



Operator Manual – *syngo*.MR Vascular VB70A



Legend

÷	Indicates a hint
	Provides information on how to avoid operating errors or information emphasizing important details
	Indicates the solution to a problem
	Provides troubleshooting information or answers to frequently asked questions
	Indicates a list item
✓	Indicates a prerequisite
	A condition that has to be fulfilled before starting a particular operation
•	Indicates a single-step operation
1 2 3	Indicates steps within operating sequences
Italic	Used for references and for table or figure titles
→	Used to identify a link to related information as well as previous or next steps
Bold	Used to identify window titles, menu items, function names, buttons, and keys, for example, the Save button
	Used for on-screen output of the system including code-related elements or com- mands
Orange	Used to emphasize particularly important sections of the text
Courier	Identifies inputs you need to provide
Menu > Menu Item	Used for the navigation to a certain submenu entry
<variable></variable>	Identifies variables or parameters, for example, within a string
	CAUTION
	Used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury or material damage.

CAUTION consists of the following elements:

- Information about the nature of a hazardous situation
- Consequences of not avoiding a hazardous situation
- Methods of avoiding a hazardous situation



WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

WARNING consists of the following elements:

- Information about the nature of a hazardous situation
- Consequences of not avoiding a hazardous situation
- Methods of avoiding a hazardous situation

1	MR V	ascular		5
	1.1	This do	ocumentation	5
	1.2	Intende	ed users / Authorized operating personnel	5
2	MR V	ascular v	workflow	6
	2.1	Loading	g the images	6
	2.2	Tracing	y vessels	6
		2.2.1	Tracing vessels semiautomatically	7
		2.2.2	Tracing vessels manually	7
		2.2.3	Editing centerlines	8
		2.2.4	Deleting parts of centerlines	13
		2.2.5	Extending a centerline	14
		2.2.6	Deleting centerlines	15
	2.3	Reading	g vascular lesions	15
		2.3.1	Displaying centerlines	15
		2.3.2	Navigating in CPRs	16
		2.3.3	Rotating along centerlines	16
		2.3.4	Displaying an inverted view	16
		2.3.5	Angulating MPR views instantly	17
		2.3.6	Displaying a straightened CPR	17
	2.4	Quanti	fication	17
		2.4.1	Locating lesions in profile curves	18
		2.4.2	Measuring stenoses	18
		2.4.3	Measuring vessel length	21
		2.4.4	Editing vessel length findings	22
		2.4.5	Measuring vessel diameter	23
		2.4.6	Editing vessel diameter findings	24
		2.4.7	Modifying lumen contours	25
		2.4.8	Adjusting CPR measurement properties	26
		2.4.9	Measuring grayscale values	26
	2.5	Docum	enting results	27
		2.5.1	Saving measurements as findings	27
		2.5.2	Editing details of findings	27
		2.5.3	Creating radial CPR ranges	29
		2.5.4	Creating parallel CPR ranges	29
		2.5.5	Creating multiple snapshots	30
		2.5.6	Creating multiple CPR snapshots	30
3	CPR n	neasure	ment properties window	31
	Index	c		32

1 MR Vascular

The MR Vascular workflow is used to read vascular images and to perform a basic vessel examination. By default this workflow is part of the MR Angiography workflow.

In order to operate the software accurately and safely, you must follow the intended use and you need to have the necessary expertise as well as knowledge of the complete operator manual.

Please read the operator manual carefully before using the software.

1.1 This documentation

This documentation includes information on frequently used functions of steps and/or workflows. Please note that your software includes several documentation modules. Therefore also observe the information provided in other Operator Manuals or the Online Help.



All documentation modules may include safety information that must be adhered to. Residual risks are indicated in the hazard hints for the respective application.

The graphics, figures, and medical images used in this documentation are examples only. Their actual display and design may be different on your system. In particular, the screenshots may show the color design of an older user interface.

This description addresses the authorized user. Basic knowledge about operating PCs and software is a prerequisite.

1.2 Intended users / Authorized operating personnel

The software must be operated according to the intended use and only by qualified persons with the necessary knowledge in accordance with country-specific regulations, for example, physicians, trained radiological technicians or technologists, having received the necessary user training.

For more information on user training see <http://www.siemens-healthineers.com>, choose your country, and select the category "Education&Training".



For the USA only: Federal law restricts this device to sale, distribution and use by or on the order of a physician.

2 MR Vascular workflow

With **MR Vascular** you can perform a basic vessel examination. If the corresponding license has been procured, the **MR Vascular** workflow is part of the MR angio workflow:

MR Angiography workflow

You can quantify the identified stenoses, create a report by assigning qualitative attributes, and document your findings by automatically saving snapshots of the most important images.

- Loading the images (→ Page 6 Loading the images)
- Navigate through the volume data and optimize the views according to your needs. (→ Page 15 *Reading vascular lesions*)
- Examine the vessels, identify and mark lesions and review and correct automatically created centerlines. MR Vascular supports you in tracing vessels semi-automatically or manually. (→ Page 6 *Tracing vessels*)
- Quantify the identified stenoses and document your findings.
 (→ Page 17 Quantification)
- Documenting results (→ Page 27 Documenting results)

Prior to starting the reading process, you can use some tools to change the displayed images, for example:

- (→ syngo.MR General: Series Selector)
- (→ syngo.via Basic Application: Alternative Configuration)

2.1 Loading the images

As **MR Vascular** is part of the MR Angiography workflow you load the images to MR Vascular from this workflow.

- ✓ MR Angiography workflow is open and the images are displayed.
- 1 In the MR Angiography Reading step, select and right-click in a segment.
- 2 Choose Open in MR Vascular from the context menu.

The images are loaded to MR Vascular.



You can configure your system so that images are automatically loaded to **MR Vascular**. For more information, see: (→ *syngo.via Basic Application: Alternative Configuration*)

2.2 Tracing vessels

MR Vascular provides tools that allow you to trace vessels manually or semiautomatically. You can also create and edit centerlines.

