Feasibility of Segmentation of Pelvic Bone structures for Fusion of low field-MRI and preoperative MR Angiography

Endovascular surgery is often guided by fluoroscopic techniques, which has the disadvantage of radiation exposure of the patient and surgical staff. Intraoperative MRI (iMRI) may be a potential alternative that is radiation-free. A great challenge that must be overcome is matching the high spatial resolution of fluoroscopy during real-time imaging. Intra-operative (i) low-field MRI (iLF-MRI) has the advantage of lower magnetic field strength and is smaller, but lacks high spatial resolution in combination with real-time imaging. Fusing iLF-MRI with preoperative MRA may provide the surgeon with a roadmap that can overcome this last problem. In this study, first steps were made for fusion of 0.25T-MRI with a 3T-MRA of a healthy volunteer.

From the 0.25T-MRI dataset, the pelvic bones were semi-automatically by k-means clustering and region growing. The 3T-MRA segmentation had to be performed manually, since the dataset contained aliasing artefacts, and lacked sufficient spatial resolution of the bone cortex. After segmentation, registration points were manually allocated on rigid and distinctive pelvic bone structures. Registration was performed with Procrustes analysis. Segmentation of the 0.25T-MRI dataset showed relevant anatomical landmarks of the pelvic bones. However, the bigger the segmented volume, the more segmentation errors, like leakage. The 3T-MRA segmentation showed less errors, but less anatomical landmarks. Both segmented sets had enough landmarks for manual allocation of registration points. The root mean square error was +/- 0.6 mm (figure 1). This study demonstrated the feasibility of fusion of iLF-MRI with MRA and shows potential for the use of LF-MRI in endovascular surgery.
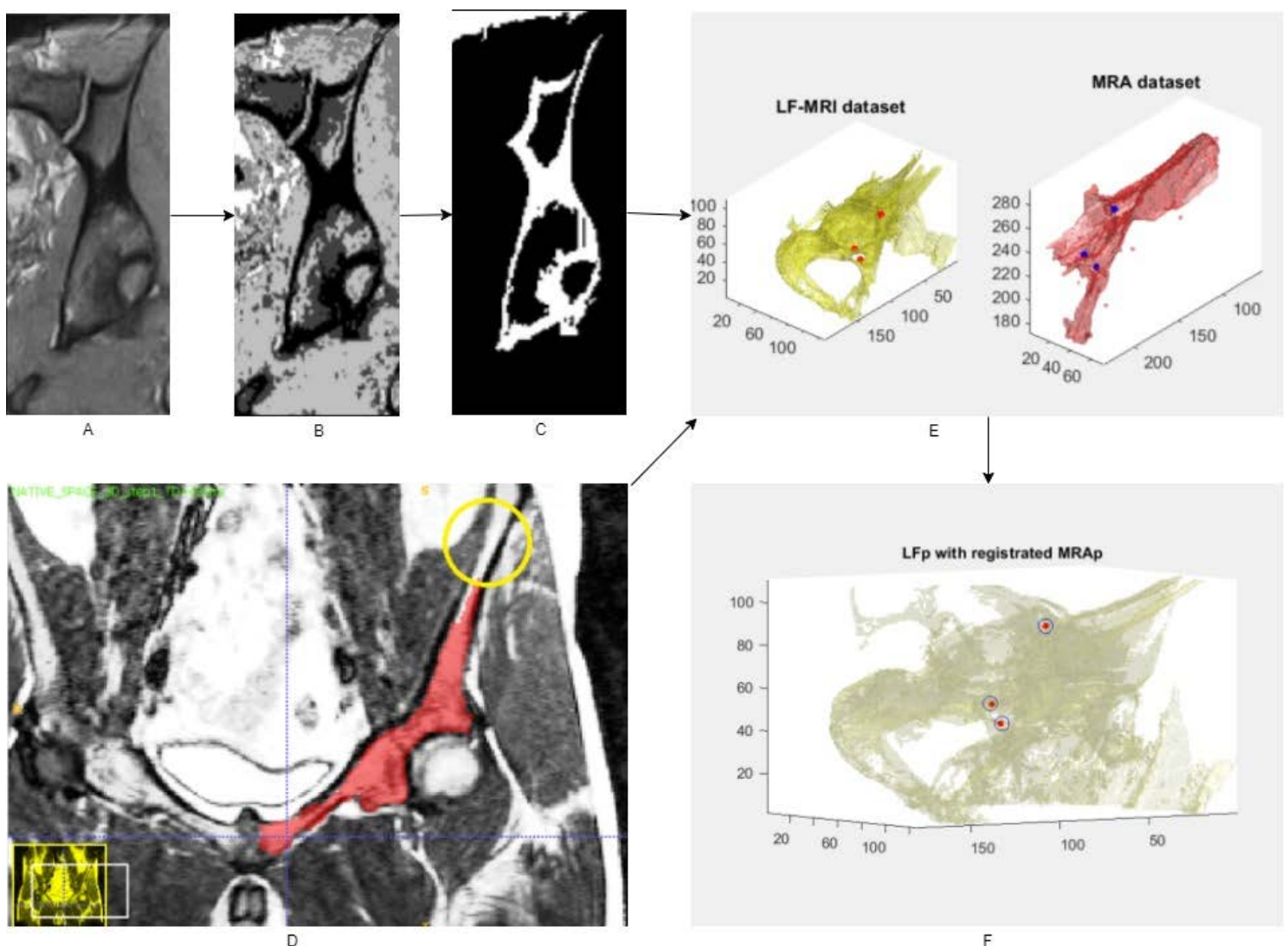

Figure 1: A) original 0.25T-MRI image. **B)** Image clustered by k-means. **C)** Regiongrowing performed on clusters. **D)** Manual segmentation of 3T-MRA. The yellow circle shows poor spatial resolution of the bone cortex. **E)** Manual allocation of registration points on segmented volumes of the pelvic bone (left side). **F)** Segmented volume of the LF-MRI dataset, made transparent. Red dots: allocated registration points of 0.25T-MRI (LFp). Blue circles: registrated points of the 3T-MRA dataset (MRAp). MRAp have almost the same position as LFp, with a RMSE of 0.6 mm.