

LITERATURE REVIEWS

AN ANALYSIS OF THE ETIOLOGY OF CERVICAL ARTERY DISSECTIONS: 1994 TO 2003

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ABSTRACT

Objective: To provide a literature review of the etiologic breakdown of cervical artery dissections.

Methods: A literature search of the MEDLINE database was conducted for English-language articles published from 1994 to 2003 using the search terms *cervical artery dissection* (CAD), *vertebral artery dissection*, and *internal carotid artery dissection*. Articles were selected for inclusion only if they incorporated a minimum of 5 case reports of CAD and contained sufficient information to ascertain a plausible etiology.

Results: One thousand fourteen citations were identified; 20 met the selection criteria. There were 606 CAD cases reported in these studies; 321 (54%) were internal carotid artery dissection and 253 (46%) were vertebral artery dissection, not including cases with both. Three hundred seventy-one (61%) were classified as spontaneous, 178 (30%) were associated with trauma/trivial trauma, and 53 (9%) were associated with cervical spinal manipulation. If one apparently biased study is dropped from the data pool, the percentage of CADs related to cervical spinal manipulation drops to approximately 6%.

Conclusions: The case series that were reviewed in this article indicated that most CADs reported in the previous decade were spontaneous but that some were associated with trauma/trivial trauma, and a minority with cervical spine manipulation. This etiologic breakdown of CAD does not differ significantly from what has been portrayed by most other authors. (J Manipulative Physiol Ther 2005;28:617-622)

Key Indexing Terms: *Cervical Artery Dissection; Trauma; Manipulation; Neck; Vertebral Artery*

Cervical artery dissection (CAD) is an uncommon condition that begins as a tear or defect of the intimal lining of one of the major arteries in the neck that supplies blood to the brain. Subsequent to this insult and because of arterial pressure, blood penetrates into the vessel wall. The intima will usually separate from the medial layer, typically in the direction of blood flow.¹ Subintimal dissection may cause luminal narrowing or even occlusion leading to cerebral ischemia (Fig 1). Cervical

artery dissection may also manifest as a subadventitial dissection, which may result in the formation of a pseudoaneurysm (Fig 2). At times, CAD occurs with no associated tear of the intima; instead, there is hemorrhage of the vasa vasorum, allowing the formation of an intramural hematoma (Fig 3).²

The precise pathogenesis of CAD is not clear in most cases. Trauma, ranging from trivial to severe, is often implicated. Trivial traumas associated with CADs are numerous and include such common events as turning the head to back up a car, receiving cervical spinal manipulation, dancing, or having dental work.³⁻⁵ More commonly, however, CADs occur spontaneously, meaning that no apparent causative agent could be determined from the available data. This conclusion has prompted some authors to suggest that there must be an underlying arteropathy, which predisposes certain individuals to dissection.⁶⁻⁸ Several authors have reported that the incidence of arterial dissection is higher among patients with fibromuscular dysplasia, Marfan's syndrome, migraine, or hypertension.³⁻⁵ Smoking and the use of oral contraceptives are behaviors that may be associated with higher rates of dissection.⁹ Recent

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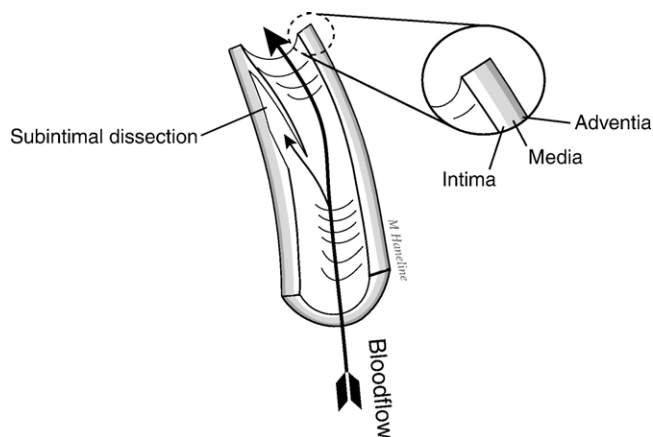


Fig 1. Subintimal dissection with associated luminal narrowing.

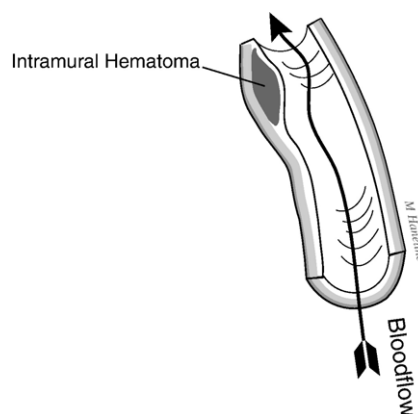


Fig 3. Cervical artery dissection without tearing of the intima, caused by hemorrhage of the vasa vasorum with subsequent formation of an intramural hematoma.