- (→ Page 7 Tracing vessels semiautomatically)
- (→ Page 7 Tracing vessels manually)

- (→ Page 8 Editing centerlines)
- (→ Page 13 Deleting parts of centerlines)
- (→ Page 14 Extending a centerline)
- (→ Page 15 Deleting centerlines)

The list of available centerlines is displayed in the segment. If the list does not fit into the segment, you can scroll through the centerlines by using the up or down arrows at the top and bottom of the list.

2.2.1 Tracing vessels semiautomatically

For CPR visualization, you can create multi-point vessel tracing with semiautomatic centerlines that can be created with a single mouse click or multiple mouse clicks.



Vessel tracing is possible on any image. It is recommended to perform a vessel tracing on the MPR images rather than on the MIP images in difficult cases, such as high-grade stenosis or suboptimal image quality.



1 In the Case Navigator, click the **Multiple Clicks** icon.

Press Alt + 2.

– or –

2 Click the target vessel to set the starting point.

A rubber band is displayed between the mouse pointer and the starting point.

- 3 Click the target vessel to set the next point. Proceed until all points are set.
- 4 If necessary, navigate through the vessel.
- **5** Double-click to set the end point. You can set the end point on a different image segment.

The software automatically creates a centerline between the starting point and the end point.



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If necessary, correct your actions by clicking Undo or Redo.

At any time, you can change the display of centerlines by choosing **Centerline** on the upper left corner menu.

2.2.2 Tracing vessels manually

You can manually trace vessels by defining a centerline through the vessel. You can trace vessels on any image. In difficult cases, for example, high-grade stenosis, or in cases of suboptimal image quality, performing vessel tracing on the MPR images (rather than on the MIP image) is recommended.

2.2.2.1 Creating a centerline based on clicked points

In any image segment, you can create a new centerline manually using consecutive clicked points along the vessel.



1 In the Case Navigator, click the Manual icon.

– or –

Press Alt + 3.

- 2 Start a new centerline by clicking the vessel of interest.
- 3 Click consecutive points along the vessel to create the centerline.

The centerline created is displayed in magenta.

- 4 Make sure to follow each turn of the centerline.
- **5** Double-click to finish the centerline.

The manually created centerline is displayed in yellow. If the centerline is not displayed, activate the **Show Centerline** function. (+ Page 15 *Displaying centerlines*)

2.2.2.2 Creating a centerline based on a drawn line

In any image segment, you can create a new centerline by dragging the mouse pointer along the vessel.



1 In the Case Navigator, click the **Manual** icon.

– or –

Press Alt + 3.

- 2 Drag the mouse pointer along the vessel to create a freehand centerline.
- 3 If necessary, click the Undo icon to undo your last step.
- **4** Double-click to finish the centerline.

The manually created centerline is displayed in yellow. If the centerline is not displayed, activate the **Show Centerline** function. (→ Page 15 *Displaying centerlines*)

2.2.3 Editing centerlines

If a centerline does not follow the required course, you can change the centerline manually or semi-automatically.



Twin CPR layouts are useful to verify the correctness of centerlines. The synchronized CPR views show the vessel at a 90° angle. Therefore, you can easily verify whether the centerline is in the middle of the lumen.

If no measurement tools are activated in the CPR mini toolbar, you can modify centerlines with the **Control Point Edit** or **Freehand Edit** function.

To limit the effect of modifications of the centerline, the control points are automatically set at relevant positions along the centerline. Each control point divides a part of the centerline into two sections. Modifications done in one of the sections do not effect the other part. Furthermore, you can use control points to change the course of the centerline. If you move a control point, the course of the centerline will move to the new position of the control point. In this case, the sections on both sides of the control point are affected.

You can correct centerlines using the following methods:

- · Modifying centerlines by freehand editing
- Modifying centerlines by control point editing
- Modifying centerlines in cross-sectional segments



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When you edit a centerline in any segment, centerlines in other segments are synchronized simultaneously.

You can toggle between **Control Point Edit** and **Freehand Edit** using **Alt** + **E** and **Alt** + **V** shortcut keys or choose it from the context menu.

2.2.3.1 Modifying centerlines by freehand editing

You can modify a centerline by drawing a freehand line, a multi-click line, or a combination of both. The new centerline can start at any point along the existing centerline. The part of the existing centerline that will be deleted is highlighted during your editing.



To modify a centerline, always start editing on an existing centerline.

If you end the editing at a position on the previous centerline, the segment between start and end point is replaced.

If you end the editing at a position of the previous centerline, the dotted part of the previous centerline is removed.

✓ No measurement tool is activated in a CPR segment.



1 In the Case Navigator, click the **Edit Centerline** icon and select **Freehand Edit** from the list.

```
– or –
```

Press the Alt + V keys.

```
– or –
```

Right-click the centerline and choose Freehand Edit from the context menu.

The centerline is displayed in magenta.

2 Move the mouse pointer over the centerline.

The mouse pointer changes into a pen.

3 To start editing, click anywhere on the centerline to be modified.

4 Click and drag the mouse pointer along the vessel to draw a line.

– or –

Follow the course of the vessel by adding points with consecutive mouse clicks.

5 Double-click to finish the centerline.

If necessary, correct your modifications by clicking Undo or Redo.

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If the **Ctrl** key is pressed, you cannot shift or rotate the image slices when the editing tool is active.



By default, the tracing support is enabled while you extend the centerline.

The tracing support is not available while editing an existing centerline. However, you can temporarily activate or deactivate the tracing support by pressing the **Ctrl** key before finalizing the modifications.

- · If you extend the centerline, double-click to finalize the modifications.
- If you modify an existing part of a centerline, click to finalize the modifications.

The mouse pointer indicates if algorithm-based tracing support will be provided when finalizing the editing:

- If the mouse pointer is displayed as a calculator and an arrow, algorithm-based tracing support is provided.
- If the mouse pointer is not displayed as a calculator and an arrow, no algorithmbased tracing support is provided when finalizing the modifications.

