Vessel Visualization using Curvicircular Feature Aggregation Evaluation

Name:
Date:

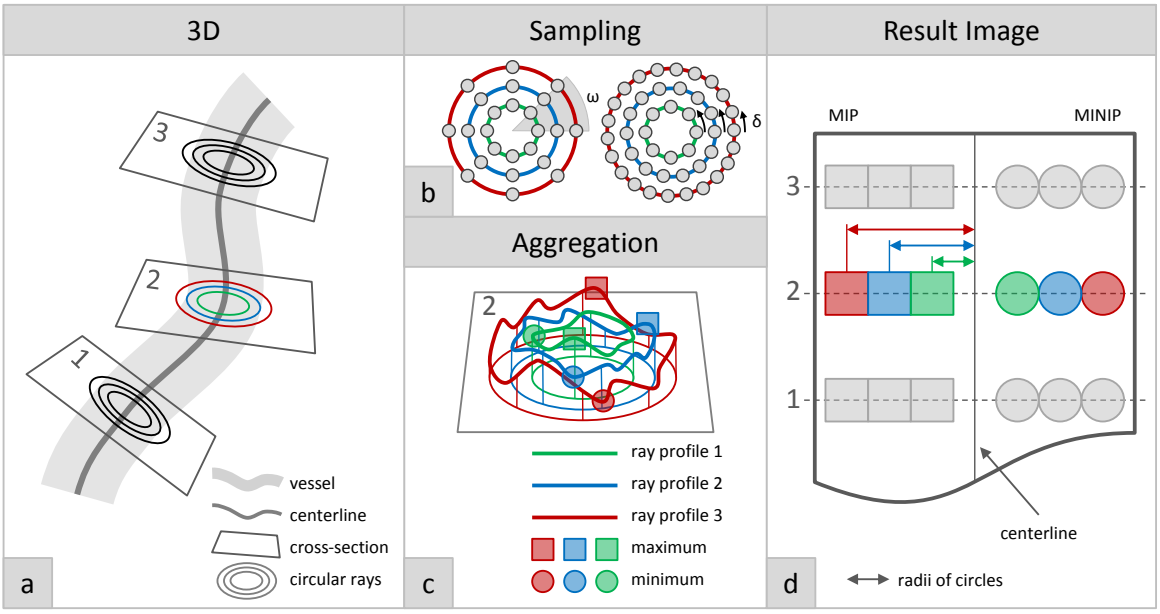
The aim of this questionnaire is the evaluation of a visualization technique, called Curvicircular Feature Aggregation (CFA). This approach is an extension of the commonly used method Maximum Intensity Projection (MIP). The difference lies in the way how the data is sampled along a given centerline of a vessel. It can be seen as a MIP *around* a vessel. MIP determines the maximum of the data along a viewing ray and shows this in the final image, whereas CFA samples the data along circular rays around the centerline of a vessel, as shown in the illustration on the bottom of this page. Different methods can be applied to these circular rays, such as determining the maximum or the minimum data value along them. The motivation behind this approach is the aggregation of features into a single image. It can be seen as combination of multiple Curved Planar Reformation (CPR) images of different viewing angles. This is suited for inspecting vessels, since they have a cylindrical shape. The circular rays start at a centerline point and go around the vessel.

In the following pages, we evaluate the advantages and disadvantages of this proposed technique, compared to CPR and MIP. In every subsequent question, you can only check one answer. The follow main questions will be investigated throughout this questionnaire.

