísticas significativas entre os dois métodos diagnósticos. A tomografia computadorizada aparentou ser o melhor método pré-operatório para a medida dos diâmetros, e a angiografia por cateter centimetrado para a avaliação das extensões (comprimentos). Portanto, os dois métodos se complementam, devendo ser realizados na avaliação de todos os pacientes candidatos ao implante de uma endoprótese aórtica.**

***Descritores:* Aneurisma da Aorta Abdominal. Prótese Vascular. Tomografia Computadorizada por Raios X. Angiografia.**

INTRODUCTION

Currently, the exclusion of abdominal aortic aneurysms (AAAs) from the circulation can be made by a conventional surgery, which implies the opening of the abdominal cavity and the correct handling of the diseased vessel [1]. Alternatively it can be effected by a new technique, the endovascular method, which is also based on the same principles as classic surgery with the inclusion of a prosthesis, in this case an endograft, in the dilated segment of the vessel. This type of approach is performed using a catheter, originating in the femoral or iliac arteries, guided by radioscopy [2].

Contrary to the classical open surgical method, detailed measurements in the pre-operative period are of extreme necessity for a good planning of the endovascular repair of the abdominal aorta aneurysm. The use of endografts can bring a great number of complications; however, an adequate selection of patients based on morphologic criteria of the abdominal aorta aneurysms, might offer excellent results. Thus, both the indication for the realization of the endovascular procedure, and the size of the endograft to be used are determined by measuring the diameter and length by diagnostic imaging methods [3].

Several methods of imaging have been described for the evaluation of the abdominal aorta aneurysm, such as ultra-sound [4,5], computed tomography (CT) [6,7], magnetic resonance [4,8] and angiography [6,9]. However all these methods present some advantages and limitations.

Ultra sound is a low-cost method, which does not expose the patient to ionizing radiation, it does not require venous contrast and presents a great sensitivity for the detection of abdominal aorta aneurysms [5]. However, it needs to be performed by an experienced technician and the evaluation of all the necessary measurements for the implantation of an endograft can be very difficult.

CT, above all spiral CT, allows a quick acquisition of images, permitting reconstruction of images in multiple aspects similar to those produced by angiography [10]. Compared with angiography, the CT angiography is less invasive and more onerous [11]. However, the spatial resolution of CT angiography is inferior to angiography, particularly in demonstrating small caliber vessels or small stenosis, as in renal arteries [11].

Magnetic resonance presents some advantages, dispensing with the injection of venous contrast, as well as not using ionizing radiation. However, the images obtained do not possess such a clear definition when compared with those obtained by Spiral CT, with contra-indications in patients with cardiac pacemakers, cochlear implantations, intra-cranial metal clips and intra-ocular prostheses [12].

Angiography is the best method of obtaining a vascular 'map', revealing specific anatomical peculiarities, such as the presence of polar renal arteries or hemodynamically significant stenosis [9]. Nonetheless, it is an invasive method that requires an injection of a considerable amount of iodous contrast.

The objective of this study is to compare the results of Spiral CT with those of angiography by calibrated catheter, to obtain the necessary information for the endovascular treatment of abdominal aorta aneurysms, by vascular endograft implantation. Special attention was paid in the evaluation of the diameters and lengths of the aorta, of the aneurysm and of the iliac arteries, as well as the location of the origin of the renal and internal iliac arteries.

METHOD

From June 1997 to March 2001, 113 patients with abdominal aorta aneurysms were attended as part of a protocol to study the TALENT vascular endograft (Medtronic-AVE, Miami, USA). They were submitted to a Spiral CT study of the abdomen and pelvic cavity and an angiography with a calibrated catheter of the aorta-iliac arterial axis. The age of the patients varied from 51 to 88 years old (mean 69 years old), with 104 male and 9 female.