2.2.3.2 Modifying centerlines by control point editing

If a centerline exceeds the course of the vessel, for example, due to an artifact, you can correct the centerline manually.



- No measurement tool is activated in a CPR segment.
- 1 In the Case Navigator, click the **Edit Centerline** icon and select **Control Point Edit** from the list.

```
– or –
```

Press the Alt + E keys.

```
– or –
```

Right-click the centerline and choose Control Point Edit from the context menu.

The centerline is displayed in magenta with control points.

2 In the CPR segment, place the mouse pointer on the control point and drag the control point to the required position.

The centerline is recalculated to a course that passes through the new position of the control point. If the new position of this control point corresponds to an existing control point, the control points are merged.

To verify the course of the newly created/updated centerline, rotate the CPR views and scroll through the volume in the MPR images.

If the **Ctrl** key is pressed, you cannot shift or rotate the image slices when the editing tool is active.

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By default, the tracing support is enabled while extending he centerline.

The tracing support is not available when you edit an existing centerline. However, you can temporarily activate or deactivate the tracing support by pressing the Ctrl key before finalizing the modifications.

- · If you extend the centerline, double-click to finalize the modifications.
- If you modify an existing part of a centerline, click to finalize the modifications.

The mouse pointer indicates if algorithm-based tracing support will be provided when finalizing the editing:

- · If the mouse pointer is displayed as a calculator and an arrow, algorithm-based tracing support is provided.
- · If the mouse pointer is not displayed as a calculator and an arrow, no algorithmbased tracing support is provided when finalizing the modifications.

2.2.3.3 Changing centerlines in cross-sectional segments

If the centerline does not run through the middle of the lumen, you can change its position in the cross-sectional segments.

✓ No measurement tool is activated in a CPR segment.



In the Case Navigator, click the Edit Centerline icon and select Control Point Edit 1 from the list.

– or –

In the Case Navigator, click the Edit Centerline icon and select Freehand Edit from the list.

In the cross-sectional segment, the centerline is marked by a magenta marker.

2 In the cross-sectional segment, drag the marker to the middle of the lumen.

The centerline is recalculated to a course that passes through the new position of the marker.

2.2.3.4 Adding control points to a centerline

Add control points if you need to modify sections of centerline without changing other parts of the same centerline. You can add several control points to each centerline.

✓ A centerline is available.

- ✓ No measurement tool is activated in a CPR segment.
- 1 Select the centerline that you want to edit.



2 In the Case Navigator, click the Edit Centerline icon and select Control Point Edit from the list.

```
– or –
```

Press the Alt + E keys.

```
– or –
```

Right-click the centerline and choose **Control Point Edit** from the context menu.

The centerline is displayed in magenta with control points.

3 Click the centerline at a position where you would like to add a control point.

– or –

Right-click the centerline at a position where you would like to add a control point and choose **Add Controlpoint** from the context menu.

The control point is added on the centerline.

2.2.3.5 Deleting control points from a centerline

If the number of added control points makes modifications of the centerline too complicated, you can delete unnecessary control points.

- ✓ A centerline with control points is available.
- ✓ No measurement tool is activated in a CPR segment.
- 1 Select the centerline that you want to edit.



2 In the Case Navigator, click the Edit Centerline icon and select Control Point Edit from the list.

– or –

Press the Alt + E keys.

– or –

Right-click the centerline and choose Control Point Edit from the context menu.

3 Drag a nearby control point over the control point you want to delete.

– or –

Right-click a control point and choose Remove Controlpoint from the context menu.

The control point is removed from the centerline.

2.2.3.6 Modifying centerlines by control point editing

If a centerline exceeds the course of the vessel, for example, due to an artifact, you can correct the centerline manually.

- ✓ Control points have been added to a centerline. (→ Page 11 Adding control points to a centerline)
- ✓ No measurement tool is activated in a CPR segment.

1 Select the centerline that you want to edit.



2 In the Case Navigator, click the Edit Centerline icon and select Control Point Edit.

```
– or –
```

Press the Alt + E keys.

```
– or –
```

Right-click the centerline and choose Control Point Edit from the context menu.

The centerline is displayed in magenta with control points.

3 In any segment, place the mouse pointer on the control point and drag the control point depending on your needs.

The centerline is recomputed to a course that goes through the new position of the control point. If the new position of a control point corresponds to another existing control point, the control points are merged.



By default, the tracing support is enabled while you extend the centerline.

The tracing support is not available while you edit an existing centerline. However, you can activate or deactivate the tracing support with the **Ctrl** key.

The mouse pointer is displayed as a calculator and an arrow when the tracing support is active.

2.2.4 Deleting parts of centerlines

You can delete parts of the centerline that are not of interest. Use this function, for example, if a centerline ends in a vein.

/ The Stenosis Measurement icon is deactivated.



In the Case Navigator, click the **Edit Centerline** icon and select **Control Point Edit**.



1

In the Case Navigator, click the Edit Centerline icon and select Freehand Edit.

2 On an existing centerline, right-click and choose **Discard Centerline above** from the context menu to delete the part of the centerline that is displayed above the clicked position in the corresponding CPR.

– or –

On an existing centerline, right-click and choose **Discard Centerline below** from the context menu to delete the part of the centerline that is displayed below the clicked position in the corresponding CPR.

– or –

On an existing centerline, press **Ctrl** and right-click where you want to start deleting part of the centerline.

The mouse pointer is displayed as a pair of scissors.

3 While holding the right mouse button, drag the mouse pointer up or down to indicate which side of the centerline you want to delete.

One section of the centerline is drawn as a dashed line.

4 Release the right mouse button to delete the dashed part of the vessel.

The centerline and the curved view are immediately updated.

5 If necessary, click the Undo icon to revoke the modification.

2.2.5 Extending a centerline

Depending on the editing mode, you can extend centerlines by lengthening the freehand line or by adding control points.

✓ Centerline editing mode is active.



1

In MRP, MIP, VRT, and CPR segments, click an end point of a centerline where the mouse pointer is displayed as a calculator and an arrow.