Q1 Location of a pathology

Q2 Size of a pathology

Q3 Centeredness of the centerline of a vessel

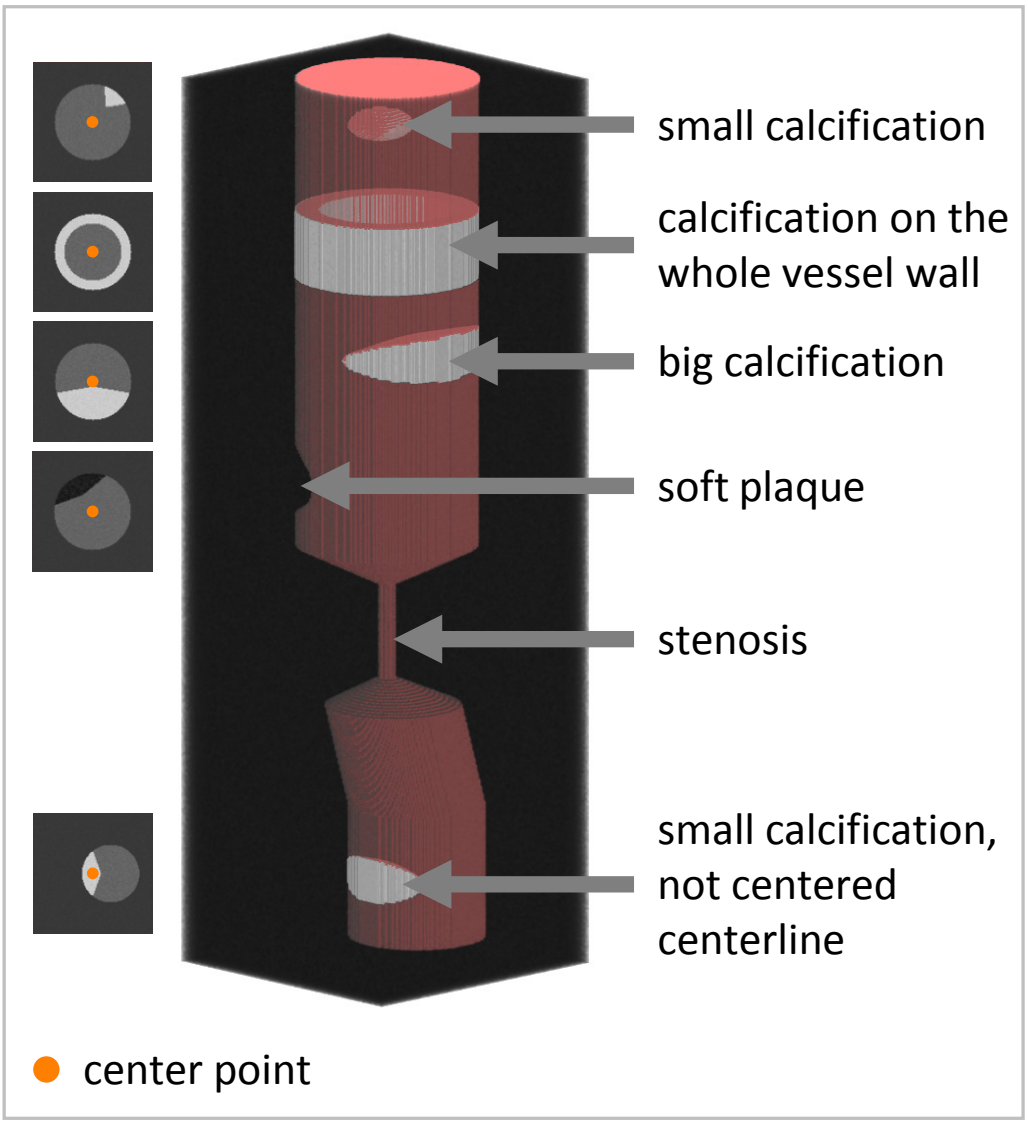


1 Phantom Data

A phantom data set showing a vessel with several pathologies should give an overview and demonstration of MIP, CPR and CFA. It covers the following important cases that need to be evaluated throughout this questionnaire:

1. Small calcification
2. A ring-like calcification around the whole vessel wall
3. Big calcification
4. Soft plaque
5. Stenosis
6. Non-centered centerline with small calcification

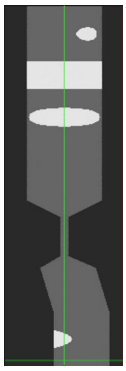
The following figure shows a 3D visualization of the phantom data set with axial slice images on the left, corresponding to the above mentioned cases, apart from the stenosis.



