Feasibility and Accuracy of Semi-Automated Analysis of 3D CE-MR Angiograms for Detection and Quantification of Stenoses in Aortoiliac Arteries

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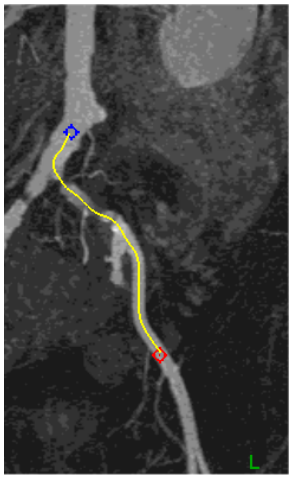
Introduction

Contrast-enhanced MR angiography (CE-MRA) is increasingly used as alternative for intra-arterial digital subtraction angiography (IA-DSA) for the diagnosis of peripheral arterial disease (PAD), because it is non-invasive and because CE-MRA offers 3D information. In daily practice it remains difficult to fully exploit the 3D information of CE-MRA datasets. This has led to the evaluation of CE-MRA datasets in a fashion similar to DSA (on 2D projectional images) where most of the present 3D information is not used. Recent developments have made it possible to semi-automatically quantify luminal diameter and luminal cross sectional area (CSA) of stenoses in 3D CE-MRA datasets (1), but this type of analysis remains to be validated in patients.

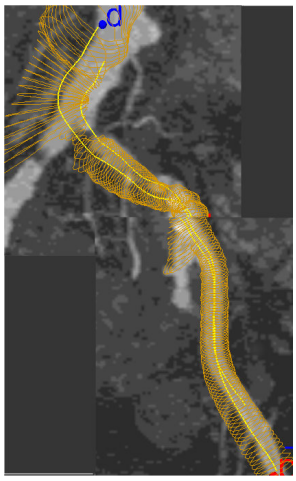


Purpose

To determine the feasibility and accuracy of semi-automated quantitative detection of stenoses in 3D CE-MR arteriograms of patients with suspected aortoiliac occlusive disease, in comparison to the commonly used analysis method of measuring degree of stensosis.

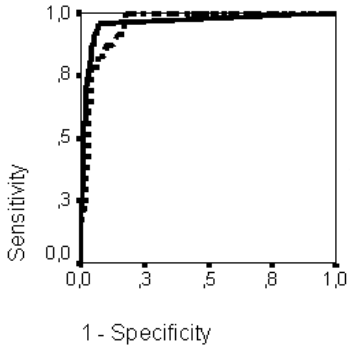
Methods

Twenty-five patients with PAD underwent aortoiliac CE-MRA followed by IA-DSA and intra-arterial pressure measurements (IAPM) in case there was a stenosis. One observer blinded for the results of IA-DSA and IAPM independently evaluated CE-MRA datasets for presence and grade of stenoses in the aortoiliac arteries using semi-automated analysis software. Observer interaction consisted of simply placing points in the proximal and distal parts of a vessel segment of interest (**figure, top**). After point placement the software automatically calculated luminal diameter and the luminal cross-sectional area (CSA) at one millimeter intervals using a fast marching level set method (**figure, bottom**) (2). Subsequently, the maximum degree of stenosis was automatically calculated in the following 7 arterial segments: aorta, and both left and right common and external iliac, and common femoral artery. Degree of stenosis was automatically calculated by dividing the smallest CSA by the CSA of the lumen in a non-diseased part of the vessel segment. Semi-automated computer analyses were compared to manually measured maximum linear degree of stenosis on rotational maximum intensity projections and original slices of the CE-MRA datasets as measured by a single observer blinded for all other measurements. A stenosis was considered to be hemodynamically significant if either the linear diameter or the CSA reduction exceeded 50% on CE-MRA or IA-DSA, or if the pressure gradient across the stenosis at IAPM exceeded 10 mmHg. Results of automated and manual measurements were compared with IA-DSA and IAPM.



Results

Computerized measurements were successful in 171 of the 175 arterial segments. In 4 arterial segments computerized measurements were impossible because there was no signal on CE-MRA due to occlusion (n=3) or in-stent signal loss (n=1). The **table** shows the results with regards to the detection of stenoses in terms of sensitivity, specificity and positive predictive value. Receiver operating characteristic (ROC) analysis (**graph**) showed no significant difference in diagnostic accuracy between the semi-automated and manual analysis of MRA (p =0.8). The solid line denotes the manual analysis ROC, the dotted line the semi-automated analysis ROC.



	Semi-automated analysis	Manual analysis	DSA
Sensitivity versus DSA	92%	87%	not applicable
Specificity versus DSA	83%	94%	not applicable
Positive predictive value versus IAPM	93%	92%	94%

Discussion and Conclusions

Semi-automated quantitative analysis of aortoiliac 3D CE-MR arteriograms for the detection and quantification of stenoses and the differentiation from normal vessel segments proved to be feasible and slightly more accurate compared to conventional reading of the CE-MRA dataset when IA-DSA was used as the standard of reference. The use of semi-automated determination of arterial caliber as shown in the present study may allow determination of size and length of vascular stents and endoprostheses prior to intervention in the future.

References

1. Schaap et al. International Congress Series 2001;1230:974-980.

2. Sethian et al. PNAS 1996;93:1591-1595.