In freehand editing mode, you can navigate to the end points of the centerline if, for example, they are hidden by anatomical structures. Right-click the centerline and, from the context menu, choose **Extend Centerline Top** or **Extend Centerline Bottom**.

2 Click consecutive points along the vessel to define the extension of the centerline.



By default, the tracing support is enabled while extending the centerline.

The tracing support is not available when you edit an existing centerline. However, you can temporarily activate or deactivate the tracing support by pressing the **Ctrl** key. Double-click to finalize your modifications.

The mouse pointer is displayed as a calculator and an arrow when the tracing support is active.



Click the **Undo** icon to undo your last step.

3 To finish the centerline extension, double-click the end point of the modified centerline.

2.2.5.1 Extending the centerline in difficult cases

In difficult cases, for example, with long vessel occlusions, perform the following steps.

- 1 Create, for example, a two-click centerline that ends shortly before the occlusion.
- 2 Click the end point of the centerline before the occlusion.
- **3** Add one extension point just after the occlusion other points along the vessel that need to be traced.
- **4** To finish the centerline extension, double-click at the end point of the modified centerline.

The centerline is modified, taking the additional points into account.

2.2.6 Deleting centerlines

You can remove any centerline, for example, to remove incorrect or unnecessary centerlines.

- 1 Right-click the centerline, the label of the centerline, or the corresponding label in the list of centerlines.
- 2 From the context menu, choose Delete Centerline. Alternatively, press Alt + C.
- **3** If findings were created for the selected centerline, confirm that you also want to discard these findings.

The centerline and associated findings are deleted.

If a centerline was deleted unintentionally, click the **Undo** icon in the Common Tools area to restore the centerline and its findings.

2.3 Reading vascular lesions

MR Vascular provides the following functions for the reading of vascular lesions:

- (→ Page 15 Displaying centerlines)
- (→ Page 16 Navigating in CPRs)
- (→ Page 16 Rotating along centerlines)
- (→ Page 16 Displaying an inverted view)
- (→ Page 17 Angulating MPR views instantly)
- (→ Page 17 Displaying a straightened CPR)

CPR (curved planar reformation): **MR Vascular** provides dedicated layouts for the evaluation of vascular lesions. Apart from MPR, MIP, and VRT segments, an additional image segment type is provided: the "curved planar reformation" (CPR). CPRs visualize a curved planar reconstruction of a vessel along a defined centerline.

2.3.1 Displaying centerlines

By default, the centerline is not activated in any segment. You can switch on or off the centerline representation.

1 From the top left corner menu, choose Show Centerline.

– or –

Press Alt + X.

The currently activated centerline is shown.

2 From the top left corner menu of a VRT, Angio, or MIP segment, choose Show All Centerlines.

All centerlines are shown. The currently active centerline is shown in yellow. Other centerlines are shown in green.

2.3.2 Navigating in CPRs

You can navigate through a vessel that is displayed in the CPR and cross-sectional segments. Depending on the current mode, one or several markers are shown in the CPR. The position of the marker is aligned with the corresponding cross-sectional segments.

• In the CPR, drag a reference marker up or down.

– or –

In a cross-sectional segment that is framed by a colored border, use the scroll wheel to navigate up or down.

– or –

For fast navigation in cross-sectional segments, right-click and drag the mousepointer up or down to navigate along the centerline.

2.3.3 Rotating along centerlines

In CPR segments, you can rotate the view around vessels at the current reference lines position. The longitudinal orientation of the vessel is fixed, however the view of the centerline changes when you move the mouse.

The current reference lines act as the focus point, which is fixed in the segment, avoiding rotation of the vessel out of the segment.

2.3.3.1 Rotating with left mouse button



- 1 From the upper left corner menu of the CPR segment, choose **Rotate** along Centerline.
- 2 Click in the CPR segment and drag the mouse in horizontal direction to rotate along the centerline.
- **3** To deactivate the rotation tool, press **ESC** or choose **Rotate along Centerline** from the upper left corner menu.

2.3.3.2 Rotating with right mouse button

In CPR segments, the right mouse button is assigned to the rotation function.

 Right-click in the CPR segment and drag the mouse in horizontal direction to rotate along the vessel.

2.3.4 Displaying an inverted view

For a visualization similar to catheter lab images from angiographic-interventional procedures, a special view of the vessels (inverted MIP) is available.



• From the lower right corner menu, choose Invert.

2.3.5 Angulating MPR views instantly

To get an oblique MPR orientation through a vessel of interest, you can angulate MPR views instantly by defining a new image plane.



1 In the Case Navigator, click the **Manual Plane** icon. Alternatively, press the **Alt** + **P** keys.

2 Click the image and drag the mouse.

A colored rubber band is displayed between the mouse pointer and the starting point.

3 Move the mouse to define the angulation and position of the new image plane.

The line defines the orientation of the new image plane.

4 Release the mouse button.

An MPR view congruent to the manually defined plane is created in the best plane segment.

2.3.6 Displaying a straightened CPR

You can switch the display of the CPR segment from a curved centerline to a straight vertical view. This allows a better view of the vessel, if the vessel is curved.

The straightened view is available for MPR and for MIP Thin display types.



From the lower left corner menu of the CPR segment, choose MPR Straightened.
 – or –



From the lower left corner menu of the CPR segment, choose **MIP Thin Straightened**.

In the CPR segment, the centerline is displayed as a straight vertical line from the top to the bottom of the segment.



In the straightened view, you can use any function that is available in the CPR segment.



To deactivate the "straightened" view, select **MPR Curved** or **MIP Thin Curved** from the lower left corner menu in the CPR segment to restore the initial MPR view.

To display a curved view in CPR, see "CT Vascular: Displaying a curved view in CPR"

2.4 Quantification

To improve your diagnostic results, you may quantify the degree and curved lengths of stenoses.

