


# Cervical dissection diagnoses increase following endovascular treatments

Soledad Pérez-Sánchez<sup>1,2</sup> ,  
Ana Domínguez-Mayoral<sup>1,2</sup>,  
Reyes De Torres-Chacón<sup>1,2</sup>,  
Miguel A Gamero-García<sup>1,2</sup>,  
Ana Barragán-Prieto<sup>1,2</sup>,  
Irene Escudero-Martínez<sup>2,4</sup>, Rafael F Ocete<sup>2,3</sup>,  
Juan Herrero-Lara<sup>5</sup>, Pilar Algaba<sup>2</sup>,  
Francisco Moniche<sup>2,4</sup>, Alejandro González<sup>2,3</sup>,  
Luis Cueto<sup>5</sup> and Joan Montaner<sup>1,2</sup>

## Abstract

**Objectives:** The detection of cervical arterial dissection (CAD) has been rising in recent years owing to advanced imaging techniques. The aim of this study was to explore whether wide implementation of endovascular treatment for ischemic stroke has an impact on the diagnosis of CAD.

**Methods:** We included all patients with CAD diagnosed at two university hospitals in Seville, Spain from January 2015 to December 2017. We collected clinical variables and information on imaging techniques used for the diagnosis. Implementation of 24 hour/365 day mechanical thrombectomy began in Seville on 15 August 2016. We compared diagnosis rates of CAD performed before and after this date.

<sup>1</sup>Department of Neurology, Hospital Universitario Virgen Macarena, Seville, Spain

<sup>2</sup>Neurovascular Research Laboratory, Instituto de Biomedicina de Sevilla-IBiS, Seville, Spain

<sup>3</sup>Department of Radiology, Hospital Universitario Virgen del Rocío, Seville, Spain

<sup>4</sup>Department of Neurology, Hospital Universitario Virgen del Rocío, Seville, Spain

<sup>5</sup>Department of Radiology, Hospital Universitario Virgen Macarena, Seville, Spain

## Corresponding author:

Soledad Pérez-Sánchez, Neurovascular Research Group, Biomedicine Institute of Seville, IBiS/Hospital Virgen del Rocío/CSIC/University of Seville, Av. Manuel Siurot s/n, Seville 41013, Spain; Department of Neurology, Hospital Universitario Virgen Macarena, Av. Doctor Fedriani no.3, Seville 41008, Spain.

Email: [soledad.perez.sanchez@gmail.com](mailto:soledad.perez.sanchez@gmail.com)



**Results:** We identified 41 patients with CAD. We found 13 patients diagnosed before (1.1% of all ischemic strokes) and 28 (2.2%) after implementation of neurointerventional therapy. In 17 patients, diagnosis was made in the acute phase. Dissection was not suspected according to computed tomography angiography in 11 patients owing to small dissections ( $n = 2$ ) or total occlusion ( $n = 9$ ).

**Conclusions:** CAD diagnoses have been rising in recent years, essentially owing to continuous improvement in imaging techniques. Rapid access to arteriography for thrombectomy is increasing the diagnoses of CAD, even in patients with a low suspicion of dissection.

### Keywords

Cervical arterial dissection, diagnosis, endovascular treatments, ischemic stroke, arteriography, mechanical thrombectomy

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### Introduction

Cervical arterial dissection (CAD) is involved in 1% to 2% of all strokes in the general population and is the main cause of stroke among young people, responsible for up to 20% of strokes in patients younger than 45 years of age.<sup>1</sup> CAD affects the internal carotid artery more frequently than the vertebral artery and may involve multiple dissections in 13% to 14% of cases.<sup>2</sup> Two-thirds of patients with CAD have a stroke or transient ischemic attack (TIA). CAD has also been associated with local signs such as pain, Horner's syndrome (in the case of the carotid artery) and cranial nerve compression. Subarachnoid hemorrhage is much less frequent in CAD than in intracranial arterial dissection and is associated with dissecting pseudoaneurysm.<sup>2,3</sup>

Diagnosis of CAD is often a challenge. High suspicion of CAD leads physicians to initiate a diagnostic workup and perform appropriate confirmatory tests. CAD incidence may be underestimated in the general population owing to asymptomatic CAD.<sup>3</sup>

The treatment of acute ischemic stroke has dramatically changed in recent years owing to endovascular procedures, which allow rapid access to artery imaging using advanced techniques. Herein, we describe

the evolution of the rate of CAD diagnoses following implementation of endovascular treatment for ischemic stroke in a region of southern Europe.

### Methods

In this study, we included all patients with CAD diagnosed from January 2015 to December 2017 at two university hospitals in Seville, Andalusia, in southern Spain. Implementation of 24-hour/365-day mechanical thrombectomy (MT) started in Seville on 15 August 2016. We compared the rate of CAD diagnoses made before this date and after this date. At the same time, a brain imaging protocol (multimodal computed tomography (CT)) was implemented for acute ischemic stroke. Previous to this date, mechanical thrombectomy was performed only during working hours and the selection of brain imaging was decided on a case-by-case basis by the treating physician and radiologist.