One the next page, a comparison of Maximum Intensity Projection (MIP), Curved Planar Reformation (CPR) and Curvicircular Feature Aggregation (CFA) will be presented based on the phantom data set. On the top-left, the MIP image is shown, where the centerline is highlighted in green. The top-right images show the axial slices of the important cases given above (except the stenosis). Several CPR images are presented in the middle, from $-90°$ to $90°$ with a step of $9°$ and 20 images in total. The bottom image demonstrates the CFA with showing the maximum data value (MIP) on its left side and the minimum data value (Minimum Intensity Projection (MINIP)) on its right side. These two sides are delineated by a thin black line. Please answer the questions on page five according to these images. If you have any comments or remarks, please fill them in below the questions.

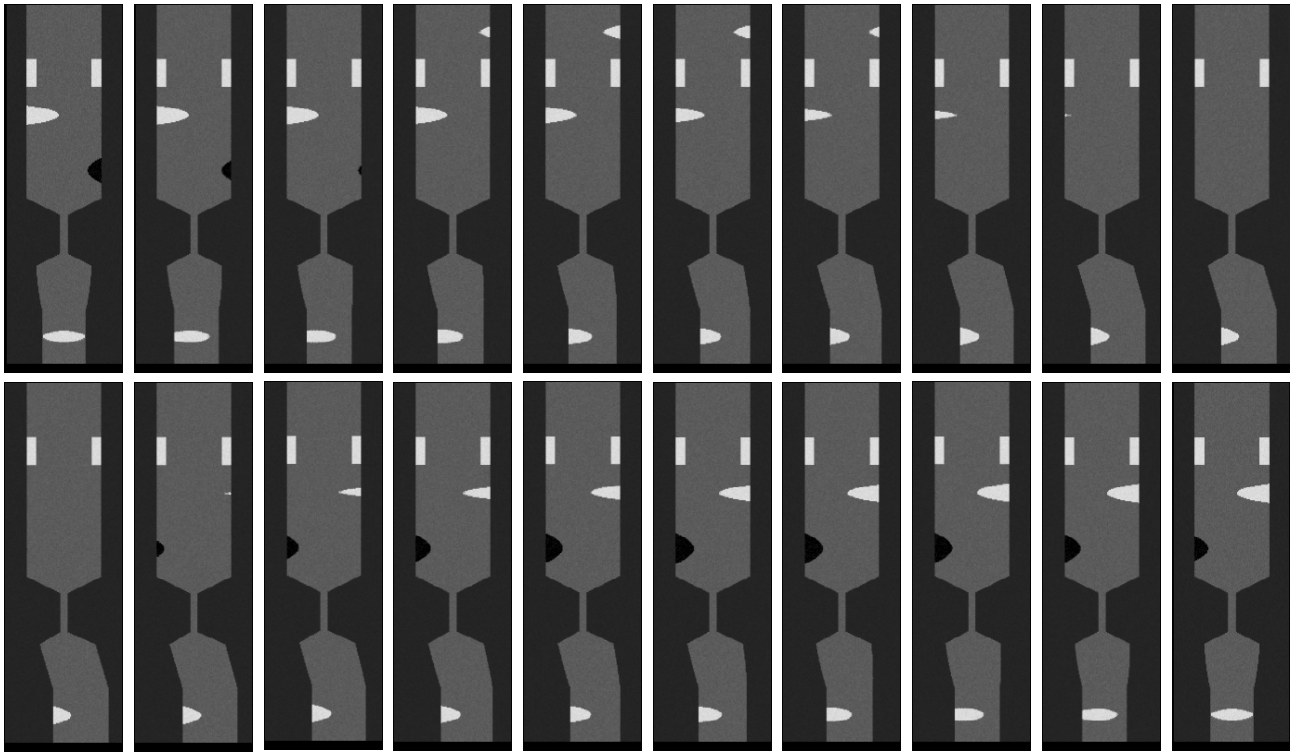
MIP

Slices



(1) (2) (3) (4) (6)

CPR



CFA

left: MIP **right:** MINIP

General

		MIP	CPR	CFA
1	Which method depicts the *small calcification* (1) best?	☐	☐	☐
2	Which method depicts the *ring-like calcification* (2) best?	☐	☐	☐
3	Which method depicts the *big calcification* (3) best?	☐	☐	☐
4	Which method depicts the *soft plaque* (4) best?	☐	☐	☐
5	Which method depicts the *stenosis* (5) best?	☐	☐	☐
6	Which method depicts the *non-centered small calcification* (6) best?	☐	☐	☐
7	Which method do you prefer solely for investigating pathologies?	☐	☐	☐
8	Which method do you prefer together with axial images for investigating pathologies?	☐	☐	☐
9	Which method is the least intuitive one?	☐	☐	☐
10	Which method is the most intuitive one?	☐	☐	☐