- (→ Page 18 Locating lesions in profile curves)
- (→ Page 18 Measuring stenoses)
- (→ Page 21 Measuring vessel length)

- (→ Page 22 Editing vessel length findings)
- (→ Page 23 Measuring vessel diameter)
- (→ Page 24 Editing vessel diameter findings)
- (→ Page 25 Modifying lumen contours)
- (→ Page 26 Adjusting CPR measurement properties)
- (→ Page 26 Measuring grayscale values)

2.4.1 Locating lesions in profile curves

To enable a quick identification of an abnormality, you can display a profile curve of the complete vessel. A local minimum of the profile curve is an indicator for a possible stenosis.

✓ A centerline is displayed in a CPR segment.



 In the mini toolbar of the CPR segment, click the Display Profile Curve icon to activate the profile curve.

A profile curve is displayed at the right side of the CPR segment. The profile curve displays the cross-sectional area of the lumen along the whole centerline. The minimum value is at the right side of the curve, the maximum value is at its left side.

The profile curve always displays the whole centerline. Accordingly, it is not a 1:1 scale reference of the CPR image displayed. Therefore, when you zoom the CPR image, edges of the profile curve that do not match the current view will be grayed out.

2.4.2 Measuring stenoses

✓ A stenosis has been identified.



1 In the mini toolbar of the CPR segment, click the **Stenosis Measurement** icon. Alternatively, press the **Alt** + **S** keys.

The following interactive markers are displayed in the CPR segment:

- · Yellow stenosis marker
- · Green and red reference marker

By default, only one reference marker is displayed.

These markers are used for the calculation of all relevant values regarding the identified stenosis.

The stenosis values are computed and displayed:

- In the cross-sectional segments, the lumen contours for each marker are displayed. The measured lumen area (A) and minimum/maximum lumen diameters (D) are displayed as image text.
- In the lower left corner of the CPR segment, information on the stenosis grades are given. The percentage of the stenosis grade with respect to area **A** and percentage of the stenosis grade with respect to diameter **D** are displayed as image text.

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The stenosis grade is calculated as follows:

Stenosis Grade = (1- S/R) * 100

- S is the measurement value at the stenosis location
- **R** is the measurement value at the reference location

For the area based stenosis grade **A**, the cross-sectional areas are used as measurement values.

For the diameter based stenosis grade **D**, the effective diameters based on area are used as measurement values.

If one reference pointer is used, either the proximal reference value RP or the distal reference value RD are used as R.

If two reference pointers are used, the estimated reference value RE is computed as the weighted average between RP and RD. RE is then used as R.

For further reading: Ota H, Takase K, Rikimaru H, Tsuboi M, Yamada T, Sato A, Higano S, Ishibashi T, Takahashi S: Quantitative vascular measurements in arterial occlusive disease. Radiographics. 2005 Sep-Oct; 25(5):1141-58.



Illustration of measurements used to determine degree of vascular stenosis

- RP Reference luminal diameter or area proximal to the stenotic lesion
- S Luminal diameter or area at the stenotic lesion
- RE Estimated luminal reference diameter or area at the level of the lesion
- RD Reference luminal diameter or area distal to the stenotic lesion
- Distance measurements are shown in the lower left corner of the CPR segment.
 - Green text: The distance between the yellow marker and the green marker.
 - Red text: The distance between the yellow marker and the red marker.
 - White text: The distance between the red marker and the green marker.
- 2 In the CPR segment, drag a marker up or down or click on a position along the centerline.

– or –

In a cross-sectional segment framed by a colored border, use the scroll wheel or drag the mouse while keeping the right mouse button pressed. The marker moves to the new position.

3 Set the stenosis marker and the reference markers to the correct positions along the vessel.



If the contour shown in the cross-sectional segment is not optimal, click the **Edit Contour** icon to modify it. See (→ Page 25 *Modifying lumen contours*).

– or –



Adapt the measurement **Properties** for stenosis measurements. See (\rightarrow Page 31 *CPR* measurement properties window).

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5 To store the current measurement position as finding, click the **Create Finding** icon in the CPR mini toolbar.

– or –

Press the Alt + W keys.

The measurement results are displayed in different ways:

• In the Findings Assistant:

The finding is named with a consecutive number and Stenosis, for example, [1] Stenosis.

In addition, a combined multiple snapshot of each related CPR and cross-sectional segment is stored with the finding.

• In a segment:

The label of the finding consists of a consecutive number and an S.

2.4.2.1 Quantifying stenoses in profile curves

You can visualize stenoses measurements in the profile curve.

✓ A stenosis has been identified.



1 In the mini toolbar of the CPR segment, click the **Display Profile Curve** icon to activate the profile curve.

A profile curve is displayed at the right side of the CPR segment.

- 2 Set the yellow stenosis marker to the local minimum.
- 3 In the profile curve, click near the local minimum, that is, the peak to the right.

When you click the profile curve once, the system suggests the local minimum closest to the click point. The reference markers are adjusted to the best fit around the stenotic region.

- 4 Position the upper green and the lower red reference marker.
- 5 Hold the CTRL key pressed and click above/below the stenosis marker.

– or –

In the CPR image, drag the reference markers with the mouse.



6 To store the current measurement position as finding, click the **Create Finding** icon in the CPR mini toolbar.

– or –

Press the Alt + W keys.

The measurement results are displayed in different ways:

· In the Findings Assistant:

The finding is named with a consecutive number and Stenosis, for example, [1] Stenosis.

In addition, a combined multiple snapshot of each related CPR and cross-sectional segment is stored with the finding.

• In a segment:

The label of the finding consists of a consecutive number and an S.

2.4.3 Measuring vessel length

You can measure curved distances along the current centerline, for example, if you want to determine the distance from the ostium of the vessel to a stenotic lesion or the extension of such a lesion.

✓ A centerline is displayed in a CPR segment.



1 In the mini toolbar of the CPR segment, click the **Vessel Length Measurement** icon.

– or –

Press the Alt + G keys.

In the CPR segment, a green and a red marker appear and represent the upper and lower border of the measurement. These markers are visualized by squared discs in the MIP. The measured section is highlighted by a blue line in the MIP and the CPR segments. The measured length between both reference markers is displayed in the lower left corner of the CPR segment.