Technique of Spiral CT

The Spiral CT studies were made using Elscint (Israel) and Somaton AR Star (Siemens, Erlangen, Germany) equipment. The examinations were performed with the volumetric acquisition of data with slice widths of 5 mm, during the administration of 125 ml of non-ionic venous contrast (Optiray 320 mg – Mallinckrodt Medical, St. Louis, USA), with a flow of 3 ml/second. Axial images with reconstruction increments at every 3 mm were obtained. The extension of the studied segment initiated above the emergence of the celiac trunk and continued to immediately below the internal iliac arteries. Also multiplane reconstructions (MPR), 3d curves (3D) with maximum intensity projection, and shadow surface displays (SSD) were made.

Angiographic Technique

The angiographic studies were performed with digital subtraction equipment (Phillips and General Electric), according to the Seldinger technique, by means of a puncture of the femoral artery and the introduction of a 5 French catheter. The angiographic catheter utilized was the calibrated 'Pigtail' catheter with radioopaque metallic marks at every centimeter (COOK, Queensland, Australia).

After positioning the first radioopaque mark of the calibrated catheter in the abdominal aorta at the origin of the renal arteries, an injection of a contrast medium by means of an injection pump (Angiomat 6000) was made. The iodous contrast utilized was Omnipaque 300, with an injection velocity of 8 ml/sec. for three seconds, with a total volume of 24 ml per injection.

Aortography was performed, checking that the origin of the renal arteries and the aorta-iliac bifurcation could be seen. For the correct evaluation of the distance between the renal arteries and the aorta-iliac bifurcation it is important that both appear on the same study plane.

After the angiographic study of the abdominal aorta, we drew back the calibrated angiographic catheter to perform the study of the iliac arterial axis, taking care to position the first radioopaque mark level with the aorta-iliac bifurcation. Anteroposterior and oblique (right and left) projections of the pelvic cavity were performed with the aim of correctly identifying the origin of the internal iliac arteries and to evaluate the distance between them and the aortic bifurcation.

Measurements and Evaluation of the Aorta and Aneurysm

The measurements of the evaluated aorta for the planning of the vascular endograft implantation are represented in Figure 1.

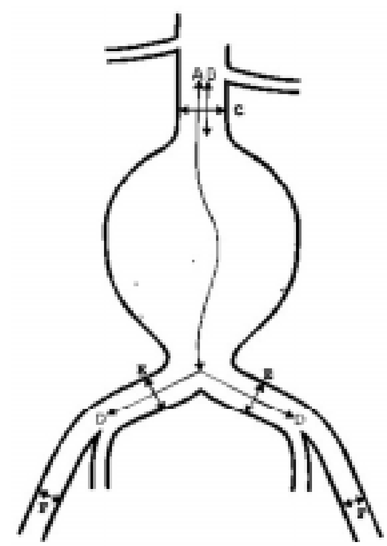

Fig. 1 - Diagram showing the basic necessary measurements to plan the implantation of a vascular endoprosthesis. A) The distance from the renal artery to the aortic bifurcation; B) length of neck; C) Diameter of the aortic neck; D) Length of the common iliac artery; E) Diameter of the common iliac artery; F) Diameter of the external iliac artery.

Diameters: Diameter of the infra-renal aortic neck; maximum diameter of the aneurysm; Diameters of the right and left common iliac arteries; diameter of the external iliac artery.

Lengths: Length of the infra-renal aortic neck; distance from the renal artery to the aortic bifurcation; lengths of the right and left common iliac arteries; distance of the renal artery to the origin of the internal iliac artery.

The objectives of the image analysis of the AAAs by Spiral CT and angiography were as follows:

1. Define the anatomy of the aneurysm, size, length and relationships with the branches of the aorta, as well as calcification of the wall and configurations of thrombi.
2. Identify and compare the dimensions of the proximal and distal necks of the aneurysm when present.
3. To detect pertinent anatomical variations, such as accessory renal arteries and retro-aortic or circum-aortic renal veins.
4. Diagnose vascular and associated extravascular anomalies which might alter the treatment of the patient.

Statistical Analysis

The results are expressed as a mean ± standard deviation (mean ± MSD). When it was necessary to compare two means the student T-test was utilized. In all cases, statistical differences were considered significant when the p-value was less than 0.05. Statistical analysis was effected by means of the "Stat View" program (Brainpower Inc., Calabasas, Ca).