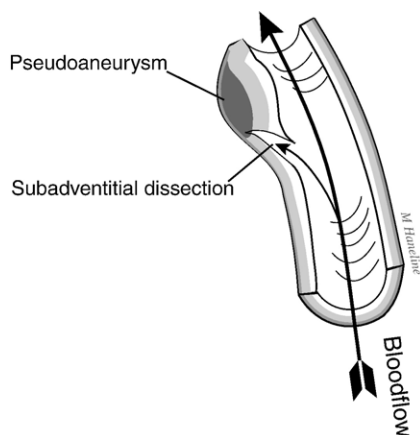


Fig 2. Subadventitial dissection with associated pseudoaneurysm.

infection and mild hyperhomocysteinemia have also been identified as risk factors and could be triggers for spontaneous CAD.^{10,11}

The distinction between spontaneous dissection and dissection due to trivial trauma is ambiguous. The clinical presentation of these two entities does not differ significantly, making it difficult to determine whether a dissection is spontaneous or secondary to trivial trauma.^{12,13} Indeed, if minimal “trauma” such as bowling and coughing is capable of precipitating CADs, then no dissection may truly be considered spontaneous. As a result, some authors have combined trivial trauma etiologies with spontaneous dissections when reporting cases in the literature.

A report highlighted a case of internal carotid artery dissection (ICAD) that was associated with French horn playing. The authors pointed out that there were concomitant aberrations of the patient’s connective tissue and mildly elevated plasma homocysteine levels that may have predisposed the patient to dissection. They stated that the growing

number of anecdotal reports linking everyday physical activities to the development of CADs may overestimate the pathogenic role of trauma.¹⁴

The incidence of vertebral artery dissection (VAD) has been estimated by Schievink et al¹⁶ to be 1 to 1.5 per 100 000 population yearly.¹⁵ Two epidemiologic studies have estimated the incidence of *spontaneous* ICAD as 2.6 and 2.9 cases per 100 000 per year.^{16,17} When comparing the two types of dissections, ICAD has been reported to occur 3 to 5 times more frequently than VAD.^{18,19} It has been reported that there are more than 7000 cases per year of ICADs alone in the United States.²⁰

Headache and neck pain occur in 50% to 80% of CADs, and may be the only warning symptoms of impending dissection.^{9,19} This is especially true when the headaches are described as new or unusual and characterized as sharp. Headaches associated with CADs often start suddenly and, most frequently, are unilateral on the side of arterial dissection. Furthermore, a CAD is even more likely when signs and symptoms of cerebral ischemia, Horner’s syndrome, or pulsatile tinnitus accompany the head and/or neck pain.

Because the earliest symptoms of a CAD are often neck pain and/or headache, it is likely that a victim of this disorder will seek assistance from one of several types of healthcare providers. Medical doctors, acupuncturists, naturopaths, herbologists, and chiropractors are all possible sources of attempted relief. Given the thousands of spontaneous CAD cases that occur each year in the United States alone, the likelihood that chiropractic physicians will encounter patients with CAD is relatively high.

There have been numerous reports in the medical literature regarding the proportion of CADs thought to be spontaneous, related to trauma/trivial trauma, or related to cervical manipulation.²¹⁻²⁵ The proportion of CADs that can be attributed to manipulation, in particular, is uncertain.

Table 1. Cervical artery dissection case series reported from 1994 to 2003, where factors of etiology could be determined^a

	n	ICAD/VAD	CAD etiology		
			Spontaneous	Trivial or other trauma	Manipulation
Bassi et al ²⁷	49	36/13	31	18	0
Chabrier et al ²⁸	5 ^b	3/2	0	5	0
Dziewas et al ⁴	126	78/46 ^c	77	29	20
Gonzales-Portillo et al ²⁹	27	18/9	22	3	2
Pezzini et al ³⁰	34	20/14	32	1	1
Camacho et al ³¹	5	4/1	5	0	0
Brandt et al ⁶	65	29/7 ^c	55	8	2 ^d
Norris et al ³²	74	21/53	14	39	21
Saeed et al ²⁵	26	§/26	12	11	3
Shin et al ³³	8 ^e	§/8	3	5	0
Ahmad et al ³⁴	18	10/8	2	14	2
Auer et al ³⁵	19	§/19	7	12	0
Brandt et al ³⁶	25	17/8	20	4	1
de Bray et al ³⁷	7	§/7	4	2	1
Mascalchi et al ³⁸	14	§/14	10	2	2
Sidhu et al ³⁹	5	5/§	5	0	0
Bakke et al ⁴⁰	14	12/2	12	2	0
Desfontaines and Despland ²⁴	60	60/§	50	10	0
Sturzenegger ⁴¹	14	§/14	5	7	2
Schievink et al ⁷	11 ^b	8/2 ^c	5	6	0
Total	606	321/253	371	178	53

§ Not included in the study.

