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Pregnancy and postpartum period as risk factors for cervical artery dissection

Janusz Skrzat, Anna Yevstifeieva, Grzegorz Goncerz

Department of Anatomy, Faculty of Medicine, Jagiellonian University Medical College, Kraków, Poland

Corresponding author: Janusz Skrzat, Ph.D., D.Sc.
Department of Anatomy, Jagiellonian University Medical College
ul. Kopernika 12, 31-034 Kraków, Poland
Phone/Fax: +48 12 422 95 11; E-mail: j.skrzat@uj.edu.pl

Abstract: Pregnancy and the postpartum period are associated with physiological, hormonal, and hemodynamic changes that may increase susceptibility to cervical artery dissection. Structural alterations of the arterial wall can result from a variety of factors, predisposing vessels to injury and subsequent neurovascular events. In the present study, we analysed the contribution of multiple factors to the development of cervical artery dissection in pregnant women, including advanced maternal age, hormonal status, hypertension, hyperlipidaemia, connective tissue disorders, arterial malformations, migraine, adverse or rapidly changing head and neck positions, neck trauma, chiropractic manipulation, the presence of an elongated styloid process, pressure-inducing activities, and physical exercise.

Keywords: carotid artery dissection, cervical artery dissection, pregnancy.

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Introduction

Pregnancy is associated with considerable cardiovascular and hemodynamic changes such as: increased blood volume, cardiac output, maternal heart rate, whereas blood pressure may either remain constant or be slightly decreased. [1] An initial increase of blood volume is observed about the 12th week of gestation, reaching a peak of 40–50% above non-pregnant levels at 32 to 34 weeks of gestation. The maternal heart rate begins to rise as early as 7 weeks of gestation. By the time of delivery, the heart rate is approximately 20% higher than the rate prior to pregnancy.

Maternal cardiac output starts to increase as early as 10 weeks of gestation, peaking at 50% above the maternal prepregnant cardiac output by the end of the second trimester. During the first stage of labour, cardiac output can increase up to 30%, mainly due to an increase in stroke volume. At term, the cardiac output for a pregnant woman at rest is between 6 and 7 L/min,

compared to the normal range of 4 to 5 L/min observed in non-pregnant women. [1] This elevated level of maternal cardiac output stabilizes and remains consistent until term. Physiological adaptations are essential to meet the increased metabolic demands of both the mother and the developing foetus, and directly influence maternal–foetal oxygen transport. Furthermore, maternal arterial blood pressure declines during the first trimester, reaches its lowest point in the second trimester, and then gradually rises, approaching prepregnant levels in the final two months of pregnancy. [2, 3] Women generally tolerate the physiological changes of pregnancy well; however, under certain conditions, impaired adaptation to hemodynamic and hormonal shifts can weaken vessel walls, leading to vascular complications such as arterial dissection. [4] Thereby, pregnancy may be regarded as a risk factor for artery wall dissection primarily due to altered interplay between hormonal, hemodynamic, and mechanical changes that affect the vascular system.

With regard to the aforementioned issues, this review summarizes the evidence on pathophysiological and mechanical factors associated with cervical artery dissection during pregnancy and the postpartum period, with particular emphasis on factors that compromise arterial wall integrity. A targeted literature search was conducted in PubMed, Scopus, and Google Scholar, considering articles published in English up to December 2025. Search terms included combinations of "cervical artery dissection," "carotid dissection," "vertebral artery dissection," "pregnancy," and "postpartum." Original studies, systematic reviews, meta-analyses, and relevant case series were included, while case reports were selectively used to illustrate specific associations.

Pathophysiology and epidemiology of arterial wall dissection

An artery dissection occurs when there is a tear in the inner layer of the artery wall, leading to a separation of the intima and media layers of the artery wall. When the inner layer of the artery is torn, blood enters the vessel wall, creating a clot or a "false lumen" (an abnormal space between layers of the arterial wall). This condition can disrupt or reduce blood flow to the brain which may lead to ischemic stroke and various neurological impairments. [5, 6] In case of the cervical arteries (the carotid and vertebral arteries) there are two types of dissections: spontaneous and traumatic. Spontaneous dissection does not result from trauma or injury to the neck but usually is a consequence of connective tissue disorders, high blood pressure, migraines, respiratory infections, contraceptive use, pregnancy, autoimmune disease (systemic lupus erythematosus) and smoking, as well. [7] In turn, traumatic dissection of the cervical arteries is caused by external forces that may act during traffic accidents, sports, or even chiropractic manipulations. [8]

