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Abdominal aorta aneurysm: Case report of high radiation dose during stent-graft implantation

Natalia Majewska¹, Robert Juszkat¹, Magdalena Błaszak², Maciej Frankiewicz¹, Marcin Makalowski¹, Michał Stanisic³, Krzysztof Wachal³, Wacław Majewski³

¹ Department of Radiology, K. Marcinkowski, Poznań University of Medical Sciences, Poznań, Poland

² Faculty of Physics, Department of Biomedical Physics, University of Warsaw, Warsaw, Poland

³ Department of General and Vascular Surgery, Poznań University of Medical Sciences, Poznań, Poland

Author's address: Natalia Majewska, Poznan University of Medical Sciences, Długa 1/2, 61-648 Poznań, Poland,
e-mail: divines@tlen.pl

Summary

This study is a case report regarding a possible problem of high radiation dose during stent-graft implantation. Before deciding on how to treat an aneurysm (stent grafting or traditional surgery), possible complications such as difficult anatomical conditions and diseases of the aorta and iliac arteries should be considered to avoid potentially high doses of radiation. In case of this patient, it was very difficult to introduce a guidewire through the contralateral limb into the body of the graft due to tortuosity and kinking of iliac arteries. Because of the long duration of the procedure (68 min), the patient was exposed to a very high radiation dose (4.37 Gy) and DAP (1760.3 Gy cm²).

Key words: abdominal stentgraft • high dose • X-ray • radiation

PDF file: <http://www.polradiol.com/fulltxt.php?ICID=882147>

Background

In recent years, endovascular stent grafting of aortic aneurysms has received considerable attention because it appears to be a promising method of treating aneurysms in iliac arteries [1–7]. The introduction of a stent-graft into the abdominal artery has two main advantages. The first advantage is lower invasiveness connected with the combination of an intravascular stent and prosthetic graft technologies, leading to a lower risk of complications [8]. Secondly, it leads to shorter hospital recuperation and faster convalescence than traditional surgical operations for preexisting severe neurological, cardiovascular, pulmonary or renal dysfunction [9]. However, appropriate placement of the stent-graft requires precision and may prolong the operation time, as well as lead to patient's exposure to a high dose of X-ray radiation. Single radiation doses of over 1 Gy cause radiation sickness. Acute effects include nausea, vomiting, and diarrhea, sometimes accompanied by malaise, fever, and hemorrhage. The dose at which a half of the exposed population would die in thirty days without medical treatment is called the LD50. In case of X-ray radiation, this is 5 Gy for adults.

It is well known that there is a possibility of high patient radiation doses during interventional radiological procedures [10,11]. In interventional radiology, the dose area product (DAP) and air kerma (AK) are the main factors related to the potential risk of radiation [6,7,10]. DAP is defined as the absorbed dose-to-air averaged over the area of the X-ray beam in a plane perpendicular to the beam axis, multiplied by the area of the beam in the same plane. Air kerma is the same as the absorbed dose delivered to the volume of air in the absence of scatter (Gy). Absorbed dose can be defined by the ratio E/m , where E is the energy absorbed by the medium due to a beam of ionizing radiation being directed at a small mass, m . With X-ray examinations, the absorbed dose is the same as the equivalent dose (Gy).

Case Report

A 76-year-old male with an abdominal aortic aneurysm was presented. Physical examination demonstrated a pulsating tumor and pain in the abdomen. There was no history of aneurysms. The patient presented a history of myocardial infarction and cerebral stroke. Abdominal ultrasound showed a large (12 cm) abdominal aortic aneurysm

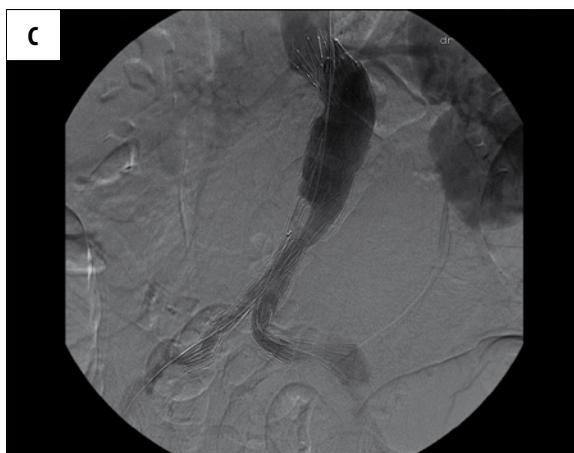
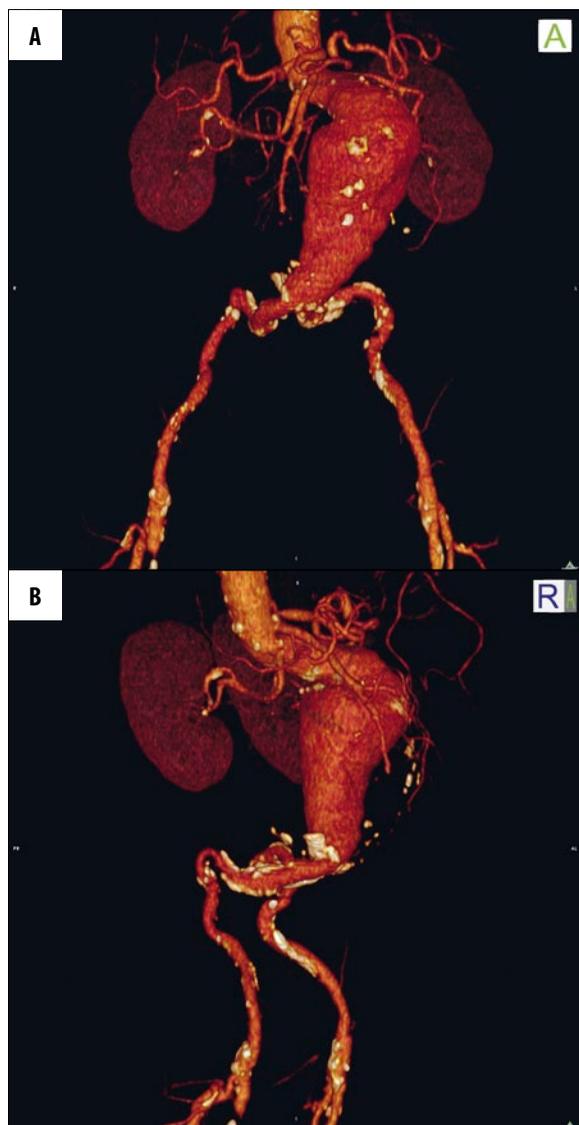


