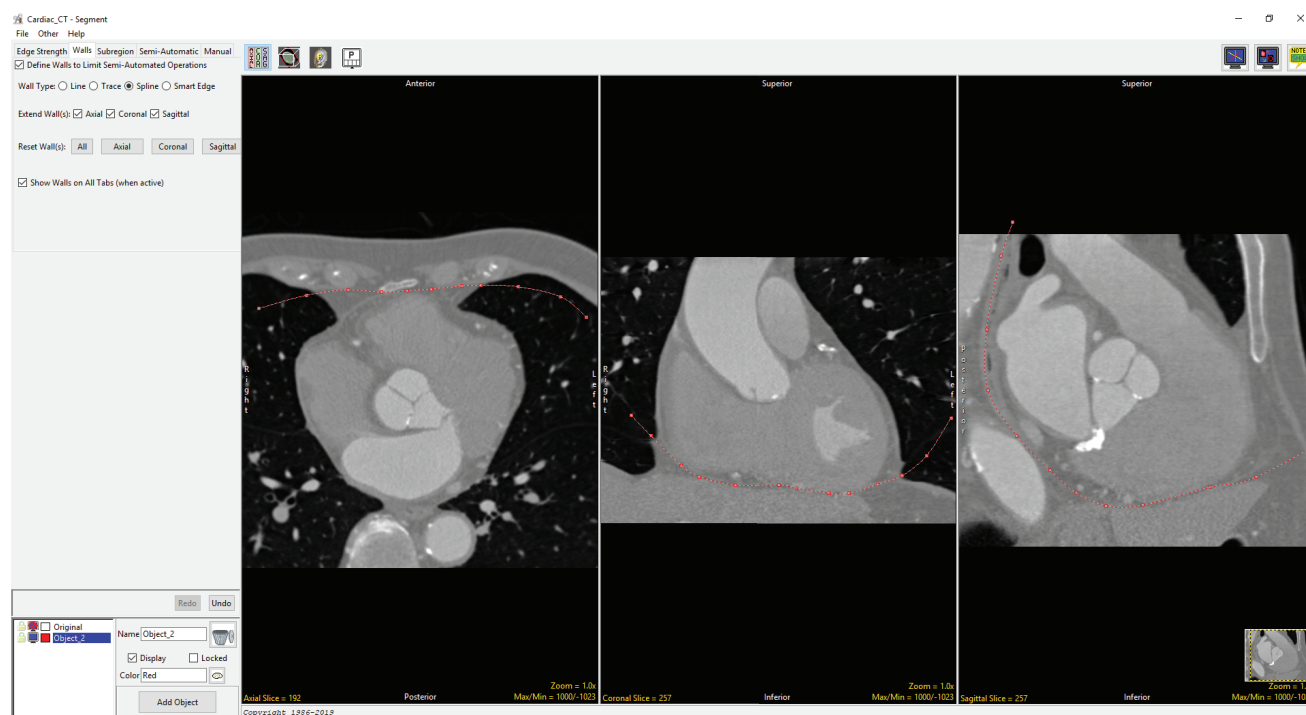# Walls

Segmenting structures of interest that are connected to surrounding anatomy with similar grayscale values can be challenging. The Walls option provides tools to create adaptable 3D limits to help make this process easier for the user. The Walls tool is useful for many segmentation applications, particularly isolating the cerebellum from the rest of the brain parenchyma or limiting the boundaries of a region grow operation to isolate blood pools from cardiac data.

The Walls option allows users to define traces which are used to limit the extent of an object. Separate walls can be created in each orientation, the wall defined in one orientation is not reflected in the other orientations. Traces defined on slices are linearly interpolated within each orientation reducing user interaction time, so that a trace defined on slice 10 and a trace defined on slice 50 are automatically interpolated between so the user doesn't have to define the wall on each slice between. The interpolated traces are designated by a dashed green line, while the user defined traces appear as a dashed red line.

Walls are used with the Threshold Volume, Region Grow, Connected Components, Object Extractor and Object Separator Semi-Automatic tools. Walls can also be used in conjunction with the Edge Strength and Subregion tools.
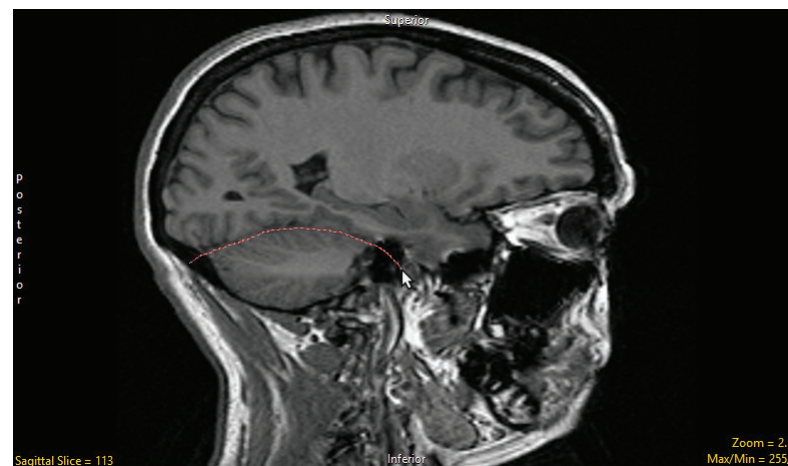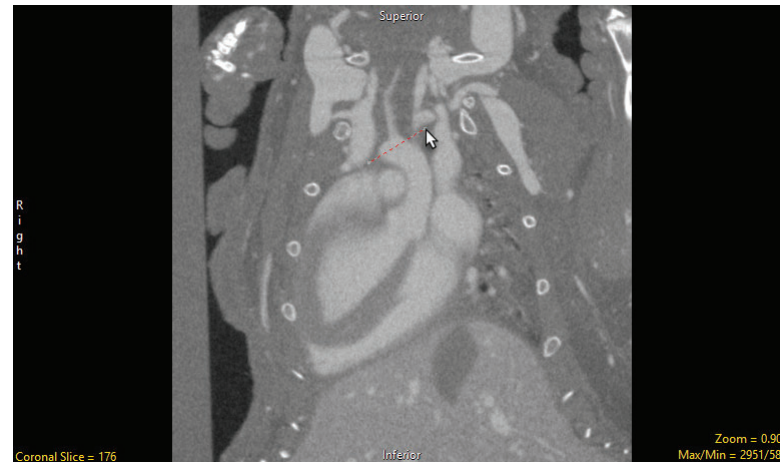
Walls Tab Options

The Walls tab provide the following option:

Define Walls to Limit Semi-Automated Operations: When checked enables wall definition options allowing users to define walls on the image data.

Wall Type: Allows users to select the wall definition mode, the options include:

- Line: The line option allows users to define a straight-line wall on the image data.

- Trace: Allows user to define a freehand wall on the image data

- Spline: The Spline option allows users to define a curved wall. Splines are flexible curve traces with movable control points that are useful for creating smooth walls.

Walls Tab Options (continued)

- Smart Edge: The smart edge option detects regions of high rate of change of voxel intensity (gradient) that represent edges, smart edge snaps to the edges of these regions.

- Sensitivity: The sensitivity of the smart edge can be adjusted using the slider or the mouse scroll wheel. The lower the value the less sensitive the tool is, the higher the value the more sensitive the tool is.

Extend Wall(s): Specifies if the wall is extended beyond the first and last user defined wall in each orientation.

Reset Wall(s): Allows the user to reset the defined walls in any or all orientations.
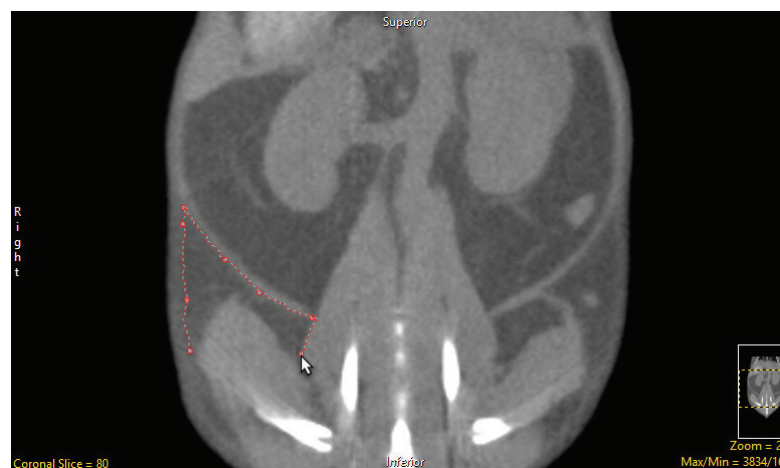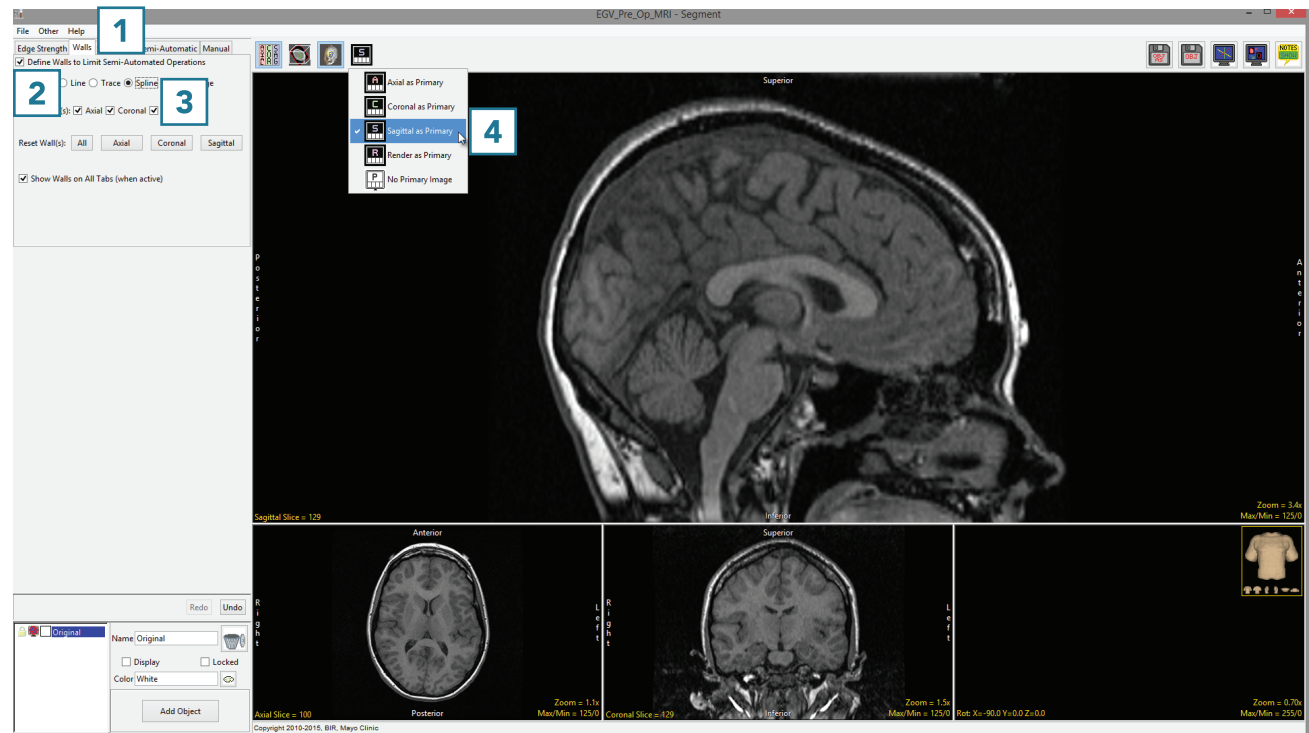
Using Walls

Here we will use the Walls functionality to segment the cerebellum from the rest of the brain parenchyma in a head MRI dataset.

To follow along, download the data set EGV_MRI from analyzedirect.com/data and load into Analyze using Input/Output.

- Select the data set and open Segment.
- Select Walls [1] and check Define Walls to Limit Semi-Automated Operations [2].
- Set the Wall Type to Spline [3].
- Set the primary display to Sagittal [4].

Using Walls (continued)

- Navigate through the sagittal slices to find the first slice that includes tissue belonging to the cerebellum. Draw a wall separating the cerebellum from the cerebrum on this slice.

- To draw a wall using the spline tool, left-click to set spline points which will connect into a smooth line. Double-click when defining the last spline point to set the spline [5].

- The spline points can be adjusted by left-clicking and dragging. Right-clicking on a spline point allows you to delete it or make other changes to the spline such as closing the spline or deleting the entire spline.

- Move forward through the sagittal slices and adjust the wall as required [6].

- The Wall can also be redrawn if necessary.
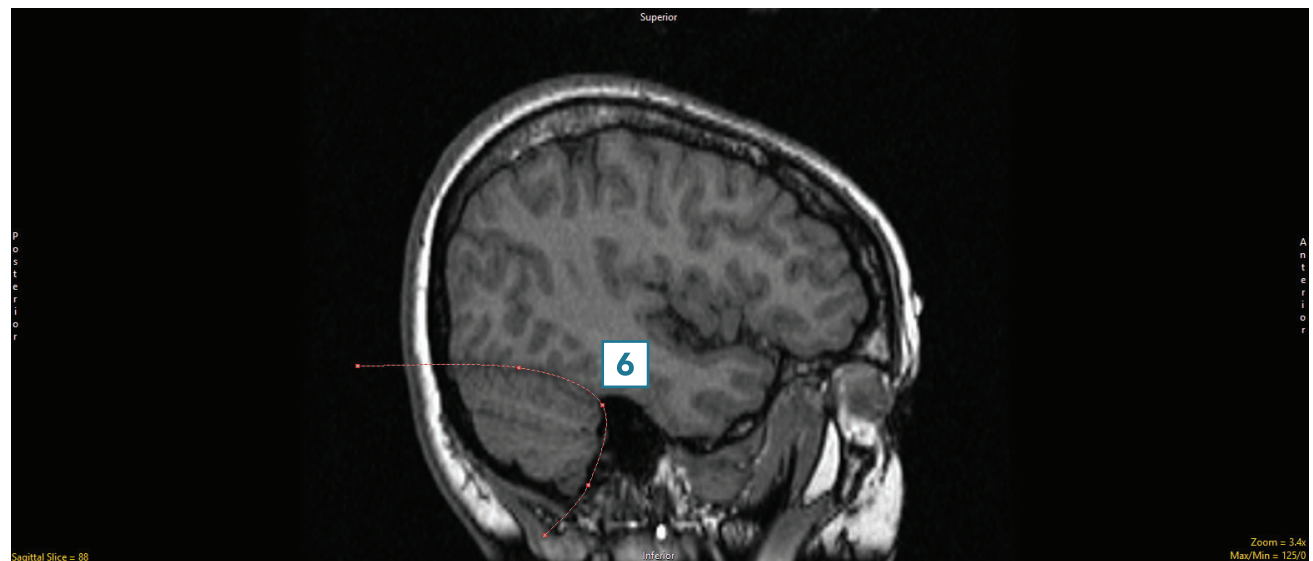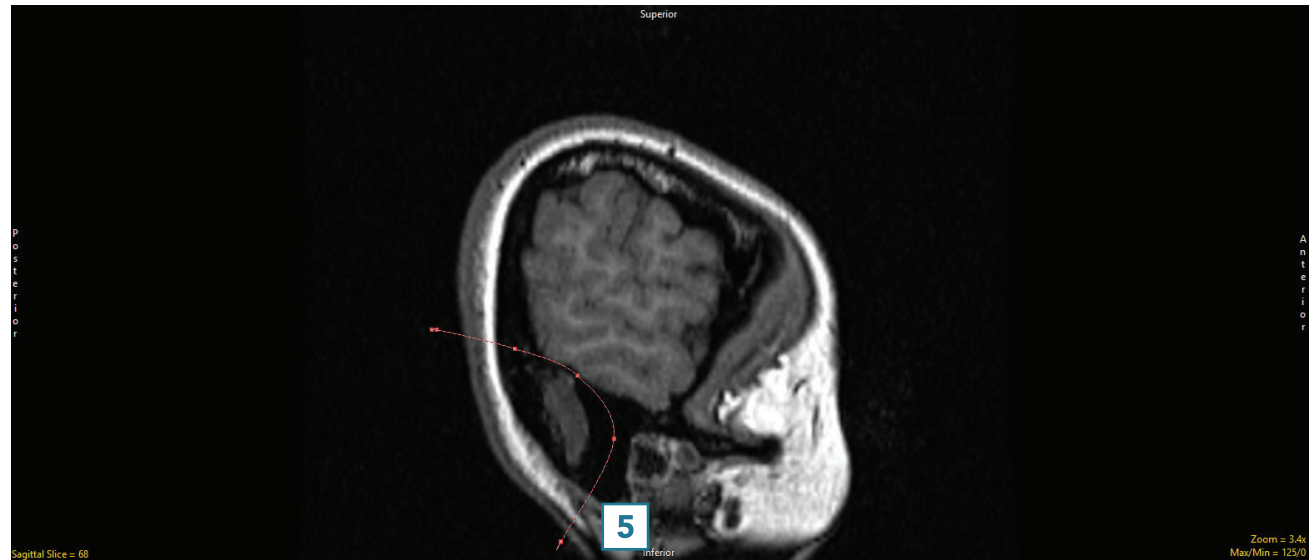
Using Walls (continued)

- Once the cerebellum is no longer well defined by the wall, redefine the wall on that slice. The wall will be interpolated between all slices on which it is defined. When finished, scroll through the slices to ensure that the cerebellum is well defined by the wall.

Note that walls can be set in multiple orientations. This is helpful when trying to isolate structures connected to several surrounding structures in all orientations. For example, it can be used when isolating the heart from the lungs, spine, sternum, etc. It can also be useful to define walls in the sagittal and coronal orientations to better segment the cerebellum.

- Continue to define walls around the cerebellum in the sagittal orientation [7], [8].
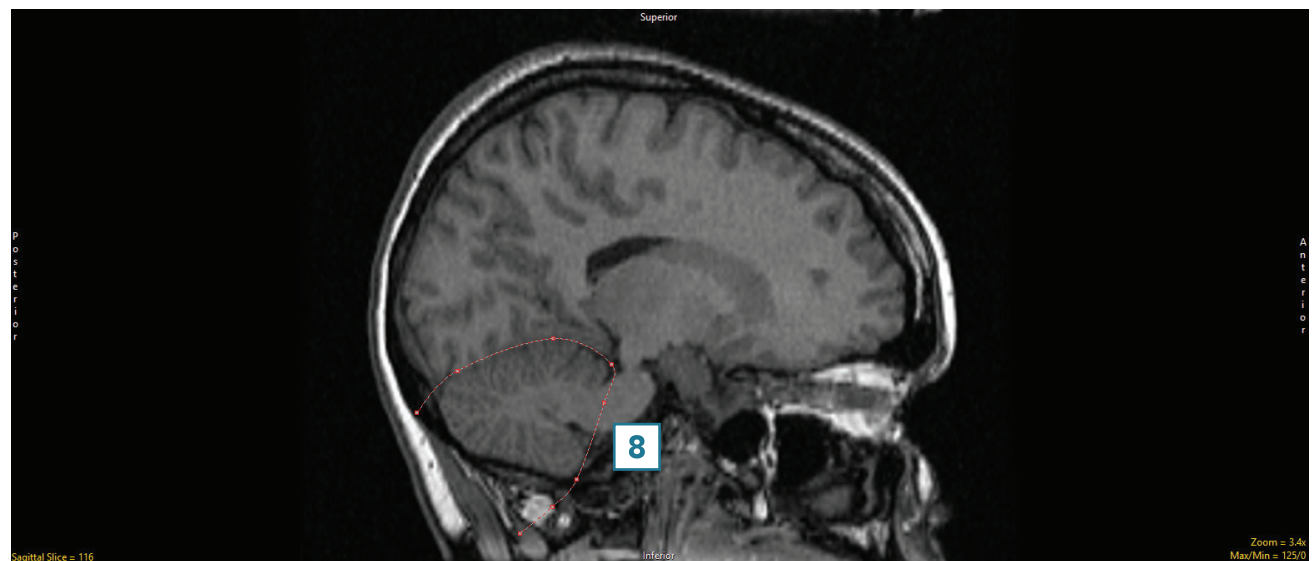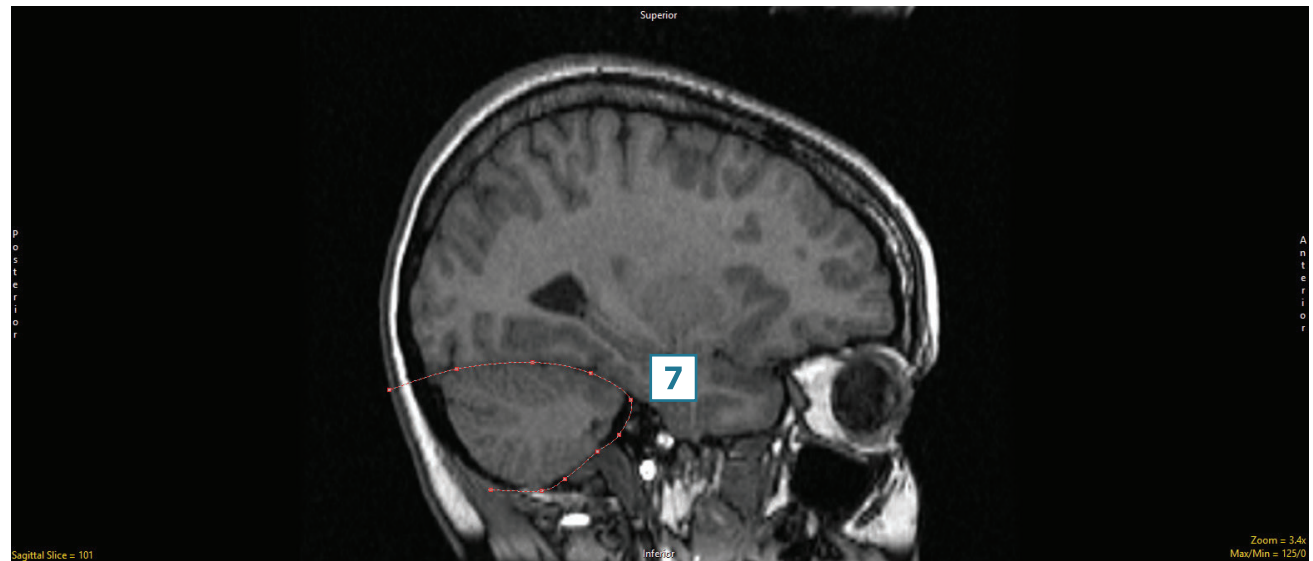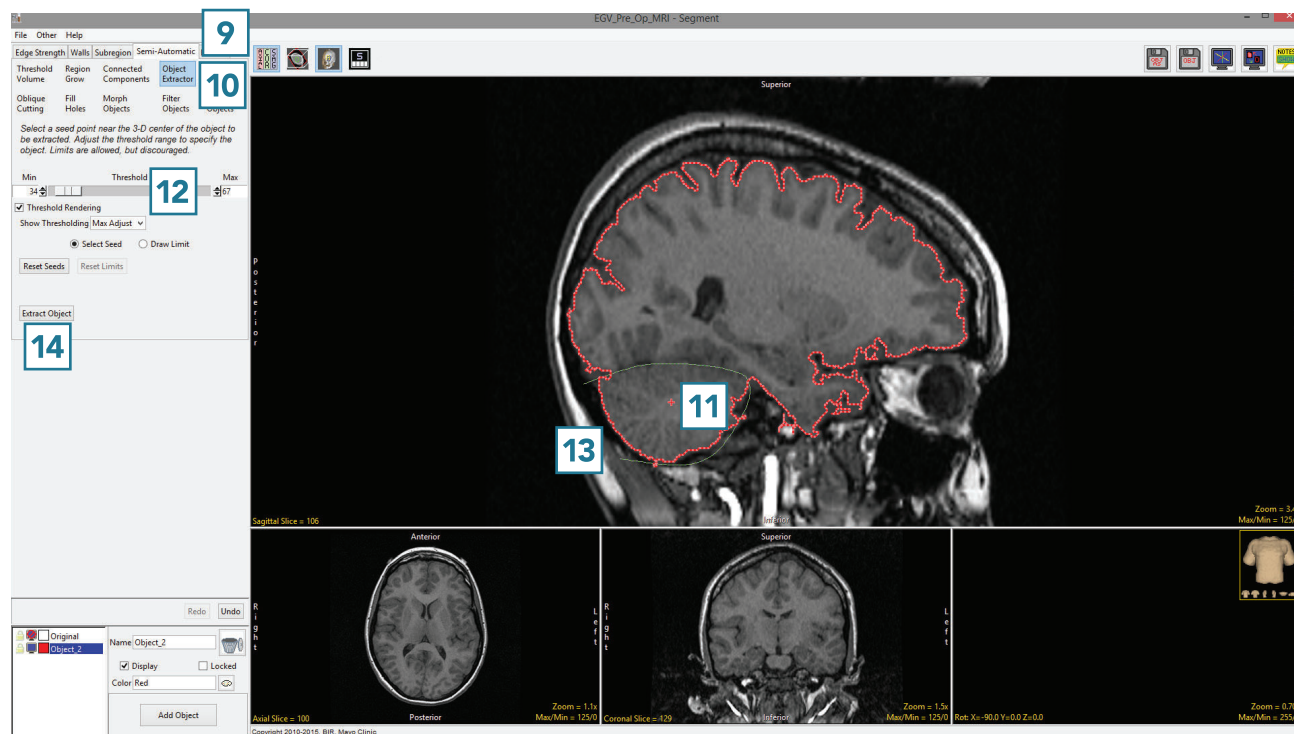
Using Walls (continued)

- Once the cerebellum boundary is defined in three dimensions by the wall, select the Semi-Automatic tab [9] and choose Object Extractor [10].
- Click in the cerebellum on a sagittal slice to set a seed point [11].
- Adjust the maximum and minimum threshold values [12] until the auto trace defines the object [13].

Note that while the entire brain will be defined, the walls will prevent the whole brain from being segmented and will confine the segmentation to the cerebellum.

- Click Extract Object [14].

Using Walls (continued)

- The cerebellum will be isolated and displayed in 3D.

- Once segmentation is complete, the structure will be rendered [15] and overlaid on the slice data [16].

- Save your work by selecting File > Save Object Map.