Section: **Ultraschall und Intervention**

ID: 137

Abstract-Title:
3-D SONOGRAPHIC VISUALIZATION AND MEASUREMENT OF THE FEMORAL ARTERY – FIRST RESULTS 3D SONOGRAPHISCHE DARSTELLUNG UND VERMESSUNG DER FEMORALARTERIE – ERSTE ERGEBNISSE

Authors:
H.M. Overhoff[1], D. Sandkühler[1], K. Bürgelin[2], T. Zeller[2]
[1] University of Applied Sciences Gelsenkirchen, Medical Engineering Laboratory
[2] Herz-Zentrum Bad Krozingen, Dept. of Angiology

Abstract-Text:
Purpose:
Usually catheterizations, e.g. for balloon angioplasty or stent implantation, are performed under angiographic and fluoroscopic X-ray view using iodinated contrast agents. The use of contrast agents has potential risks like contrast induced nephropathy, hyperthyreosis and allergic reaction. Two-dimensional (2-D) color Doppler sonography has already been proven to visualize the vessel system sufficiently during an intervention, and it avoids X-ray exposure as well as contrast agent donation. But an on-line acquisition of ultrasound images demands for additional staff and is limited by the insufficient visualization of the catheter tip, especially missing ultrasound visible markers to identify the length of balloon catheters and stent devices. In this pilot study, we investigated the acquisition of three-dimensional ultrasound (3-D US) image volumes of the femoral artery and the visualization and measurement of its geometry.
Method:
Three-dimensional ultrasound image volumes of the femur of 4 healthy volunteers were acquired. For this a high end conventional ultrasound imaging system (iU 22, Philips Medical Systems, Bothell, USA) with a linear 4-8 MHz probe was used together with an electro-magnetic localizer system (AURORA™, Northern Digital Inc., Waterloo, Ontario, Canada). This sensor system consists of a coil group emitting inhomogeneous magnetic fields, which are measured by sensor-solenoids. Two six degrees-of-freedom sensors were attached to the transducer. The sensor positions were recorded along with the 2-D images during image vs. sensor calibration and during manually performed freehand sweeps. The sweeps of the same anatomical structures are re-recorded five times to control for the influence of small patient movements and possible investigator induced tissue deformations during acquisition. An image series consisted of about 300–400 2-D images. Additionally MRT image volumes of the femurs were acquired.
After their recording the 2-D images are segmented semi-automatically. The segmentation process exploits the colored flow information (fig. 1) and a heuristics on anatomic plausibility of the vessel's continuity (figs. 2 and 3), and its results can be corrected manually in an interactive graphical user interface (GUI) on a PC screen. The images are visualized as original, segmented 2-D planes, and segmented 3-D volumes in the GUI. Furthermore a fusion of segmented 3-D ultrasound images and MRT image volumes is generated manually to compare for conformity. The result of the fusion can be regarded as 3-D image overlay in the GUI.

Results:
Image acquisition of all sweeps took less then 10 minutes for each patient. By positioning the patient in a stable supine position the course of the femoral artery, their bifurcation and the superficial femoral artery could be recorded. The visualization of all US image sweeps of one patient showed slightly deformed and translated vessel shapes with a maximum deviation of 5 mm. The minimal diameter of automatically detected vessels was 3 mm. A high conformity between segmented 3-D US and MRT image volumes was provided evident.
Conclusion:
The representability of the femoral artery in 3-D ultrasound volumes has been proven quite successful. Already the actually realized image acquisition without any fixation of hip and lower limb yields vessel courses with an estimated geometric reproducibility of 4 mm. Further improvement can be expected by an image-based image fusion of ultrasound images. As image segmentation is a tedious and fault-prone procedure, the ongoing work is directed to a more robust image segmentation procedure.
Figure 1: Delineation line (white) of the color encoded blood flow in a vessel
Figure 2: Delineation of the vessel wall. Segmentation based on color encoded blood flow.
Figure 3: Delineation of the vessel wall. Segmentation based detected vessels in temporally preceding or following US images.

Bild 1/JPG

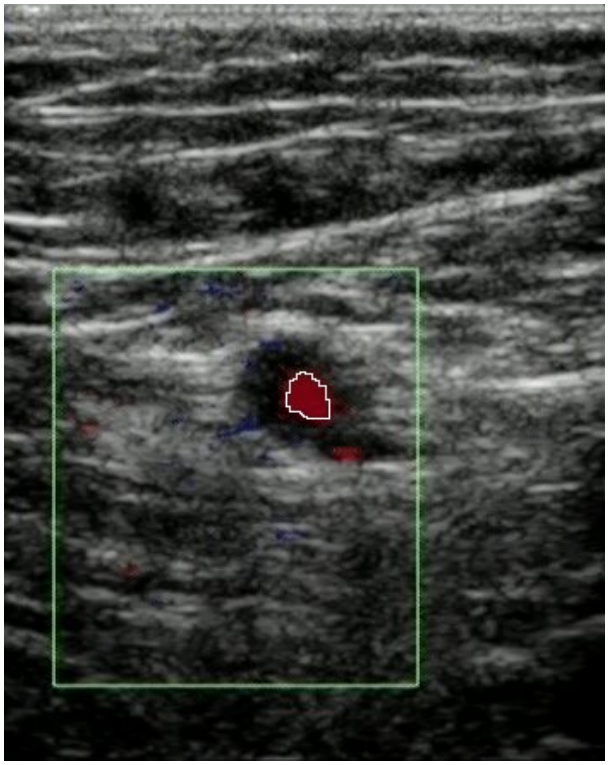

Bild 2/JPG

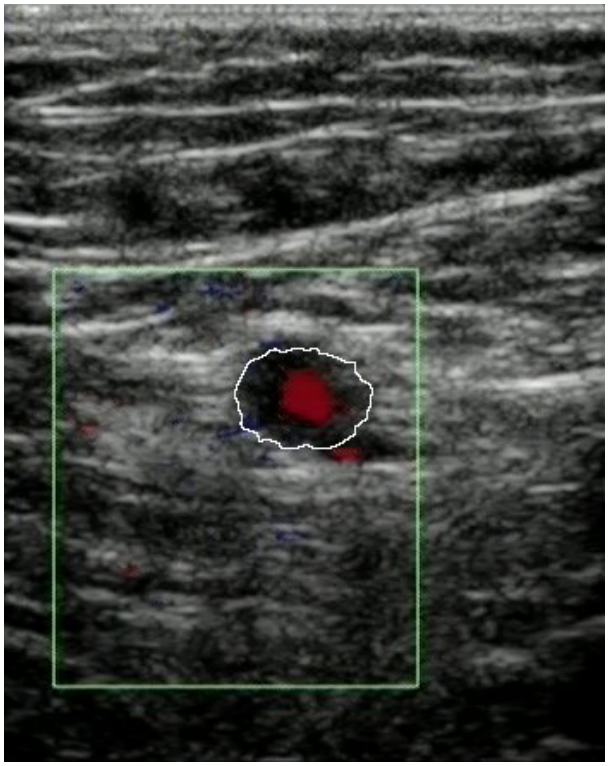

Bild 3/JPG