The diagnostic rate was based on all patients with stroke admitted to both hospitals during the study period. Only data for patients with CAD who presented with ischemic stroke or TIA were included in the study.

We collected demographic data and clinical variables such as the affected artery and clinical presentation (ischemic stroke or TIA). Clinical severity of stroke was assessed using National Institutes of Health Stroke Scale (NIHSS) scores at admission and discharge. We collected details on treatment administered during the acute phase (intravenous thrombolysis (IVT) or endovascular treatment) and at discharge (antiplatelets, anticoagulants).

Imaging data of the affected artery were registered (occlusion, stenosis, or no hemodynamic involvement). We also included the time of diagnosis (acute phase if less than 24 hours or non-acute phase if more than 24 hours after symptoms onset) and imaging techniques used for the diagnosis (arteriography, CT angiography (CTA), magnetic resonance imaging (MRI), and MR angiography (MRA)). Radiological criteria for CAD diagnosis were intimal flap, irregular stenosis or occlusion sparing the carotid bifurcation, dissecting pseudoaneurysm, false channel, or detection of mural hematoma in the case of MRI.

This study was conducted under local ethics regulations. Informed consent was waived because of the retrospective design of the study.

Statistical analysis was performed with IBM SPSS version 23.0 (IBM Corp., Armonk, NY, USA). A two-sided  $p$  value  $<0.05$  was considered to indicate statistical significance.

### Data availability

The present study is compliant with the journal's data availability standards and any data not provided in the article may be shared upon request by a qualified investigator.

## Results

We identified 41 patients with CAD. Thirty-two patients had ischemic stroke

and nine had TIA. Thirteen patients (31.7%) had vertebrobasilar stroke. Thirty patients (73.17%) had idiopathic CAD and ten patients (24.39%) had post-traumatic CAD. In one patient, dissection was secondary to endovascular procedures. Characteristics of these patients are shown in Table 1.

Among patients with stroke, IVT was performed in 9 patients and endovascular treatment in 14. At discharge, antiplatelets were indicated in 82.9% of patients and anticoagulants in the remaining patients.

All patients with CAD were included, regardless of the technique used for diagnosis. Seventeen CADs (three of which were vertebral dissection) were identified in the acute phase using arteriography (all positive) or CTA (positive in 6 of 17 patients, 35.2%). CAD was not suspected on CTA in 11 patients owing to a small dissection ( $n=2$ ) or total occlusion ( $n=9$ ). The remaining patients were diagnosed using MRI (19) or arteriography (5) (diagnostic purposes only) in the non-acute phase.

**Table 1.** Patients' baseline characteristics.

	Total N = 41
Age (years), mean $\pm$ SD	47.34 $\pm$ 11.55
NIHSS score at admission, mean $\pm$ SD	7.02 $\pm$ 8.28
NIHSS score at discharge, mean $\pm$ SD	4 $\pm$ 5.24
Sex, n (%)	
Male	21 (51.2)
Symptoms, n (%)	
Ischemic stroke	32 (78.0)
Involved artery, n (%)	
Carotid	28 (68.3)
Vertebral	13 (31.7)
Artery lumen involvement, n (%)	
Occlusion	19 (46.3)
Stenosis	17 (41.5)
No involvement	5 (12.2)

SD, standard deviation; NIHSS, National Institute of Health Stroke Scale.

MRI was the most widely used technique, followed by arteriography.

In the analysis of both periods (before and after implementation of 24-hour/365-day mechanical thrombectomy in Seville), the number of MTs was higher after the implementation of endovascular treatment (57 vs. 343). We also found a higher rate of CAD diagnosis during the second period (1.1% vs. 2.2% of the total number of strokes,  $p < 0.001$ ), and this finding was true for both hospitals. In fact, 13 patients were diagnosed in the period before (1.1% of total strokes in 19.5 months) and 28 in the period following endovascular therapy implementation (2.2% of total strokes in 16.5 months). The rate of acute-phase diagnosis also increased during the second period (15.4% vs. 53.6%,  $p = 0.02$ ).

## Discussion

Diagnosis of CAD has increased in recent years owing to the continuous development of medical imaging technologies. Ultrasound, CTA, MRA, and digital subtraction angiography can all be used to diagnose CAD. Radiologically, evocative signs of CAD are a long and irregular stenosis sparing the carotid bifurcation, an intimal flap, or a false channel.<sup>3</sup> CAD may also present as an arterial occlusion or a dissecting aneurysm.<sup>3,4</sup> Currently, non-invasive imaging techniques such as MRI or MRA play an important role in the detection of mural hematoma.<sup>4</sup> Previous studies have shown that MRI can be used to detect hemodynamic changes within the first weeks after symptom onset.<sup>4</sup>

After the introduction of endovascular therapies for ischemic stroke, CTA has become the primary technique for the evaluation of vascular disorders. Our current results are consistent with those of other reports indicating that CTA has low accuracy for CAD detection, especially in vertebral arteries. In fact, CAD usually goes

unnoticed in cases of non-hemodynamic reperfusion or total occlusion.<sup>5</sup> Regardless of the CTA findings, arteriography is performed in patients with indications of thrombectomy, leading to the diagnosis of CAD even in cases with low suspicion. Although CAD can be secondary to endovascular procedures, primary CAD diagnosis is made based on previous arterial features, especially if vascular tortuosity is present.<sup>6</sup>

Rapid diagnosis of CAD is essential, especially in young patients with high rates of cryptogenic stroke, to determine the etiology of stroke.<sup>7</sup> Early diagnosis of CAD allows for a reduction in the number of tests performed, especially in patients with low suspicion of CAD.