2 In the CPR segment, drag a measurement marker up or down or click on a position along the centerline.

– or –

In the MIP segment, drag the corresponding disc along the vessel or click on a position along the centerline.

– or –

In the cross-sectional segment framed by a green or a red border, use the scroll wheel or drag the mouse while keeping the right mouse button pressed.

The measurement marker moves to the new position.

3 To show or hide the blue line that marks the measured section, click the **Length** label in the lower left corner of the CPR segment.



If you want to store the current measurement as a finding, click the **Create Finding** icon in the CPR mini toolbar.

– or –

Press the Alt + W keys.

The vessel length tool remains active and allows you to create consecutive measurements.

The measurement results are displayed in different ways:

• In the Findings Assistant:

The finding is named with a consecutive number and Vessel Length, for example, [1] Vessel Length.

In addition, a combined multiple snapshot of each related CPR and cross-sectional segment is stored with the finding.

• In a segment:

The label of the finding consists of a consecutive number and an vL.

2.4.4 Editing vessel length findings

You can update a finding that was created with the **Vessel Length Measurement**. See (+ Page 23 *Measuring vessel diameter*)

- ✓ A finding starting with vL is listed in the Findings Assistant.
- 1 In the Findings Assistant, mark the finding that you want to edit.

– or –

In any segment, click the label of the finding that you want to edit.

All segments focus on the selected finding. The **Vessel Length Measurement** is activated. Red and green squared discs mark the new positions.

2 In the CPR segment, drag the measurement marker up or down or click on a position along the centerline.

– or –

In the MIP segment, drag the corresponding disc along the vessel or click on a position along the centerline.

– or –

In the cross-sectional segment framed by a yellow border, use the scroll wheel or drag the mouse while keeping the right mouse button pressed.

The measurement marker moves to the new position.



3 Click the Create Finding icon in the CPR mini toolbar.

– or –

Press the Alt + W keys.

The selected finding is updated according to the current position of the measurement. The finding values and the snapshot are replaced.



The **Vessel Length Measurement** tool remains active, but clicking the **Create Finding** icon again will create a new finding and no longer update the previously selected finding.

2.4.5 Measuring vessel diameter

You can measure a lumen diameter at any position along the centerline, for example, to determine the diameter of an aneurysm.

✓ A centerline is displayed in a CPR segment.



1 In the mini toolbar of the CPR segment, click the Vessel Diameter Measurement icon.

– or –

Press the Alt + D keys.

A yellow-blue marker appears in the CPR segment and the corresponding position is marked by a blue disk in the MIP. The measured diameter is displayed in the lower left corner of the CPR segment.

In the cross-sectional segments, the image text displays the following measured values:

- Lumen area (A)
- Minimum/maximum lumen diameters (D)

In the CPR segments, the image text displays the following measured values:

- The cross-sectional lumen area (Area)
- The perimeter of the contour (Perim)
- The effective diameter based on the area of the contour (D eff (Area))
- The effective diameter based on the perimeter of the contour (D eff (Perim)).
- i

By default, the lumen diameter is provided with its maximum and minimum values, marked by **D**. In cross-sectional segments, click the diameter value to switch to the effective diameter values, marked by **D eff**.

The effective diameter is based on the area of the contour and is calculated as follows:

- A: Area of the contour in mm²
- Pi: 3.14159265
- effD(A) = 2 * |sqrt(A / Pi)|

The effective diameter is based on the perimeter of the contour and is calculated as follows:

- Perim: Perimeter of the contour in mm
- Pi: 3.14159265
- effD(P) = Perim / Pi

You can move the measurement marker to a new position.

2 In the CPR segment, drag the measurement marker up or down or click a position along the centerline.

– or –

In the MIP segment, drag the corresponding disc along the vessel or click on a position along the centerline.

– or –

In the cross-sectional segment framed by a yellow border, use the scroll wheel or drag the mouse while keeping the right mouse button pressed.

The measurement marker moves to the new position.



If the contour shown in the cross-sectional segment is not as expected, click the **Edit Contour** icon to modify the contour. See (+ Page 25 *Modifying lumen contours*)

– or –

3



Adapt the measurement Properties for vessel diameter measurements.

4 In the CPR segment, click the blue line of the measurement marker.

– or –

Click the Create Finding icon in the CPR mini toolbar.

```
– or –
```

Press the Alt + W keys.

The measurement results are displayed in different ways:

• In the **Findings Assistant**, the finding is named with a consecutive number and Vessel Diameter, for example, **[1] Vessel Diameter**.

In addition, a combined multiple snapshot of each related CPR and cross-sectional segment is stored with the finding.

• In a segment, the label of the finding consists of a consecutive number and an vD.

2.4.6 Editing vessel diameter findings

You can update a finding that was created with the **Vessel Diameter Measurement**. See (→ Page 23 *Measuring vessel diameter*)

- ✓ A finding starting with vD is listed in the Findings Assistant.
- 1 In the Findings Assistant, mark the finding that you want to edit.

– or –

In any segment, click the label of the finding that you want to edit.

All segments focus on the selected finding. The **Vessel Diameter Measurement** is activated. A blue disc appears at the stored position of the measurement marker.

2 In the CPR segment, drag the measurement marker up or down or click on a position along the centerline.

– or –

In the MIP segment, drag the corresponding disc along the vessel or click on a position along the centerline.

– or –

In the cross-sectional segment framed by a yellow border, use the scroll wheel or drag the mouse while keeping the right mouse button pressed.

The measurement marker moves to the new position.



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To update the finding according to the current measurement position, click the **Create Finding** icon in the CPR mini toolbar.

– or –

Press the Alt + W keys.

The selected finding is updated according to the current position of the measurement. The finding values and the snapshot are replaced.

The **Vessel Diameter Measurement** tool remains active, but clicking the **Create Finding** icon again will create a new finding and no longer update the previously selected finding.

