Comparison between manual aortic measurement by experienced radiologists and radiologists in training versus semiautomatic centerline analysis

Poster No.: C-1707
Congress: ECR 2019
Type: Scientific Exhibit
Authors: A. P. A. F. Martins¹, M. S. santos¹, S. T. C. D. Melo², B. pereira¹, P. A. L. T. Tito¹, J. G. Domingues³, T. C. D. S. Bernardino¹, G. H. N. OLIVEIRA⁴, P. lazzaroni¹; ¹Belo Horizonte/BR, ²Belo Horizonte, Mi/BR, ³Belo Horizonte, MG/BR, ⁴BELO HORIZONTE /BR
Keywords: Epidemiology, Dissection, Aneurysms, Technology assessment, Education, Computer Applications-Detection, diagnosis, CT-Angiography, Computer applications, Artificial Intelligence, Arteries / Aorta
DOI: 10.26044/ecr2019/C-1707

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.
As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.
You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.
Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.
www.myESR.org
Aims and objectives

Since its introduction in 1991, endovascular aneurysms repair (EVAR) has been the method of choice for the treatment of this morbidity, since it is less invasive and also related to a lower postoperative mortality rate¹. In this context, the morphometric study of the aorta stands out, which allows the follow-up of patients with this pathology, evaluation of the need for surgical intervention, as well as the correct planning of this, since the size and type of the endoprosthesis to be used are determined by the diameters and lengths measured by the imaging methods¹². Failure to correctly measure an aneurysm can lead to several complications such as endoleaks (persistence of blood flow within an aneurysm), thrombosis or graft misalignment, vessel wall injury, and even aneurysm caliber increase¹³.

Computed tomography angiography (CTA) is the imaging method of choice to provide the information necessary for the evaluation of an aneurysm, since it allows rapid acquisition of images, reconstructions in several planes, and is cheaper than angiography and noninvasive¹⁴. The aortic diameter data can be obtained by (1) measurements strictly made in the axial plane (Ax), (2) multiplanar reformation (MPR) or (3) automated analysis by centerline (CLA). In the first case, the measurements are acquired only in the axial plane and may not represent the real dimensions of a tortuous aorta¹⁵. On the other hand, the MPR allows, by plane manual angulation, the measurement of the aortic diameter in a cross-section of the vessel. Finally, the CLA consists of a post-processing technique, which automatically generates MPRs perpendicular to the course of the vessel under study, after the computerized detection of the geometry of the vessel and design of a reference centerline¹⁶. Therefore, it is essential to recognize the relationship between the measurements performed by the radiologist and those defined through specific software, since the correct analysis of aortic morphometry is fundamental for the success of EVAR, as well as for the reduction of morbidity and mortality postoperative period.

The present study aims to verify the agreement between the diameter measurement of specific aortic segments provided by CTA, performed by expert radiologists (ER) using manual assessment and by a radiologist in training (RT) assisted and unassisted by a specialized software: CLA.
Methods and materials

Population:

This is a prospective study conducted in a 3 months period (July to September 2018). The study population was composed of people of both genders, regardless of ethnicity or age, who underwent CTA of the thorax, abdomen and/or pelvis for evaluation of the aorta in our Imaging Service and who were aware of their participation, by signing of the written informed consent. Forty patients were recruited: 24 men with mean age of 73 (range 54-85 years); 16 women, mean age of 81.3 (range 63-82 years). Patients with dissection and those who underwent CTA for postoperative aortic control were excluded from the study. We also did not undergo examinations with aortic enhancement below 180 HU.

Data acquisition:

All exams were performed using a 160 detectors CT scanner (MDCT Aquilion prime, Toshiba Medical System). Images were obtained with 120 kV tube voltage and a current modulation between 50 and 550 mA. Other parameters were: 80x0.5 mm collimation; 0.5 sec gantry rotation time; a pitch of 0.813. A high concentration contrast medium (Iobitridol 350 mg I/ml, XENETIX 350, Guerbet) was given; mean volume was 100 ml (range 80-140 ml); an injection rate of 3.0- 4.0 ml/s was used for all patients. Contrast injection was always followed by a 30-40 ml saline chaser at the same rate of 3.0-4.0 ml/s, using an automated power injector (optiVantage DH, Mallinckrodt) Stellant, Medrad, Bayer Healthcare, Germany). Both the automatic and manual timing of the arterial phase acquisition were used. Only exams with aortic enhancement equal to or greater than 180 HU were considered.

Data analysis:

The measurements were performed at the following sites (figure 1), according to the examination performed:

1. Chest CTA:
   
   P1) plane of the sinus of Valsalva;

   P2) ascending tubular segment;

   P3) immediately after the left subclavian artery.

2. CTA of abdomen and pelvis:
P4) proximal in the celiac trunk level;

P5) infrarenal immediately after the emergence of the lower renal artery.

In the presence of aneurysmal dilations, measurements of the:

P6) diameter of aortic neck;

P7) maximum diameter of an aneurysm;

In cases where aneurysmal dilatation reached some of the previously defined sites, these locations were disregarded and measurements were performed on aneurysm (P6 and P7).

All these measurements were performed by two ERs, using manual assessment (in the axial plane and through MPR) and by an RT through the three methods of analysis: Ax, MPR and CLA (figures 2, 3 and 4).