RESULTS

Patient Classification

In a total of 113 patients, the endovascular procedure could be performed in 98 (86.7%) of the cases. Of the 14 patients in which the treatment via endovascular was contra-indicated, 12 presented with the infra-renal neck less than 5 mm, seven had compromise of the supra-renal aorta and two presented with extensive involvement of both iliac arteries. Of the 99 patients, in which the implantation of an endograft was attempted, 98 were successful, as one patient presented with the external iliac artery very thin, which did not permit the progression of the liberating system.

Of the 98 patients treated, 84 presented with an infra-renal neck with an extension equal or greater than 15 mm, and 14 presented with a length between 5 and 14 mm. In 12 patients we observed involvement by aneurysmal disease of one of the iliac arteries.

Diameters and lengths of the aneurysms

Diameters

The measurements by CT of the diameters in a total of 113 patients were: the diameter of the infra-renal aortic neck varied from 18.1 to 33.5 mm (mean 24.5 ± 3.4 mm) and the maximum diameter of the aortic aneurysms ranged from 39.2 to 113.7 mm (mean 55.7 ± 4.6 mm). There was no significant difference between the measurement of the anteroposterior (mean 53.8 ± 4.8 mm) and transverse (mean 55.1 ± 4.9 mm) axis diameter of the aneurysms ($p > 0.05$).

The diameter of the common iliac arteries varied from 8.0 to 17.5 mm (mean 13.1 ± 1.1 mm) for the right iliac artery and 8.0 to 19.0 mm (mean 12.7 ± 1.2 mm) for the left iliac artery. In 12 cases (11.3%) the aneurysm was associated with the presence of an iliac aneurysm.

In relation to the measurements of the diameters by angiography with a calibrated catheter, the diameter of the infra-renal aortic neck varied from 16.3 to 31.2 mm (mean 21.4 ± 2.1 mm); the maximum diameter of the aortic aneurysms ranged from 26.2 to 68.4 mm (mean 28.7 ± 3.2 mm) and the diameters of the common iliac arteries varied from 7.0 to 17.0 mm (mean 12.6 ± 0.9 mm) for the right iliac artery and 8.0 to 17.5 (mean 12.1 ± 0.9 mm) for the left iliac artery.

When the averages of the diameters measured by CT and by angiography were compared, in the 113 patients (Figure 2), it was observed that the difference for the infra-renal aortic neck was significant ($p < 0.05$) and very significant for the maximum diameter of the aortic aneurysms ($p < 0.01$). There was no significant difference between the mean diameters of the iliac arteries ($p > 0.05$).

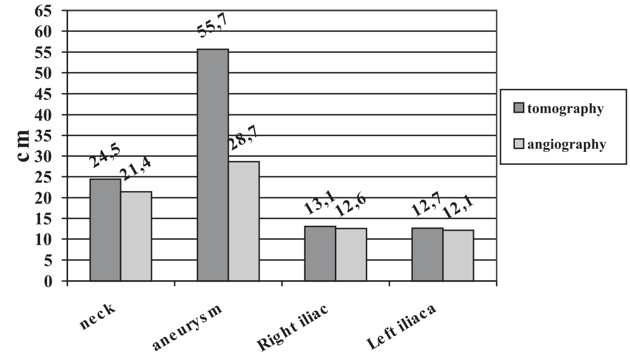

Fig. 2- Comparative graph of the mean diameters measured by spiral TC and by angiography (n=113).

Lengths

The length measurements by CT were the infra-renal aortic neck length, which ranged from 5 to 57 mm (mean 21.2 ± 2.6 mm), the distance from the renal arteries to the aortic-iliac bifurcation, which ranged from 65 to 135 mm (mean 99.7 ± 4.3 mm), the length of the common iliac arteries which varied from 15 to 75 mm (mean 34.7 ± 2.4 mm) and the distance from the renal arteries to the origin of the internal iliac arteries, which ranged from 105 to 185 mm (mean 148.6 ± 4.3 mm).