2.4.7 Modifying lumen contours

If the automatic segmentation is not satisfactory, you can modify the lumen contours manually by drawing freehand lines, multi-click lines, or a combination of both.

✓ A measurement tool that is using lumen contours is activated in a CPR segment.



1 In the Case Navigator, click the Edit Contour icon.

– or –

Press the Alt + T keys.

- 2 In a cross-sectional segment displaying the lumen contour, double-click the segment to expand it.
- 3 Click the starting point of the contour section to be changed.
- 4 Drag the mouse pointer to draw a lumen contour.

– or –

Insert straight line segments by dragging and clicking the mouse alternately.

5 Finish the new contour section by double-clicking.



The newly drawn contour section must intersect with the existing lumen contour at both ends.

A new lumen contour is displayed. The software calculates the new values, such as area, diameters, and grades of stenosis.

2.4.7.1 Deleting a contour section

After editing the contour, the software may not be able to decide which part of the contour is to be discarded. In this case, a manual cutting mode is activated automatically.

- ✓ A measurement tool that uses lumen contours is activated in a CPR segment.
- 1 Drag the mouse to highlight the part of the contour that has to be deleted.

The part of the contour to be discarded is displayed as a dotted line.

- 2 To select a different part of the existing contour to be deleted, move the mouse to the opposite side of the contour.
- **3** Cut the highlighted part by clicking.



At any time, you can reject the current drawing by pressing the Esc key.

2.4.8 Adjusting CPR measurement properties

With the **Measurement Properties** window, you can change the behavior of the measurements provided by the CPR mini toolbar. The available settings correspond to the currently activated measurement.

1 In the CPR mini toolbar, select one of the measurement icons.



2 In the CPR mini toolbar, click the **Properties** icon.

The CPR Measurement Properties window opens. See

(→ Page 31 CPR measurement properties window)

2.4.9 Measuring grayscale values

CAUTION

The pixel marker has a constant size and is independent of the zoom factor of the image!

Wrong diagnosis caused by misleading image information

 Please note that the pixel marker is only a pointer indicating the position (not the size) of the measured area.

To measure grayscale values, the pixel lens processes the information stored in the image and not the information shown in the segment. For example, if you measure an area with an applied punch, the measurement represents the values of the original data set.



1 From the upper right corner menu, choose **Pixel Lens**.

The mouse pointer changes its shape.

2 Move the mouse pointer across the image and click the requested position.

The grayscale value is displayed next to the pixel marker and is preceded by a consecutive number. The pixel marker is always in the center of the area of which the average value is calculated.

The displayed value is obtained by averaging the grayscale values of one, nine, or 25 pixels (2D), or of one, 27, or 125 voxels (3D), as specified in the properties dialog box of the **Pixel Lens** tool.

2.5 Documenting results

To document your findings, you have the following options:

- (→ Page 27 Saving measurements as findings)
- (→ Page 27 Editing details of findings)
- (→ Page 29 Creating radial CPR ranges)
- (→ Page 29 Creating parallel CPR ranges)
- (→ Page 30 Creating multiple snapshots)

The Findings Assistant is displayed as Findings in the user interface.

2.5.1 Saving measurements as findings

After measuring a stenosis, a vessel length, or a vessel diameter, you can directly save the result as a finding.

✓ One of the measurement tools in the CPR mini toolbar is activated and the results are satisfactory.



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 In the CPR mini toolbar, click the Create Finding icon to finish the measurement and to store the current measurement results as a new finding.

– or –

Press the Alt + W keys.

The new finding is listed in the **Findings Assistant** including snapshot images for the Image Gallery in the details view.

2.5.2 Editing details of findings

In the details view of the **Findings Assistant**, you can edit the details of measurements and markers. The different types of findings are listed on the following tabs:

- Stenoses: Stenosis measurements
- Markers: Review markers
- · Vessel Diameters: Vessel diameter measurements
- · Vessel Lengths: Vessel length measurements
- Others: Curved Distance and other general measurements

• In the **Findings Assistant**, move the mouse over the arrow on the right side of the finding name to view the finding **Details** section.

By clicking a specific body region, separate pictograms with the corresponding vessels are displayed in greater detail.

2.5.2.1 Defining the location of a marker

You can define the position of findings.

- 1 Click the **Markers** tab.
- 2 From the list of markers, select an entry.
- **3** In the upper part of the window, click the corresponding segment of the pictograms.

– or –

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From the Location list, select one of the proposed locations.

– or –

Click an existing position marker in the pictogram and drag it to a new position.

The location label of the marker is updated accordingly.

2.5.2.2 Adding comments to findings

You can add an arbitrary text to the comment attribute of a finding.

- 1 From the list of findings, select an entry.
- 2 Click the **Comment** field and enter your comment.

The comment attribute of the finding is updated accordingly. Alternatively, you can edit the comment attribute in the Viewer.

2.5.2.3 Preparing the report

In the Findings Assistant, you can define which data shall be added to the report.

- 1 In the details view of the finding, click the **Markers** tab or the **Others** tab.
- 2 In the **Summary** field, enter a summary of your findings.
- **3** Check the snapshots of the remaining findings.

The report data is prepared. You can continue to generate the report.

2.5.2.4 Exporting finding data

- 1 In the Findings Assistant, select one or multiple findings.
- 2 To copy a finding, select **Copy to Clipboard** from the **Export selected Item** button (PDF icon with arrow down).
- **3** Switch to the application with which you would like to use the selected data, for example, MS Word.

4 Paste the information to the application, for example, with the CTRL + V keys.

2.5.3 Creating radial CPR ranges

To document condition of vessels, you can create series of images along the CPR. Radial CPR ranges save a stack of images containing multiple CPR views of the displayed vessel from different viewing directions around the vessel.

The Radial CPR Ranges window provides the following parameters:

Degree Steps

Defines the angle between pairs of images. The value also defines the total number of images ($360^{\circ} \div$ [degree steps]).

High Resolution

Defines the resolution of DICOM images. The resolution may vary from 512×512 pixels to 2048 x 2048 pixels. The image resolution will be set automatically to the same physical resolution stated in the input image.