Until now, CAD endovascular treatment has been controversial, and stent placement was only performed in cases of recurrence.<sup>8</sup> Changes in the acute management of stroke have permitted this entity to be managed in a different way. IVT has already been demonstrated to be safe in these patients;<sup>9</sup> however, no well-controlled (randomized or otherwise) studies on the effect of IVT in patients with CAD have yet been published. Thrombectomy is proving to be a safe procedure, and our data are consistent with this fact. The RECAST study showed that compared with isolated intracranial occlusion, mechanical treatment of CAD tandem occlusion is safe and effective.<sup>10</sup> However, no clinical trials have been conducted in this regard, and we only have data from observational studies to date.

The present study showed that CAD diagnosis in Seville, Spain, specifically in the acute phase, increased after the implementation of endovascular treatment for acute ischemic stroke; however, it is not possible to ascertain whether this increase is owing only to the arteriography technique itself, to the implementation of a brain imaging protocol for acute ischemic stroke, or both. However, because CT does not reveal dissection in many cases; it

seems that arteriography has a more important role in the increase of CAD diagnoses. In any event, acute-phase diagnosis allows for specific management, avoiding unnecessary tests.

Although our analysis is based on retrospective data with a small number of patients, our results yield evidence, for the first time, that rapid access to arteriography for thrombectomy is increasing the diagnoses of CAD. It would be most appropriate to show the overall number of patients with acute ischemic stroke referred to the two study hospitals during the two study periods to demographically and clinically characterize the study population so as to exclude differences between the two periods. However, we were unable to do so as the information systems of our two hospitals precluded our ability to collect these data automatically and reliably. Although we believe that it is quite improbable that bias owing to a higher proportion of younger patients during the second period is responsible for the increased rates of dissection, this issue should be better controlled in future studies.

Owing to the lack of characterization of the overall stroke population and absence of information on the exact diagnostic techniques used during the two study periods, the current data strongly support the increased diagnostic rate of arterial dissection during the acute phase. We can only speculate that this is the result of increased and faster access to arteriography for thrombectomy in acute stroke therapy during recent years.

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### Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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### ORCID iD

Soledad Pérez-Sánchez  <https://orcid.org/0000-0002-8940-9763>

### References

1. CADISP trial investigators, Markus HS, Hayter E, et al. Antiplatelet treatment compared with anticoagulation treatment for cervical artery dissection (CADISP): a randomised trial. *Lancet Neurol* 2015; 14: 361–367.
2. Debette S. Pathophysiology and risk factors of cervical artery dissection: what have we learnt from large hospital-based cohorts? *Curr Opin Neurol* 2014; 27: 20–48.
3. Ben Hassen W, Mached A, Edjlali-Goujon M, et al. Imaging of cervical artery dissection. *Diagn Interv Imaging* 2014; 94: 1151–1161.
4. Heldner MR, Nedelcheva M, Yan X, et al. Dynamic changes of intramural hematoma in patients with acute spontaneous internal carotid artery dissection. *Int J Stroke* 2015; 10: 887–892.
5. Lum C, Chakarborty S, Schlossmacher M, et al. Vertebral artery dissection with a normal-appearing lumen at multisection CT angiography: the importance of identifying wall hematoma. *ANJR Am J Neuroradiol* 2009; 30: 787–792.
6. Kim BJ, Yang E, Kim N, et al. Vascular tortuosity may be associated with cervical artery dissection. *Stroke* 2016; 47: 2548–2552.
7. Li L, Yiin GS, Geraghty OC, et al. Incidence, outcome, risk factors, and long-term prognosis of cryptogenic transient ischaemic attack and ischaemic stroke: a population-based study. *Lancet Neurol* 2015; 14: 903–913.
8. Moon K, Albuquerque FC, Cole T, et al. Stroke prevention by endovascular treatment of carotid and vertebral artery dissections. *J Neurointerv Surg* 2017; 9: 952–957.
9. Zinkstok SM, Vergouwen MD, Engelter ST, et al. Safety and functional outcome of

thrombolysis in dissection-related ischemic stroke: a meta-analysis of individual patient data. *Stroke* 2011; 42: 2515–2520.

10. Marnat G, Mourand I, Eker O, et al. Endovascular management of tandem

occlusion stroke relate to internal carotid artery dissection using a distal to proximal approach: insight from the RECAST study. *AJNR Am J Neuroradiol* 2016; 37: 1281–1288.