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A Method for Quantifying Angiographic Severity of Extracranial Vertebral Artery Stenosis

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Vertebral artery origin stenosis is a common occurrence among patients with ischemic events in the vertebral and basilar arterial distribution [1,2]. Of the 407 patients in the New England Medical Center Posterior Circulation Registry, 80 (20%) of patients with ischemic events in the vertebral and basilar arterial distribution had vertebral artery origin occlusion or high-grade stenosis [1]. Treatment options for vertebral artery origin occlusion or high-grade stenosis associated with ischemic events, include medical therapy, angioplasty and stent placement, and open surgical revascularization procedures. Aggressive medical therapy may or may not be effective for the reduction of cerebral ischemic events among patients with symptoms caused by hemodynamic impairment from vertebral artery origin occlusion or high-grade stenosis [3]. Stent placement is a treatment option for patients with extracranial vertebral artery stenosis when patients are having symptoms despite optimal medical treatment (Class IIb; Level of Evidence C) [3].

However, no validated or reproducible criteria exist to quantify the severity of stenosis for effective risk stratification. The Carotid And Vertebral Artery Transluminal Angioplasty Study (CAVATAS) [4] randomized 16 subjects with vertebral artery origin stenosis (>50% in severity) to receive either endovascular therapy (angioplasty or stent placement) or medical management alone. The stenosis severity was calculated from the images acquired by catheter angiogram using the following formula:

$$\text{Percent stenosis} = 100(1 - A/V)$$

Where A = diameter of the residual lumen at the point of maximal stenosis and V = diameter of disease-free distal vertebral artery. The disease-free segment was defined at the point where the walls were approximately parallel. The mean severity of stenosis was 73% (range: 58–92%) in the endovascular group and 74% (range: 53–95%) in the medical group.

The reference artery for quantifying the stenosis lies within the sixth segment which extends classically from the subclavian artery to the transverse foramen of sixth cervical vertebrae. The sixth segment of the artery courses obliquely upwards and posteriorly at a distance of 5 to 10 mm from the level of the seventh vertebral body [5]. Because of severe tortuosity in the sixth segment of the vertebral artery, seen in approximately 47% of patients [6], identifying the reference segment on the basis of parallel alignment of arterial walls may be challenging. To avoid variation in quantification between observers, we describe another method for identifying the reference segment of vertebral artery and thus providing a more reliable method for quantifying the severity of stenosis.

The method requires measurement of the diameter of the segment of the subclavian artery, that is inferior to the origin of the ipsilateral vertebral artery origin. The segment of the vertebral artery that is equidistant from visualized origin, as the diameter of the subclavian artery, is used as the reference artery. The lumen diameter at the point of maximum narrowing is expressed as a proportion of the diameter of the reference vertebral artery segment (Fig. 1). The possibility that D1 (Fig. 1) may be the reference diameter is still an option. In previous studies, to quantitate the severity of internal carotid artery or intracranial arterial stenosis, the proximal artery has been used as reference segment [7–10].

The angulation of the origin of vertebral artery from the subclavian artery is an important determinant of the complexity of the angioplasty and stent procedure [11]. We further provide a classification to categorize the relationship between alignment of the vertebral artery and subclavian artery. For further classification, the subclavian artery is divided into an ascending segment and a horizontal segment. The person ascertaining the segment should base the judgement on the alignment of the subclavian artery using an imaginary line connecting the midpoint of the segment immediately proximal and dis-

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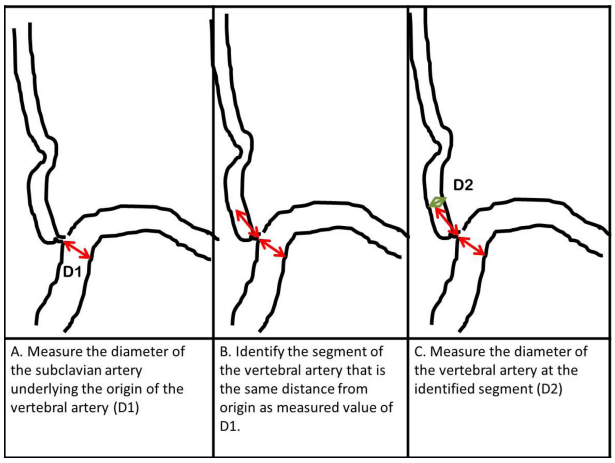

Figure 1. Method of quantifying the severity of stenosis at vertebral artery origin

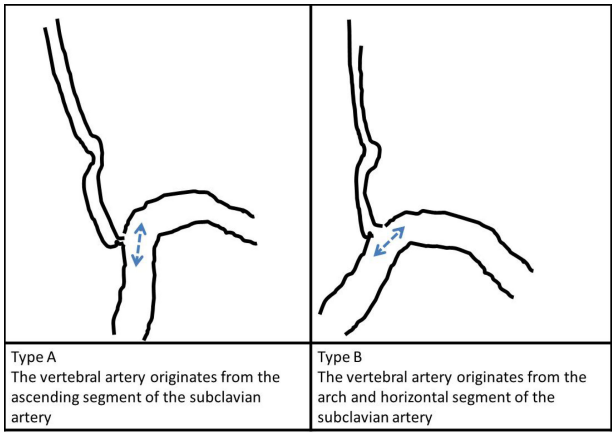

Figure 2. Method of classifying the anatomical variations in the origin of vertebral artery from subclavian artery

tal to the origin of the vertebral artery. A schematic to describe the classification is shown in Figure 2.

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