Image Comment

Defines a text that is written into the DICOM image comment.

Ranges Series Name

Defines the name of the result series. The default name uses the name of the selected centerline followed by "Curved Range Radial" and the filter that is currently applied to the CPR.



You can select another centerline or segment while the **Radial CPR Ranges** window is open.



- 1 From the upper left corner menu of the CPR segment, choose Radial CPR Ranges.
- 2 Modify the values in the Radial CPR Ranges window according to your needs.
- 3 Click the **Start** button.

A new series containing the radial CPR range is created, based on the currently selected centerline.

2.5.4 Creating parallel CPR ranges

To document condition of vessels, you can create series of images along the CPR. Parallel CPR ranges save a stack of images containing cross-sectional images along the corresponding centerline. One curved MPR image provides the reference location for the corresponding cross-sectional images.

The Parallel CPR Ranges window provides the following parameter:

Distance

Defines the distance between pairs of images of the series in mm.

Image Comment

Defines a text that is written into the DICOM image comment.

Ranges Series Name

Defines the name of the result series. The default name uses the name of the selected centerline followed by "Cross Sections" and the filter that is currently applied to the cross-sectional segments.



You can select another centerline or segment while the **Parallel CPR Ranges** window is open.



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- 1 From the upper left corner menu of the CPR segment, choose Parallel CPR Ranges.
- 2 Modify the values in the **Parallel CPR Ranges** window according to your needs.
- **3** Click the **Start** button.

A new series containing the parallel CPR range is created, based on the currently selected centerline.

If the stenosis measurement or the vessel length measurement is activated, the **Parallel CPR Ranges** creates a stack of cross-sectional images along the corresponding centerline, but limits the range to the region between the reference markers.

2.5.5 Creating multiple snapshots

The **Multiple Snapshot** function creates a snapshot finding of the selected CPR segment together with its cross-sectional MPRs. If the current layout uses Twin CPRs, two CPRs per vessel are incorporated into the snapshot. The cross-sectional MPRs are shown as a gallery.



1 From the lower right corner menu of the CPR segment, choose **Multiple Snapshot**.

A snapshot finding is added to the Findings Assistant.



2 In the **Findings Assistant**, double-click the corresponding snapshot icon to check the image.

2.5.6 Creating multiple CPR snapshots

In cases with no abnormality detected, it can be useful to document an image displaying the course of the main examined vessels. The **Multiple CPRs Snapshot** function creates a combined snapshot finding of all currently visible CPR segments. If the current layout uses Twin CPRs, two CPRs per vessel are incorporated into the snapshot. This snapshot does not include the cross-sectional MPRs which are shown as a gallery.



1 From the lower right corner menu of the CPR segment, choose **Multiple CPRs Snapshot**.

A snapshot finding is added to the Findings Assistant.



2 In the **Findings Assistant**, double-click the corresponding snapshot icon to check the image.

You can also print multiple snapshots. See "CT Vascular: Printing multiple snapshots"

3 CPR measurement properties window

Stenosis measurement properties

With the **Measurement Properties** window, you can change the behavior of the stenosis measurement.

 One Reference pointer above, One Reference Pointer below, and Two Reference Pointers

Defines the number and the position of reference marker of a stenosis measurement.

Measurement results are based on the reference markers representing healthy reference regions. Depending on the anatomy to be examined, you can improve the measurement results by modifying the number of reference markers that a reused for calculation. For example, if the vessel diameter is reduced across a longer distance, you can select two reference markers, one above and one below the lesion, and locate the different healthy regions accordingly. When measuring lesions close to a vessel bifurcation, it is better to select one reference marker only. At best, position the reference marker distal to the lesion, for example, to follow the NASCET (North American Symptomatic Carotid Endarterectomy Trial) standard. For additional literature on this topic: Ota H, Takase K, Rikimaru H, Tsuboi M, Yamada T, SatoA, et al. Quantitative Vascular Measurements in Arterial Occlusive Disease. RadioGraphics. 2005 Sept-Oct; 25(5):1141–1158.

Vessel length measurement properties

With the **Measurement Properties** window, you can change the behavior of the vessel length measurement.

· Display existing measurement locations

If the **Display existing measurement locations** check box is selected, previously created findings are marked in the CPR segment.

С

centerlines rotating 16 CPR measurement properties 26 properties window 31

CPR measurement properties 26, 31

CPR mini toolbar display profile curve 18 stenosis measurement 18 vessel diameter measurement 23, 24 vessel length measurement 21, 22 CPR ranges

parallel 29 radial 29 CPR screenshots multiple 30

D

documenting results MR Vascular 27

F

Findings Assistant editing details of findings 27 saving findings 27

I

inverted view 16

L

lesion location curves 18 loading images 6

Μ

MPR views angulating 17

MR Vascular angulating MPR views 17 CPR measurement properties 26, 31 creating multiple CPR screenshots 30 creating multiple screenshots 30 creating parallel CPR ranges 29 creating radial CPR ranges 29 displaying an inverted view 16 documenting results 27 editing details of findings 27 editing vessel length findings 22 locating lesions 18 measuring stenoses 18 measuring vessel length 21 quantification 17 reading lesions 15 rotating along centerlines 16 saving measurements as findings 27 tracing vessels 6, 7, 8, 13, 14, 15, 25, 26 vessel diameter findings 24 vessel diameter measurement 23

Ν

navigating in CPRs 16 MR Vascular 16

Q

quantification MR Vascular 17

R

reading vascular lesions MR Vascular 15

S

screenshots multiple 30 stenoses measuring 18

т

tracing vessels correcting centerlines 8 deleting centerlines 15 deleting parts of centerlines 13 display centerlines 15 extending a centerline 14 measuring grayscale values 26 modifying lumen contours 25 MR Vascular 6 tracing vessels manually 7 tracing vessels semi-automatically 7

۷

vessel diameter editing findings 23, 24 vessel length editing findings 22 measuring 21

W

workflow MR Vascular 6



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