The lengths measured by angiography with a calibrated catheter were the infra-renal aortic neck length, which ranged from 5 to 70 mm (mean 28.3 ± 3.2 mm), the distance from the renal arteries to the aorta-iliac bifurcation, which varied from 70 to 150 mm (mean 112.9 ± 4.6 mm), the length of the common iliac arteries which varied from 24 to 85 mm (mean 46.2 ± 2.6 mm) and the distance from the renal arteries to the origin of the internal iliac arteries, which ranged from 105 to 225 mm (mean 175.3 ± 4.8 mm) (Figure 3).

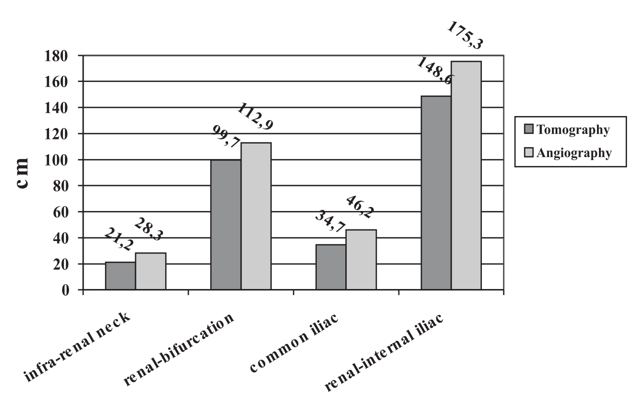

Fig. 3 - Comparative graph of the mean lengths measured by spiral TC and by angiography (n=113).

When the mean lengths measured by CT and angiography were compared in the 113 patients (Figure 3), it was observed that the difference was significant for the infra-renal aortic neck ($p < 0.05$), for the distance between the renal artery and the aortic-iliac bifurcation ($p < 0.05$) and for the common iliac arteries ($p < 0.05$). A comparison between the means was also significant for the distance between the renal artery and the internal iliac artery ($p < 0.05$).

Evaluation of the aortic and the aneurysm

In the 113 studied patients, five possessed only one kidney and occlusion of the contralateral renal artery, with a total of 221 renal arteries. Eight patients presented with an accessory polar renal artery and two patients presented with polar arteries for each kidney (bilateral), giving a total of 12 polar arteries. One patient presented with a renal graft in the right pelvic cavity, with end-to-end anastomosis with the internal iliac artery.

Spiral CT was able to show 217 renal arteries (98.2%) and 7 polar arteries (58.3%), whilst angiography showed all the renal and polar arteries. Spiral CT also managed to demonstrate, in one patient, accentuated thickening of the aortic wall and peri-aortic inflammatory signs compatible with the diagnosis of inflammatory aneurysm. Both Spiral CT and angiography were satisfactory in the evaluation of the vascular anatomy of the transplanted kidney.

COMMENTS

Convention surgery for the treatment of AAAs, performed with the object of preventing the rupture of the aneurysm and prolonging the life of the patients, has been well studied and documented, and so is established as an effective method for the treatment of this type of disease [2]. However, the risk of this surgery must be considered, as it surpasses 10% mortality in most previously published studies, a reason why many surgical high-risk patients are refused because of the great chance they present of developing complications [2].

The possibility of a less invasive therapeutic method, by via endovascular, might reduce the risk for the patient and diminish the costs of this type of treatment [13], an idea which arouses great enthusiasm both in doctors and the patients themselves. Thus, currently there is immense interest around the world to develop this type of treatment.

Based on the results of this study, as well as of other publications by several authors, we believe that a significant number of AAA patients can be treated by via endovascular. However, it has not yet been defined what percentage might be satisfactorily treated by this method [2,14]. The principal factor, which indicates the possibility of performing this type of procedure, is the anatomy. Initially, when the endografts were handmade, only 30 to 60% of the patients could be considered [2]. Today, with the great technological advances, as well as the possibility of these endografts being made-to-measure in a specific form for the patient in question, this rate surpasses 80% [2].

According to several published works, it is possible to treat 30 to 80% of AAA patients by via endovascular [2,14]. In this work with 106 AAA patients, it was possible to effectively treat 92 by means of a vascular endograft implant, corresponding to 86.8% of the patients. We believe that the great differences found in publications [6] are due to differences in the types of endografts utilized, the techniques employed and the experience of the medical team.

