Fusion imaging significantly reduces contrast doses and radiation during endovascular aortic repair

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Introduction

Endovascular procedures like endovascular aortic repair (EVAR) require considerable amounts of ionizing radiation and contrast media. Fusion imaging (FI) has been developed to reduce both, radiation and contrast exposure. FI has been introduced in 2010 [1]. FI allows for three-dimensional (3D) intra-operative visualization of the vascular anatomy by projecting 3D images derived from the preoperative computed tomography (CT) angiography (CTA) scan onto the two-dimensional (2D) intraoperative fluoroscopic image (2D-3D fusion imaging) [2]. Recent studies have indicated the potential of FI to reduce contrast media and radiation exposure as well as procedure time for fenestrated or bifurcated abdominal endovascular aortic repair (EVAR) [3-6]. However, only few studies have analyzed the impact of FI on iliac procedures [7].

We designed this study to evaluate the feasibility, safety and efficacy of 2D-3D fusion imaging for visualization of the distal landing zone (DLZ) and guidance of limb deployment during endovascular aortic repair (EVAR). Furthermore we compared FI to an “optimal” EVAR planning.

Materials and Methods

Two groups were compared in this study. In the first group [OPT, n=23 limbs] optimal c-arm positions for visualization of the DLZ had been calculated using a computed tomography post-processing software (Syngo.via™, CT Vascular, Siemens Healthcare, Germany). This position was applied for digital subtraction angiography (DSA) in order to visualize the DLZ for limb deployment during EVAR. In the second group [FUSION, n=13 limbs] we attempted to solely deploy the limbs by use of FI with 2D registration (VesselNavigator®, Philips Healthcare, Netherlands). The rate of limbs deployed by use of FI only was calculated for the FUSION group. Patency of the ipsilateral hypogastric artery was evaluated for both groups. The mean contrast dose (ml) and radiation (mGy/cm²) per iliac bifurcation were compared between both groups. Statistical significance (p-)level was set to 0.05.

Results

In the FUSION group limb deployment was feasible in 10/13 cases (76.9%). Failures caused by mismatch of FI and stiff guidewires occurred in 3 cases, and DSA was used in these patients. All hypogastric arteries in both groups were patent at the end of EVAR. Mean contrast dose per iliac bifurcation (2.3ml, p=0.002) and radiation exposure (6523mGy²/cm², p=0.001) were significant lower in the FUSION group compared to the standard approach (OPT, 13.0ml, 11951mGy²/cm²).

Discussion

Fusion imaging offers interventionists the possibility to utilize a 3D vascular model derived from CTA and MRA datasets as a 3D overlay during live fluoroscopy. In order to rely fully on fusion imaging practical experience and precise knowledge of the limitations and accuracy of this technology are of critical importance. The fusion software uses an intensity based (mostly bone structures), information registration algorithm to automatically align the preoperative CT with the intraoperative cone-beam CT scans (3D registration) or with fluoroscopic images acquired in two planes (2D registration). Both methods have shown to be accurate to a certain degree but still need fine adjustment after matching which seems to be most accurate after adjustment with a DSA run [9]. One possible explanation for a discrepancy between the relative position of the bones and the aorta and branches between intraoperative and preoperative imaging might be related to respiration-related vessel displacement, the patient’s position (preoperative CT scan is usually done with the arms above the patient’s head, and the cone-beam CT is done with the arms alongside the body) or attributed to the different distortion of the arterial system caused by the stiff endovascular devices [9,10] which is most often seen at the iliac level in lateral direction. For this reason angiography should be performed if there is any doubt regarding accuracy of fusion images and the vascular anatomy prior to the final deployment of any device [11].

Recent studies have shown that fusion imaging is associated with less radiation exposure by a median of 20-60%, with a reduction of the amount of contrast media of up to 70% and with shorter fluoroscopy and procedural times by 18-67% [3,4,5,6,8,12]. Our data suggest that FI allows for significant reduction of contrast media and radiation exposure compared to optimal preparation of an EVAR procedure (e.g. by predicting the optimal c-arm positions by use of a pre-interventional CTA post-processing software).

In conclusion, fusion imaging can be applied safe and efficient in the majority of EVAR procedures and helps to reduce contrast doses as well as radiation exposure. It should be used whenever possible.

References:


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