^a Selection criteria: cervical artery dissection case series of 5 or more cases reported between 1994 and 2003 (inclusive); sufficient information was presented regarding etiology; and cases were not selected based on type of etiology (ie, all manipulation-related or all spontaneous).

^b Children; does not include intracranial cases.

^c Does not include cases that experienced both ICAD and VAD.

^d Personal communication with T Brandt, MD.

^e Intracranial CAD cases were excluded.

Table 2. Breakdown of CADs involving the ICA vs the VA (when reported) that were associated with manipulation from case series reported from 1994 to 2003

	N	Manipulation-related CAD	
		ICAD	VAD
Dziewas et al ⁴	19 ^a	5	14
Gonzales-Portillo et al ²⁹	2	0	2
Brandt et al ⁶	2	1	1 ^b
Saeed et al ²⁵	3	‡	3
Ahmad et al ³⁴	2	1	1
Brandt et al ³⁶	1	1	0
de Bray et al ³⁷	1	‡	1
Mascalchi et al ³⁸	2	‡	2
Sturzenegger ⁴¹	2	‡	2
Total	34	8	26

‡ Not included in the study.

^a Does not include cases that experienced both ICAD and VAD.

^b Personal communication with T Brandt, MD.

Accordingly, the purpose of this article is to produce a reasonable estimate of the etiologic breakdown based upon a literature search of suitable studies published during the previous decade.

METHODS

A literature search was performed to locate case series that dealt with etiologic factors of CAD during the preceding 10-year period. The MEDLINE database was searched for English-language articles published during the period extending from 1994 to 2003. Search terms included *cervical artery dissection*, *vertebral artery dissection*, and *internal carotid artery dissection*. In addition, a cross tabulation was performed from the reference section of the selected articles to find other suitable studies. The inclusion criteria for article selection encompassed all studies that reported 5 or more cases of CAD and also provided enough information to ascertain the supposed etiology of the dissections.

In an attempt to minimize possible selection bias, only studies that included 5 or more cases were included in this research. Single case reports often have dealt with an atypical patient whose condition was highlighted to educate the reader about an unusual medical situation. Authors typically select rare or unusual conditions as topics for case reports. Where CAD is involved, certain types of trauma or manipulation-related cases may be over-represented because they tend to be more interesting than CADs with an uneventful or mundane history. This type of problem was

apparent in a study by Frisoni and Anzola²⁶ where 3 cases of CAD were presented in an article highlighting the alleged relationship of VAD with neck motion, when all 3 cases were manipulation-related.

RESULTS

A total of 1014 citations were identified, 20 of which reported sufficient numbers of CAD cases to be included in this analysis. There were 606 CAD cases reported among the 20 studies; 321 (54%) were ICAD and 253 (46%) were VAD. When only considering studies that included both types of dissection, there were 256 (61%) ICADs and 165 (39%) VADs. Most of the authors (58%) incorporated both types of dissection in the same study, whereas 42% exclusively reported either VAD or ICAD cases.

There were 371 (61%) CADs listed as spontaneous, 178 (30%) associated with trauma/trivial trauma, and 53 (9%) associated with manipulation. Table 1 lists all of the case series that were included. Seven studies with sufficient numbers of CADs cases to meet the inclusion criteria did not differentiate spontaneous cases from other possible causes and were therefore excluded from the analysis.⁴²⁻⁴⁸ When specifically considering studies reporting manipulation-related CADs that made a distinction between the occurrence of dissection in the internal carotid artery (ICA) vs the vertebral artery (VA), there were 34 cases, 8 (24%) involving the ICA and 26 (76%), the VA (Table 2).