Size of pathology

		Yes		No
11	Is it helpful to know the size of a pathology?	☐		☐
12	Is it required to know the size of a pathology?	☐		☐
		MIP	CPR	CFA
13	Which method depicts the size of a pathology best?	☐	☐	☐
14	Which method do you prefer together with axial images to determine the size?	☐	☐	☐

Location of pathology

		Yes		No
15	Is it helpful to know the location of a pathology regarding the vessel diameter?	☐		☐
16	Is it required to know the location of a pathology regarding the vessel diameter?	☐		☐
		MIP	CPR	CFA
17	Which method depicts the location of a pathology best?	☐	☐	☐
18	Which method do you prefer together with axial images to determine the location?	☐	☐	☐

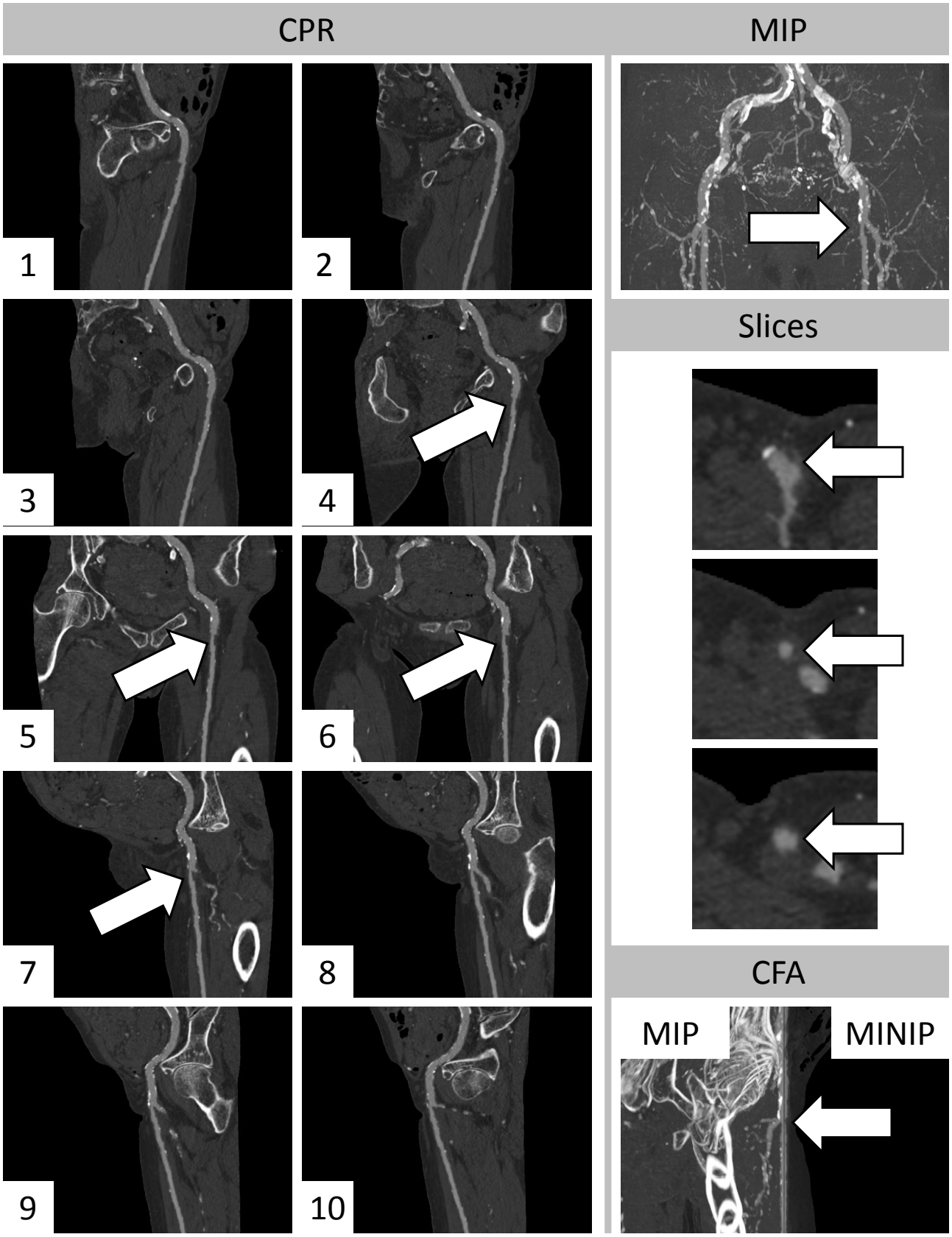
Centeredness of centerline

		Yes		No
19	Is it helpful to visually perceive if a centerline is not centered properly?	☐		☐
20	Is it required to visually perceive if a centerline is not centered properly?	☐		☐
		MIP	CPR	CFA
21	Which method depicts the non-centeredness of the centerline best?	☐	☐	☐
22	Which method do you prefer together with axial images to verify and correct this?	☐	☐	☐

Remarks:

2 Vessel Stenosis

The following images show a stenosis pointed out by white arrows. CPR images (from $-90°$ to $90°$, 10 images) are shown on the left side, top-right a MIP and bottom-right a CFA. The CFA shows the maximum (MIP) on its left side and the minimum (MINIP) on the right. The axial slice images show on top the start of the stenosis, in the middle the center of the stenosis and on the bottom the end. The vessel of interest is pointed out with the arrows. Please answer the questions on page seven according to these images. If you have any comments or remarks, please fill them in below the questions.



General

		MIP	CPR	CFA
23	Which method depicts the stenosis best?	☐	☐	☐
24	Which method do you prefer solely for investigating the stenosis?	☐	☐	☐
25	Which method do you prefer together with axial images for investigating the stenosis?	☐	☐	☐
26	Which method is the least intuitive one?	☐	☐	☐
27	Which method is the most intuitive one?	☐	☐	☐

Size of the stenosis

		Yes		No
28	Is it helpful to know the size of the stenosis?	☐		☐
29	Is it required to know the size of the stenosis?	☐		☐
		MIP	CPR	CFA
30	Which method depicts the size of the stenosis best?	☐	☐	☐
31	Which method do you prefer together with axial images to determine the size?	☐	☐	☐