Faithful measurements of the aorto-iliac dimensions, both diameters and lengths, are essential for the manufacture of safe endovascular grafts. If too short, the prosthesis can break loose inside the aneurysmal balloon, whilst an excessively long graft may acquire curves or be positioned at a exaggeratedly distal site, compromising the blood supply of the pelvic cavity to occlude a internal iliac artery. Thence, it is important to assess the performance of the different methods of imaging available for the comparison of the basic measurements.

There are some diagnostic imaging aspects which are necessary in the pre-operative selection of patients. Safe implantation of the vascular endograft depends on the presence of a healthy vascular blood flow above and below the aneurysm, as it will be in these points that the endograft will be fixed. Thus, the most important anatomic sites to be studied in AAA are the proximal and distal necks and the iliac artery axis [15].

Probably, the most important criterion for the safe implantation of an endovascular endograft is the presence of a satisfactory infra-renal aortic neck. The proximal anchoring of the endograft on the aortic neck must be firm to prevent dislocation during implantation and to promote a good seal, excluding the aneurysmal balloon from the circulation system. It is advisable that this portion of the aorta is free of large calcifications or intramural thrombi [9].

The proximal and distal necks can be accurately studied, enabling the selection of candidate patients for endovascular treatment. The length of the necks can be measured both with SSD reconstruction and the center of the aperture, utilizing multiplane reconstruction. Longer proximal necks are necessary when lined endografts are used to avoid compromising the blood flow to the renal arteries [16].

The majority of the AAAs extend to the bifurcation and so cases in which straight tubes can be used are rare. Even with an acceptable distal neck it is recommended to use bifurcated systems to avoid posterior dilation of the distal aortic neck [16].

The irregularity of an aneurysmal thrombus or the presence of ulcerated plaque along the femoral-iliac access can be risk factors for embolic complications described in the installation procedures of vascular endografts [14]. The presence of additional iliac aneurysms, depending on the size and position, can change the endovascular tactic.

For the safe distal implantation of endografts, at the level of the iliac arteries it is recommended that the diameter does not exceed 18 mm, normally varying between 10 and 16 mm, with a length of at least 30 mm of artery free from calcification and thrombosis. The common iliac artery is the ideal site for the distal anchoring of the endograft, in order to preserve the internal iliac artery [16]. In selected cases, in which the patient also presents with an iliac aneurysm, the external iliac artery can be used as the anchorage site of the endograft, but only when the contralateral internal artery is of a good quality [11].

The main methods to measure the AAAs are CT and angiography. The principal advantage of Spiral CT is the rapid acquisition of information [16]. To perform an angiographic CT, speed of image collection is very important for two reasons: 1) it allows the completion of the examination in an optimal interval after the injection of the contrast. Thus, the images obtained through the injection of a contrast medium in a peripheral vein are, in many aspects, similar to those produced by angiography [10]. 2) The region of interest can be integrally examined in a single apnea, thus eliminating artifacts of movement, which results in good quality images [10]. Compared with the incremental method, a smaller volume of intravascular dye can be used in some cases, leading to greater safety of the method and a reduction of the costs [11].

Comparing with angiography, a CT angiography is less invasive and less onerous [11]. The reconstruction with overlapping improves the visualization of small structures and a more accurate characterization of poorly defined lesions. It presents a better enhancement of the vascular structure, but the spatial resolution is inferior to that of angiography, which can be compensated with the ability to illustrate the vasculature in several 3D and multiplane constructions [16]. CT can also supply information about the vascular wall different to angiography, which only visualizes the aperture. In our work we were able to identify one case of inflammatory aneurysm.

Some recent works defend the advantages of CT angiography in relation to conventional angiography [17,18]. A technically well performed CT angiography would dispense with the necessity of the angiography before the surgery for the treatment of aneurysms and dissections, utilizing angiography only in a small number of problematic cases [19,20]. However, the question is if the CT angiography possesses similar functions to angiography, in the morphometric planning of the endovascular treatment of the AAAs, it is necessary to await a prospective analysis of its correlation with angiography, as well as with the result of the performed endovascular treatments [9,11,16].

The greater diameter the aneurysm can be accurately measured in axial slices without the use of venous contrast. Generally two orthogonal dimensions of the aneurysm are obtained. In cases of examinations for evolutional follow-ups, the measurements should be taken in identical levels to precisely compare any alteration of the greatest diameter [21]. In conventional CT, such measurements in the axial plane can be overestimated as the aneurysm is often measured in oblique planes due to its twisting [16]. This problem is easily solved in the spiral CT utilizing a multiplane reformatting (MPR), which pairs the trajectory and twisting of the aorta, enabling the comparison of the appropriate measurements, including in the perpendicular plane of the vessel [11].

Evaluation of the twisting of the vessels is extremely important in the pre-operative preparation of these patients. The angles of the region of the infra-renal aortic neck constitute a great obstacle for the safe implantation of the endograft [15]. The angle between the aneurysmal neck and the axis of the aneurysm is well defined and can be measured both with MPR and 3D images. The twisting of the iliac arteries can also make the passage of the liberation system extremely difficult [16].

The origins of the renal arteries are often difficult to see in conventional CT. But on the Spiral CT, RUBIN et al. [22] reported in their work, a sensitivity of 92% and specificity of 83% for the detection of renal artery stenosis in at least 70% of CT angiography. The work of VAN HOE et al. [23] demonstrated a specificity of 95% in the evaluation of stenosis in the renal artery utilizing Spiral CT with observation of 2 mm. The identification of one kidney in horseshoe inclines the option of treatment to via endovascular, due to the great difficulty in surgical access to the infra-renal aortic neck, unless a caudal origin, expressive of the multiple renal vessels is detected in angiography [11]. In our study, Spiral CT was able to evidence 217 of the 221 renal arteries.

Between 1994 and 1996, ARMON et al. [6] evaluated the longitudinal lengths of AAAs of 208 patients candidates for endovascular treatment by means of Spiral CT angiography and aortagraphy. They elected the distance of the upper limit of the proximal neck to the aorta bifurcation and the distance from the aorta bifurcation to the origin of the internal iliac arteries bilaterally as the fundamental measurements. Based on the findings of ARMON et al. [6], we concluded that CT angiography is sufficiently accurate for small diameter aneurysms (< 4.5 cm), but is not reliable for endovascular grafting in other cases. Thus, in our study we routinely performed CT and angiography in all patients.

In 1997, BROEDERS et al. [11] published a study of 21 AAA patients measured using Spiral CT angiography, conventional CT and angiography. The objective was to evaluate the impact of Spiral CT in the morphometric study of AAAs. These authors concentrated on the measurement of the diameters of the superior and inferior aneurysmal necks and their respective longitudinal lengths between the anchorage points of the endograft in each case. The authors concluded that neither arteriography nor CT were adequate methods in isolation for the pre-operative evaluation of trans-femoral endovascular treatment of aortic aneurysms. In our study, Spiral CT was significantly better in the evaluation of the diameters.

Angiographic investigation is fundamental for a good assessment of the vascular anatomy of the patient. Angiography can reveal specific anatomical peculiarities, such as the presence of a polar renal artery or hemodynamically significant stenosis of the iliac arteries [9]. In our study, angiography was superior to CT in evidencing all the polar and renal arteries.

Angiography is the best method to obtain a vascular 'map' for the orientation of later therapy. Although more recent techniques, such as CT angiography, angioresonance and vascular ultrasound carry out an important function and, sometimes, dispense with the necessity of performing angiography [10], this remains to be one of the principal choice examinations for patients who are going to be submitted to treatment for AAAs [16,24].

Many vascular surgeons argue that AAA patients and some non-aortic patients, can be diagnosed and treated based on the findings of one or more non-invasive methods of imaging [22,25]. This affirmation sometimes can be true when the treatment is surgical. However, when endografts are utilized, additional information must be collected which is not obtained by these methods. In these cases, it is of great value to perform an arteriography before the endoluminal reconstruction [16].