DISCUSSION

The breakdown of CAD etiologies that has been presented in this review provides a reasonable depiction of what is contained in the recently published literature. However, because there are no widely-agreed-upon definitions for the categorization of CAD etiologies, these figures may not accurately reflect the true breakdown. Categorizing CADs as spontaneous or trivial trauma-related may seem, at first glance, to be a straightforward task. Nevertheless, the issue of trauma/trivial trauma and its connection to CAD is controversial because a temporal link is generally the only evidence that is available when determining culpability. Brandt and Grond-Ginsbach⁴⁹ pointed out that, based on clinical and histopathologic studies, mechanical trauma was not an "important and frequent cause" for the development of CAD. They indicated that although mechanical stretching or compression of the cervical arteries may be capable of triggering CAD, mechanical injury may not be the most important risk factor in such cases. Moreover, supposed "traumas" or "trivial traumas" may not have been involved at all in some instances. This concept was substantiated by a histopathologic study of 50 ICADs that found less than 10% of the

preparations showed any indication of mechanical damage to the artery.⁵⁰

Pathogenic arterial wall weakness is a predisposing factor that is often present in CAD patients and may play a more important causative role than mechanical factors.⁴⁹ In cases where there are no adverse symptoms within a reasonably close temporal proximity to trauma/trivial trauma, there will always be doubt regarding its connection with any given CAD. Furthermore, patients with arterial disorders are plausibly at risk for developing CAD when subjected to virtually any sort of head or neck motion.

It was previously mentioned that ICADs have been reported to occur 3 to 5 times more frequently than VADs. However, this review points toward a ratio of approximately 3 ICADs for every two VADs. The reader should bear in mind that the accuracy of this ratio is dependent upon the various methods of data collection used in the collected research.

The relative proportions of CAD etiology among the studies included in this analysis were fairly consistent. One exception to this consistency does exist, however. The Norris et al³² case series presented data highly atypical of past studies, especially about the reported ratio of VAD to ICAD cases. All of the other studies showed a higher number of ICADs as compared with VADs. In fact, the overall ratio of ICAD to VAD was 300:200, not including the Norris et al data. In contrast, the Norris et al ratio was 21:53, with VAD cases more than doubling the number of CAD cases. Another inconsistent finding in the Norris et al study concerned the authors' statement that more than 80% of their CAD cases were related to trivial trauma or manipulation, with 28% being related to cervical manipulation alone. These figures were much higher than what was reported in any of the other studies reviewed.

In an attempt to appreciate how the above referenced discrepancies might have occurred, we offer a very brief critique of that Norris et al³² study. There appears to have been systematic methodological biases that were integrated into the study's design. For example, the survey instrument used to gather the study's CAD data, available from the Canadian Stroke Consortium (www.strokeconsortium.ca) contained a serious problem with respect to its poor construction. There was a leading question in a foundational portion of the questionnaire that may have caused the physician respondents to provide biased answers. The question dealt with whether trauma was related to the CAD under consideration and reads, "Cervical trauma/manipulation." Because manipulation is only one of the many trivial events that are thought to be associated with CAD, it should not have been singled out and, thus, presented as a leading question. Bias was again evident when the word "manipulation" was used 13 times in this short article about the association of *all* sudden neck movement to CAD.

Reviewing all the studies included in this analysis, 30% of the CADs were found to be associated with trauma/trivial

trauma and 9%, with manipulation. These percentages include the Norris et al³² data, although they appeared to be biased against manipulation. If one excludes the suspect Norris et al data, the percentage of CADs related to trauma/trivial trauma drops to 26%, and the percentage related to manipulation decreases to 6.1%.

Rothwell et al⁴⁷ recently carried out a population-based study which appears to be the most reliable investigation to date regarding the percentage of VADs associated with manipulation. Its reliability lies in the fact that the study included all VADs occurring in the Province of Ontario, Canada that were admitted to any acute-care facility during a 6-year period. This method minimized selection biases that have plagued most other studies. The figures they presented suggest that approximately 1.6% of persons with VAD received cervical manipulation in the week before the onset of definitive cerebral ischemic findings. This percentage was significantly less than 9%, which represented the average of all the studies included herein. Accordingly, the true proportion of VADs ostensibly associated with manipulation remains elusive, but it is most likely less than 9%.

CONCLUSION

This work provides an estimate of the etiologic breakdown of CADs reported during the previous decade. The case studies reviewed indicate that, during the specified period, most CADs were labeled as spontaneous, but some were associated with trauma/trivial trauma, and a minority was associated with cervical manipulation. The proportion of CAD etiologies presented does not differ significantly from what has been presented by other authors, with the exception of Norris et al.³²

The etiology of CAD has been difficult to investigate because of its relatively uncommon rate of occurrence, the delay that is thought to transpire between the time of dissection and onset of symptoms, and the lack of available histopathologic information in most cases. Moreover, the temporal relationship of an event with the onset of symptoms does not necessarily imply causation. As stated previously, the etiology of CAD is complex and often multifactorial, especially when trivial trauma and manipulation are involved. Other risk factors or risk conditions, such as fibromuscular dysplasia, Marfan's syndrome, migraine, hypertension, smoking, use of oral contraceptives, recent infection, and mild hyperhomocysteinemia, should be considered in any given case.

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