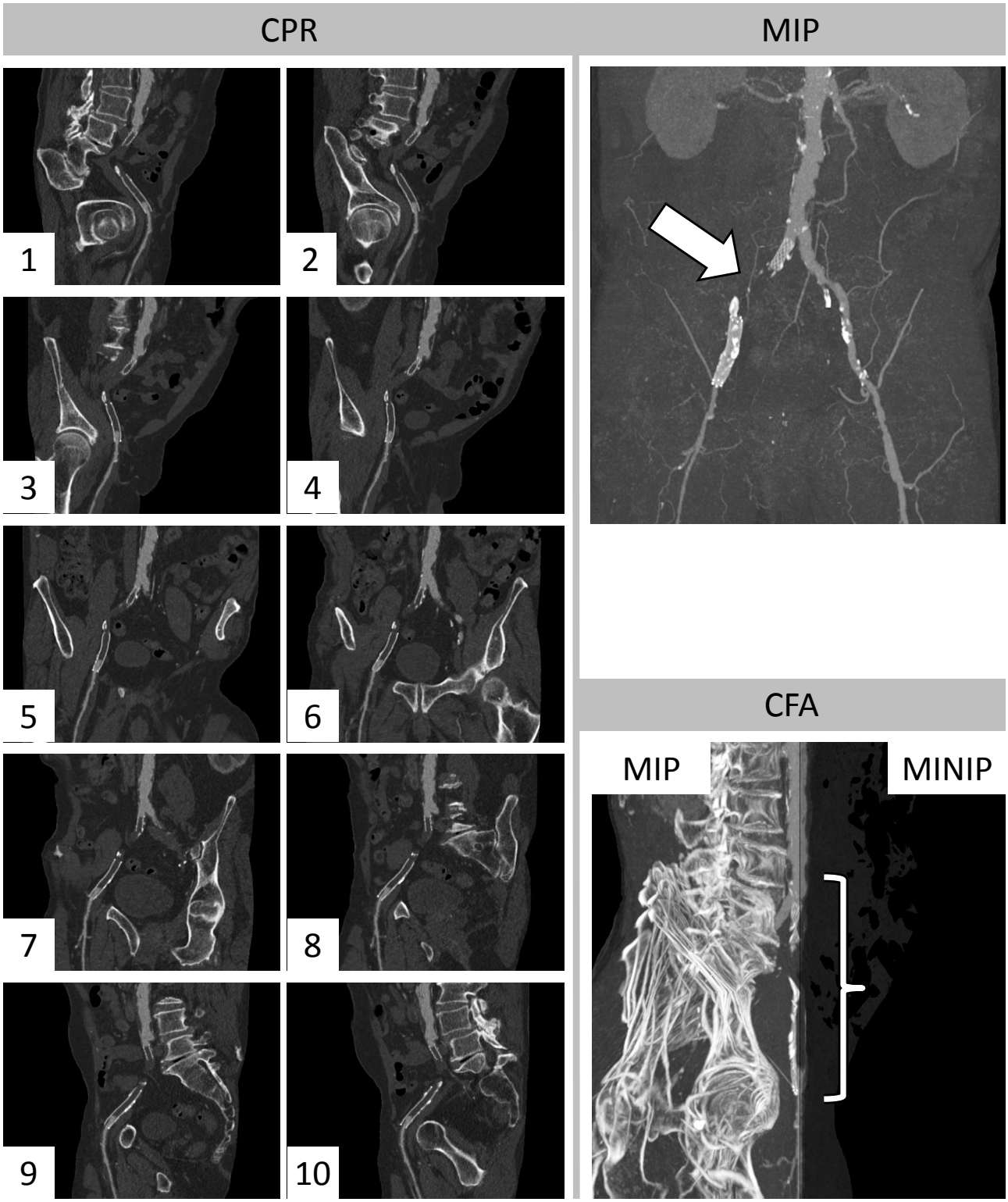
Location of the stenosis

		Yes		No
32	Is it helpful to know the location of the stenosis regarding the vessel diameter?	☐		☐
33	Is it required to know the location of the stenosis regarding the vessel diameter?	☐		☐
		MIP	CPR	CFA
34	Which method depicts the location of the stenosis best?	☐	☐	☐
35	Which method do you prefer together with axial images to determine the location?	☐	☐	☐

Remarks:

3 Vessel Occlusion

The following images show an occlusion pointed out with an arrow and bracket. CPR images (from $-90°$ to $90°$, 10 images) are shown on the left side, top-right a MIP and bottom-right a CFA. The CFA shows the maximum (MIP) on its left side and the minimum (MINIP) on the right. The occlusion starts immediately after the aorta branch. Please answer the questions on page nine according to these images. If you have any comments or remarks, please fill them in below the questions.



General

		MIP	CPR	CFA
36	Which method depicts the occlusion best?	☐	☐	☐
37	Which method do you prefer solely for investigating the occlusion?	☐	☐	☐
38	Which method do you prefer together with axial images for investigating the occlusion?	☐	☐	☐
39	Which method is the least intuitive one?	☐	☐	☐
40	Which method is the most intuitive one?	☐	☐	☐

Length of the occlusion

		Yes		No
41	Is it helpful to know the length of the occlusion?	☐		☐
42	Is it required to know the length of the occlusion?	☐		☐
		MIP	CPR	CFA
43	Which method depicts the length of the occlusion best?	☐	☐	☐
44	Which method do you prefer together with axial images to determine the length?	☐	☐	☐

Location of the occlusion

		Yes		No
45	Is it helpful to know the location of the occlusion regarding the vessel diameter?	☐		☐
46	Is it required to know the location of the occlusion regarding the vessel diameter?	☐		☐
		MIP	CPR	CFA
47	Which method depicts the location of the occlusion best?	☐	☐	☐
48	Which method do you prefer together with axial images to determine the location?	☐	☐	☐

Remarks: