THE VALUE OF ADDING AXIAL MULTIPLANAR RECONSTRUCTION IMAGES TO CORONAL MIP IMAGES AT THE EVALUATION OF SUPRAAORTIC VESSEL STENOSIS BY USING 3D-CE-MRA: COMPARISON WITH DIGITAL SUBTRACTION ANGIOGRAPHY

H. Musapasaoglu[1], A. M. Agildere[1], M. Teksam[1], C. Aytekin[1], A. Firat[1], F. Boyvat[1]

[1]Radiology, Baskent University, Ankara, Turkey

Purpose:

Manipulation of contrast-enhanced (CE) three dimensional (3D) magnetic resonance angiography (MRA) images in three dimensions allows for direct measurement of vessels luminal diameter. Coronal maximum intensity projection (MIP) is a widely used algorithm to display CE 3D-MRA images. In this study we estimated the value of adding axial multiplanar reconstruction (MPR) images to coronal MIP images at the evaluation of supraaortic vessel stenosis. Furthermore the value of adding subtracted CE-MRA images were also evaluated.

Material and Method:

In all patients, CE 3D MRA was performed by using phased-array CP neck coil integrated with CP spine coil in 1.5T system. Intravenous contrast was injected by using MR compatible injector with a rate of 2 ml/s and a dose of 0.2 ml/kg. A care bolus technique was used by MR fluoroscopy triggering. 3D flash sequence was used (TR: 4.47 ms, TE: 1.54 ms, matrix: 192x512, acq: 1, FA: 25^o). Image subtraction and reconstructions were created after obtaining source images in the coronal plane. Two radiologists evaluated retrospectively supraaortic vessels on coronal MIP reconstruction images and combination of coronal MIP reconstruction with axial MPR images and combination of coronal MIP reconstruction with subtraction images in 333 segments of 21 symptomatic patients. The gold standart was DSA. Stenotic vessels were evaluated by using North American Symptomatic Carotid Endarterectomy Trial (NASCET) criteria on both CE 3D MRA and DSA images. The narrowest diameter of the residual lumen was compared with the luminal diameter of the vessel. The stenosis was defined as normal (0%); mildly stenosed (1-29%); moderately stenosed (30-69%); severely stenosed (70-99%); and occluded (100%). Results of coronal MIP reconstruction images; coronal MIP reconstruction with axial MPR images and coronal MIP reconstruction with subtraction images were compared with the corresponding DSA findings.

Sensitivity, specificity, accuracy, positive predictivity and negative predictivity value of the CE 3D MRA coronal MIP reconstructions and combination of coronal MIP reconstruction with axial MPR images and coronal MIP reconstruction with subtraction images were calculated separately (Table). Statistical analysis was performed by using kappa correlation coefficient.

Results:

Total occlusion in 9 arteries, severe stenosis in 16 arteries , moderate stenosis in 90 arteries , mild stenosis in 105 arteries were detected on DSA and 113 arteries were normal. CE 3D MRA coronal MIP reconstructions revealed 9 total occlusions, 25 severe stenosis, 78 moderate stenosis, 92 mild stenosis and 129 normal segments. Combination of coronal MIP reconstruction with axial MPR images revealed 9 total occlusions, 17 severe stenosis, 67 moderate stenosis, 106 mild stenosis and 134 normal segments. Total occlusion in 9 arteries, severe stenosis in 17 arteries, moderate stenosis in 72 arteries, mild stenosis in 102 arteries were detected on combination of coronal MIP reconstruction with subtraction images and 133 arteries with in normal limits. Sensitivity, specificity, accuracy and κ coefficients of CE 3D MRA coronal MIP reconstructions and combinations of coronal MIP reconstruction with axial MPR images and coronal MIP reconstruction with subtraction images are documented in Table.

Conclusion:

As a general consensus the specificity and negative predictivity of the CE 3D MRA is acceptable and as a diagnostic tool CE 3D MRA can replace DSA at the quantitative evaluation of supraaortic vessel disease. However, the performance of CE 3D MRA image subtraction and multiplanar reconstructions has not been rigorously analyzed before. In this study, we compared CE 3D MRA coronal MIP reconstructions and combinations of coronal MIP reconstruction + axial MPR images and coronal MIP reconstruction + subtraction images with DSA in 21 patients and 333 segments. Our study showed that coronal MIP reconstruction with axial MPR images had a higher sensitivity, specificity, accuracy and κ coefficient in the evaluation of stenosis of the supraaortic vessels, quantitatively. Used alone, CE 3D MRA coronal MIP reconstruction images are not accurate enough to replace conventional DSA in the evaluation of supraaortic arteries. In 33 segments (6 CCA, 6 ICA, 9 ECA, 2 SA and 10 VA), stenosis of the supraaortic vessel was overestimated with CE 3D MRA coronal MIP images compared with DSA. Adding axial MPR to coronal MIP reconstruction images decrease these overestimation and 24 segments of these vessels (4 CCA, 4 ICA, 8 ECA, 2 SA and 6 VA) were calculated correctly. In 30 segments (12 CCA, 11 ICA, 5 SA and 2 VA), stenosis of the supraaortic vessel was underestimated with CE 3D MRA coronal MIP images compared with DSA. In 5 segments of these vessels (1 CCA, 3 ICA and 1 SA), degrees of stenosis were determined accurately by adding axial MPR to coronal MIP reconstruction images. Axial reconstruction images are particularly useful for evaluation of stenosis of vessel on anterior-posterior projection.

Adding subtraction images also increase the sensitivity, specificity, accuracy and κ coefficient more than the coronal MIP images. Particularly, increase in the evaluation of internal carotid arteries were noted as an increase in the sensitivity, specificity, accuracy and κ coefficient of coronal MIP reconstruction with axial MPR images. The results showed that sensitivity of the combinations of coronal MIP reconstruction with axial MPR images and coronal MIP reconstruction with subtraction images were slightly more than coronal MIP reconstruction images in most of the supraaortic arteries. Nevertheless, interestingly, sensitivity of these combinations was lower than coronal MIP reconstruction images for the vertebral artery. In addition, κ coefficient values of these combinations increased in all of these supraaortic arteries.

		Supraaortic vessels	Common Carotid Artery	Internal Carotid Artery	External Carotid Artery	Subclavian Artery	Vertebral Artery
Coronal MIP reconstruction	Sensitivity	**85%**	**74%**	**82.5%**	**100%**	**84.3%**	**94.4%**
	Specificity	**75.6%**	**85%**	**75%**	**57%**	**80%**	**75%**
	Accuracy	**81%**	**79%**	**80%**	**78%**	**83.3%**	**84%**
	κ coefficient	**0.722**	**0.637**	**0.735**	**0.672**	**0.729**	**0.765**
Coronal MIP reconstruction with axial MPR images	Sensitivity	**87.5%**	**78%**	**87%**	**100%**	**87.5%**	**90.5%**
	Specificity	**94%**	**94.4%**	**90.5%**	**93.7%**	**100%**	**94.2%**
	Accuracy	**89.8%**	**84.8%**	**88.5%**	**97.6%**	**90.5%**	**92.1%**
	κ coefficient	**0.838**	**0.724**	**0.843**	**0.896**	**0.846**	**0.880**
Coronal MIP reconstruction with subtraction images	Sensitivity	**87.9%**	**84.3%**	**84.8%**	**96%**	**87.5%**	**92.7%**
	Specificity	**91.5%**	**100%**	**90.5%**	**82.3%**	**90%**	**88.6%**
	Accuracy	**89.1%**	**90.6%**	**86.2%**	**90.5%**	**88.1%**	**90.8%**
	κ coefficient	**0.830**	**-**	**0.812**	**0.829**	**0.808**	**0.861**

Table