Figure 1. (A,B) Angio-CT 3D images before stent-graft implantation (various angles of visualization in the Osirix program); (C) DSA image after stent-graft implantation.

with a thick concentric zone of thrombus. The patient's abdomen was scanned by CT. The dose-length product (DLP) was 2010 mGy cm, and 100 ml of non-ionic contrast agent was administered. The CT scan confirmed the presence of aortic aneurysm with a maximum transverse diameter of 12.4 cm. The neck of the aneurysm measured 2 cm and did not include the renal artery. The patient had an extremely tortuous iliac artery (Figure 1A–C), with a diameter of 1.5 cm (right) and 1.7 cm (left).

Due to a previous myocardial infarction and cerebral stroke, a traditional operation was abandoned in favor of stent-graft treatment. The patient signed the informed consent form. The procedure was performed under general anaesthesia. Both common femoral arteries were exposed by surgical dissection. A calibrated 5F pigtail catheter was introduced into the aorta above the renal arteries through the left common femoral artery over a hydrophilic guidewire 0.035 (Roadrunner: Cook Ireland Ltd., Europe Shared Service Center, O'Halloran Rd., National Technology Park, Limerick, Ireland). Then, the body of the stent-graft (Cook company Inc. USA Terumo Corp., Tokyo, Japan) was

introduced over a stiff Lunderquist 0.35 (Extra Stiff Wire Guide Cook Medical Inc., USA) guide through the right femoral artery, into the abdominal aorta, and positioned below the renal arteries. For 45 minutes unsuccessful attempts were made to pass the guidewire into the left leg of the graft. Afterwards, the right brachial artery was selectively catheterized and the guide was passed through the prosthesis into the left iliac and common femoral artery where it was pulled out of the vessel. The iliac part of the stent-graft was introduced into the aorta through an Amplatz 0.35 guide. Then, the right stent-graft arm was extended up to the iliac artery. Directly after stent grafting, digital subtraction angiography (DSA) was performed to examine the location and tightness of the prosthesis (Figure 1C). In the presented case of abdominal aortic stent-graft implantation, the patient received a very high total dose of radiation because of the long duration of the procedure. The total radiation dose received by this patient was 4.37 Gy and DAP was 1760.3 Gy cm². The cumulative fluoroscopy time was 68 minutes and the total number of exposure runs was fourteen (1540 ms).

Discussion

In interventional cardiology an entity called "DAP trigger level" of 300 Gy cm² has been proposed by Neofotistou et al. [12]. This trigger level indicates the DAP level at which there is a risk for a possible deterministic injury. In aortic stent grafting, this trigger level would probably be lower since, compared with interventional cardiology, the exposure is concentrated on a smaller area of the skin, which means that it would be easier to get a skin injury from a certain DAP level [6].

As previously mentioned, in this case the patient received a high dose of radiation (AK=4.37 Gy and DAP=1760.3 Gy cm²). The main problem was that the patient had a tortuous iliac artery. It was very difficult and took a lot of time to deliver the stent-graft safely through this convoluted vessel. Moreover, much time was spent avoiding renal artery covering and consequential renal dysfunction and introducing the wire guide through the open and contralateral limb into the body of the abdominal graft.

In addition, after a few attempts to introduce the stent-graft leg through the femoral artery, a decision was made to do it through the brachial artery, due to the high pressure of blood in the aorta and the tortuous course of the aorta. When a stent-graft is to be deployed in a tortuous vessel, the operator should have contingency plans for this complication. A rigid stent-graft may straighten a tortuous arterial segment, drawing up redundant artery distal to the device [13,14]. Recognition of this phenomenon (a tortuous vessel) is important when making anatomical measurements before endovascular device placement and when assessing iliac run-off.

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Conclusions

The time required for stent-graft implantation is influenced by the anatomy of the aorta and iliac arteries. Diseases such as atherosclerosis, artery stenosis or tortuous vessels lead to higher doses of ionic radiation, causing a problem with the positioning and deployment of the prosthesis. Before making a decision on how to treat an aneurysm (stent grafting or traditional surgery), possible complications should be considered to avoid high doses of X-ray radiation.

The patient, who must take a conscious decision of the surgery, should be informed about possible complications that can lead to the exposure to a high dose of radiation.