Angiography can be performed employing a simple apparatus or techniques of image subtraction [7]. Digital subtraction possesses many advantages, including the fact of using a smaller quantity of contrast, supplying several incidences rapidly and the sequential visualization of images, permitting easy evaluation of the flow direction. Thus, the maximum quantity of information is rapidly obtained with a single injection. As the images can be magnified, but the degree of magnification can not be checked, catheters calibrated with radioopaque markers must be used [9].

Angiography with a calibrated catheter is used mainly to measure heights and lengths, to evaluate iliac arteries and the origin of the internal iliac arteries, as it supplies more details in relation to the effects of twisting than only CT [11]. These measurements depend on the presence of a catheter, inside the artery, marking each centimeter as a base for the measurements. Angiography also is used to evaluate the mesenteric circulation, to detect stenosis of the renal arteries and to show the relationship between the renal arteries and the proximal length of the aneurysm neck [9,16].

As accurate measurements must be obtained, it is advisable to use a calibrated catheter of the type 'pigtail', with varying radioopaque markers positioned at every centimeter [11]. The diameter and the length of the distal and proximal necks can be determined. The extension of the aneurysm, which is not indispensable in surgical repairs, might be important in endovascular procedures and can be measured using the calibrated catheter [16].

In our study, the mean diameter of the infra-renal aortic neck studied using CT was 24.5 mm and by arteriography it was 21.4 mm. The maximum diameter of the aortic aneurysms by CT was 55.7 mm and by arteriography it was 28.7 mm. So, CT presented with significantly larger diameters than arteriography. This is surely because the arteriography is capable of showing only the aperture of the vessel due to the presence of mural thrombi, which reduce the opening of the aorta. This effect is more evident at the aneurysmal balloon level, where in specific cases the aortic aperture can seem practically normal. Thus, we noted that CT is more reliable than arteriography in the evaluation of the axial diameters.

In relation to the longitudinal lengths, we saw that the mean length of the infra-renal aortic neck measured using CT was 21.2 mm and by angiography it was 28.3 mm. The distance from the renal arteries to the aorto-iliac bifurcation measured by CT was 99.7 mm and by angiography it was 112.9 mm. The length of the common iliac arteries measured using CT was 34.7 mm and by angiography it was 46.2 mm. The mean distance from the renal arteries to the origin of the internal iliac arteries measured by CT was 148.6 mm and by angiography it was 175.3 mm. Thus, we concluded that the lengths are significantly greater when measured by angiography than by CT, principally at the level of the iliac arteries, which can present with much twisting. In these cases a combined evaluation of both angiography and CT is indispensable.

In conclusion, in the evaluation by imaging of AAAs spiral CT appeared to be the best pre-operative method to measure the diameters and angiography using a calibrated catheter for the evaluation of the lengths. The two methods complement each other and they should be used in the evaluation of all patients who are candidates for aortic endograft implantation.

BIBLIOGRAPHIC REFERENCES

1. Rutherford RB. Atlas de cirurgia vascular. 1a. ed. Rio de Janeiro: Interlivros.Di-Livros; 1998. p.172-85.

2. Brewster DC, Geller SC, Kaufman JA, Cambria RP, Gertler JP, LaMuraglia GM et al. Initial experience with endovascular aneurysm repair: comparison of early results with outcome of conventional open repair. J Vasc Surg 1998;27: 992-1005.

3. Cherryman GR, Moody AR, Rogers P. New imaging techniques and arterial disease. Vasc Med Ver 1994; 798: 524-9.

4. Amparo EG, Hoddick WK, Hricak H, Sollitto R, Justich E, Filly RA et al. Comparison of magnetic resonance imaging and ultrasonography in the evaluation of abdominal aortic aneurysms. Radiology 1985; 154: 451-6.

5. Quill DS, Colgan MP, Summer DS. Ultrasonic screening for the detection of abdominal aortic aneurysms. Surg Clin North Am 1989; 69: 713-20.