Four comparative groups were then established (figure 5):

(1) comparison of ERs measures with each other;

(2) comparison of RT measures with each other;

(3) comparison between ERs and RT measures in manual - Ax and MPR;

(4) comparison between manual measures of all researchers (ERs and RT) and those of RT through CLA.

**Statistical analysis:**

After the acquisition of the measurements, the data were manipulated by a third researcher, blinded to the groups and to the data collection procedures, which followed up with the statistical analysis through the GraphPad Prism 6 ® statistical software. After evaluation of the distribution pattern of the sampled data, unpaired comparisons were performed for multiple groups through an analysis of variance (ANOVA), followed by intergroup comparison with post-hoc tests for data with parametric or non-parametric distribution.
Fig. 1: Positions of aortic segments where the measurements were made.

© Instituto das Pequenas Missionárias de Maria Imaculada, Hospital Madre Teresa - Belo Horizonte/BR
Fig. 2: Diameter measurement of an infrarenal abdominal aneurysm by RT using the axial technique, that allows only the measurement of diameter in the transverse plane.

© Instituto das Pequenas Missionárias de Maria Imaculada, Hospital Madre Teresa - Belo Horizonte/BR
Fig. 3: Double oblique multiplanar reformation (MPR) of an aneurysm in the same patient seen in figure 2. The orientation of image planes is changed to generate MPR perpendicular to vessel course.

© Instituto das Pequenas Missionárias de Maria Imaculada, Hospital Madre Teresa - Belo Horizonte/BR
Fig. 4: Overview over the computed centerline in a 3D volume rendering of the aorta of the same patient of Figures 1 and 2 (A) with a central lumen line which makes it possible to find the appropriate plane perpendicular to the central line, represented by the blue line in (B). (C) A maximum diameter of an aneurysm automatically generated by CLA, after marking the perpendicular line to the central line (blue line in B).

© Instituto das Pequenas Missionárias de Maria Imaculada, Hospital Madre Teresa - Belo Horizonte/BR
**Fig. 5:** Comparison of the three measurement techniques of the aorta under study.

© Instituto das Pequenas Missionárias de Maria Imaculada, Hospital Madre Teresa - Belo Horizonte/BR
Results

There was no statistical difference between measurements of ER and RT in any of the previously mentioned sites when MPR technique was used. On the other hand, the most significant difference (p < 0.0001) was seen at P5 (RT_Ax vs. RT_CLA; RT_MPR vs. ER_Ax; RT_CLA vs. ER_MPR), mainly when RT used CLA and ER used MPR (figure 6). There was also a contrast (p= 0.0065) between RT measurements among each other at P4 (RT_AX vs. RT_MPR; RT_Ax vs. RT_CLA) and at P3 (p= 0.0092) when the MPR technique is compared with CLA (RT_MPR vs. RT_CLA), figures 7 and 8, respectively. There was no significant difference between the measurements executed by ER using Ax or MPR technique.
Fig. 6: Measurements at the level of the lowest renal artery (P5). The most significant difference was seen between RT-CLA and ER-MPR (p < 0.0001). The asterisk (*) represents a significant statistical difference (p < 0.05).

© Instituto das Pequenas Missionárias de Maria Imaculada, Hospital Madre Teresa - Belo Horizonte/BR
Fig. 7: Difference between RT measurements at the level of celiac trunk- P4 (p < 0.0065). The asterisk (*) represents a significant statistical difference (p < 0.05).

© Instituto das Pequenas Missionárias de Maria Imaculada, Hospital Madre Teresa - Belo Horizonte/BR
**Fig. 8:** Difference between RT measurements at the level immediately after the left subclavian artery - P3 (p= 0.0092). The asterisk (*) represents a significant statistical difference (p < 0.05)

© Instituto das Pequenas Missionárias de Maria Imaculada, Hospital Madre Teresa - Belo Horizonte/BR
Conclusion

Discrepancies between CLA and MPR in P5 may be caused due to the non-evaluation of the anatomic variations by the software automatic calculation. The exact location of the renal artery may be impaired by extrarenal arteries, which are a common anatomic variant, present in about 30% of the population. Variations are classified into (1) accessory or hilar arteries and (2) aberrant or polar artery. Hilar arteries enter kidneys from the hilus with the main renal artery, whereas polar arteries enter kidneys directly from the capsule outside the hilus.

The thoracic aorta physiological bending of the aortic arch added to the inexperience of RT may justify the difference between RT measurements among each other at P3. Significant kinking, elongation, asymmetric dilatation of the abdominal aorta and, again, the less experience of RT may cause the same drawbacks at RT measurements at P4.

The MPR technique allows even the RT to obtain reliable measurements of the aortic segments and is thus reproducible.
Personal information

Ana Paula A. F. Martins¹
Marcela S. Santos¹
Saulo T.C.D. Melo¹
Bianca L. Pereira¹
Pedro A. L. Tito¹
Júlio G. Domingues¹
Túlio C.D.S. Bernardino¹
Guilherme H.N Oliveira¹
Pedro H. Lazzaroni¹

Diagnostic Imaging Center, Madre Teresa Hospital, Belo Horizonte, MG, Brazil.

Corresponding author:
Ana Paula Martins
paulinhaalk@yahoo.com.br
References