6. Armon MP, Whitaker SC, Gregson RH, Wenham PW, Hopkinson BR. Spiral CT angiography versus aortography in the assessment of aortoiliac length in patients undergoing endovascular abdominal aortic aneurysm repair. J Endovasc Surg 1998; 5: 222-7.

7. Costello P, Gaa J. Spiral CT angiography of abdominal aortic aneurysms. Radiographics 1995; 15: 397-406.

8. Kaufman JA, Geller SC, Petersen MJ, Cambria RP, Prince MR, Waltman AC. MR imaging (including MR angiography) of abdominal aortic aneurysms: comparison with conventional angiography. AJR Am J Roentgenol 1994; 163: 203-10.

9. Diethrich EB. Will contrast aortography become obsolete in the preoperative evaluation of abdominal aortic aneurysm for endovascular exclusion?. J Endovasc Surg 1997; 4: 5-12.

10. Beebe HG, Kritpracha B, Serres S, Pigott JP, Price CI, Williams DM. Endograft planning without preoperative arteriography: a clinical feasibility study. J Endovasc Ther 2000; 7: 8-15.

11. Broeders IA, Blankensteijn JD; Olree M, Mali W, Eikelboom BC. Preoperative sizing of grafts for transfemoral endovascular aneurysm management: a prospective comparative study of spiral CT angiography, arteriography and conventional CT imaging. J Endovasc Surg 1997; 4: 252-61.

12. Bradley Jr. WG, Waluch V. Blood flow: magnetic resonance imaging. Radiology 1985; 154: 443-50.

13. Sternbergh WC, Money SR. Hospital cost of endovascular versus open repair of abdominal aortic aneurysms: a multicenter study. J Vasc Surg 2000; 31: 237-44.

14. Mialhe C, Amicabile C, Becquemin JP. Endovascular treatment of infrarenal abdominal aneurysms by the Stentor system: preliminary results of 79 cases. Stentor Retrospective Study Group. J Vasc Surg 1997; 26: 199-209.

15. Schumacher H, Eckstein HH, Kallinowski F, Allenberg JR. Morphometry and classification in abdominal aortic aneurysms: patient selection for endovascular and open surgery.. J Endovasc Surg 1997; 4: 39-44.

16. Beebe HG, Jackson T, Pigott JP. Aortic aneurysm morphology for planning endovascular aortic grafts: limitations of conventional imaging methods. J Endovasc Surg 1995;2: 139-48.

17. Ernst CB. Abdominal aortic aneurysm. N Engl J Med 1993; 328: 1167-72.

18. Rozenblit A, Bennett J, Cop A. Preoperative assessment of aortic branch vessels with CT-angiography in patients with abdominal aortic aneurysms. AJR 1996; 166: 38-43.

19. Bluemke DA, Chambers TP. Spiral CT angiography: an alternative to conventional angiography. Radiology 1995; 195: 317-9.

20. Rubin GD, Walker PJ, Dake MD, Napel S, Jeffrey RB, McDonnell CH et al. Three-dimensional spiral computed topographic angiography: an alternative imaging modality for the abdominal aorta and its branches. J Vasc Surg 1993; 18: 656-65.

21. Parodi JC. Endovascular repair of abdominal aortic aneurysms and other arterial lesions. J Vasc Surg 1995; 21: 549-57.

22. Rubin GD, Dake MD, Napel S, Jeffrey RB Jr, McDonnell CH, Sommer FG et al. Spiral CT of renal artery stenosis: comparison of three-dimensional rendering techniques. Radiology 1994; 190: 181-9.

23. Van Hoe L, Baert AL, Gryspeerdt S, Marchal G, Lacroix H, Wilms G et al. Supra and juxtarenal aneurysms of the abdominal aorta: preoperative assessment with thin-section spiral CT. Radiology 1996; 198: 443-8.

24. Borrello JA. MR angiography versus conventional X-ray angiography in the lower extremities: everyone wins. Radiology 1993; 187: 615-7.

25. Zeman RK, Fox SH, Silverman PM, Davros WJ, Carter LM, Griego D et al. Helical (spiral) CT of the abdomen. AJR Am J Roentgenol 1993; 160: 719-25.