Arterial dissections were noted in 5.5 per 100,000 hospitalized pregnant or postpartum women, with the highest occurrence observed during the postpartum period. The most common locations for dissections were coronary (38.2%), vertebral (22.9%), aortic (19.8%), and carotid (19.5%). [9] The average annual incidence of cervical artery dissection has been estimated at 2.6 per 100,000 individuals. [10] Furthermore, Schievink and Roiter noted the incidence of spontaneous cervical artery dissection is highest in autumn (approximately 5 per 100,000). [11] Trager *et al.* found that women during pregnancy and the postpartum period have a twofold increased risk of cervical artery dissection compared to non-pregnant women. [12]

Cervical artery dissection that occurs spontaneously may cause ischaemic stroke or transient ischaemic attack in both young and middle-aged persons, regardless of their sex, although the risk of stroke is higher in women than in men. Additionally, the stroke outcomes for women are

more severe compared to men. [13] Recent studies indicate that cervical artery dissection may occur in both males and females at nearly the same rate. [14] Conversely, Metanis *et al.*, found that cervical artery dissection occurs more frequently in males, who are more likely to have associated risk factors and traumatic neck injuries. [15] As reported by Griffin *et al.*, the incidence rate of spontaneous cervical artery dissection has increased nearly four times from 2002 to 2020, with a pronounced increase of over twelvefold in women. [16]

Contribution of pathophysiological and traumatic factors increasing risk of cervical artery dissection during pregnancy

According to Omran *et al.* pregnancy roughly doubles the risk of cervical artery dissection compared to non-pregnant women, but this risk escalates in postpartum phase, reaching a rate that is 5.5 times higher. [17] This condition provides a possible explanation for why pregnancy is a risk factor for stroke, and why neurologic symptoms such as headache or neck pain occur. [18, 19] Borelli *et al.* noted that postpartum headaches are relatively common and can sometimes be a symptom of serious cerebrovascular events resulting from spontaneous cervical artery dissection. [20] However, not all pregnant women face the same risks of cervical artery dissection, as specific pregnancy-related factors elevate susceptibility in certain cases. The risk is highest in the late third trimester and early postpartum period, when hormonal, hemodynamic, and mechanical stresses overlap. According to Kärkkäinen *et al.* the carotid artery elasticity decreases progressively during pregnancy, particularly in the third trimester. [21] The stiffening of the carotid artery results primarily form advanced gestational age, and does not have a direct correlation with maternal hyperlipidaemia, the diameter of the carotid artery, or alterations in endothelial function. Visontai *et al.* found that during pregnancy, carotid artery stiffness increases, leading to reduced baroreflex sensitivity, despite a concurrent increase in systemic arterial distensibility. [22] This reduction in carotid elasticity is primarily associated with advancing gestational age and is independent of maternal hyperlipidaemia, carotid diameter, or endothelial function. These findings suggest that decreased carotid elasticity represents an adaptive response to pregnancy-related hemodynamic changes, including increased cardiac output and blood volume.

Analysis of risk factors of cervical artery dissection

Various factors, including both pathological and non-pathological, can influence the likelihood of arterial wall dissection by either weakening or damaging the structural composition of the wall. A thorough retrospective cohort study or meta-analysis of these conditions were performed by: Abdelnour *et al.*, [23] Beyer *et al.*, [9] Biller *et al.*, [24] Jacobs *et al.*, [6] Rist *et al.*, [25] Sun *et al.*, [26] Trager *et al.* [12]

From the whole spectrum of risk factors of cervical artery dissection we selected and analysed the conditions that increase vulnerability of the cervical arteries to injury, either by weakening the arterial wall or by exposing it to mechanical stress (Table 1). Thereby, selected factors were classified into two categories:

1. Intrinsic factors / pathogenic conditions — predisposing factors represent underlying conditions that weaken arterial wall, increasing susceptibility to dissection.
2. Mechanical factors / environmental factors — triggering factors that directly cause dissection of arterial wall through mechanical stress.

Table 1. Potential factors predisposing development of the cervical artery dissection during pregnancy and postpartum period.

Intrinsic factors / Pathogenic conditions	Mechanical factors / Environmental factors
Advanced age	Adverse head position and rapid movements
Hormonal level	Neck injuries
Hypertension and hyperlipidaemia	Chiropractic manipulation
Connective tissue disorders	Elongated styloid process
Arterial malformations	Pressure-inducing activities
Migraine	Physical exercises

The influence of intrinsic factors or pathogenic conditions on the arterial wall

Advanced maternal age

Advanced maternal age is associated with three-fold increased risk of cervical artery dissection during pregnancy. In a large case-control and cohort study, pregnant women aged ≥35 years had a higher relative incidence of cervical artery dissection (IRR 3.0) compared with younger women (IRR 1.9) during pregnancy. [17] According to Beyer *et al.*, older maternal age (mean 33 years in women with dissection vs. 28 years in those without) was associated with a higher risk of arterial dissection. Postponed pregnancy may increase the risk of negative pregnancy outcomes, including hypertensive disorders, possibly because of changes in arterial structure and function or inadequate vascular adaptations throughout pregnancy. [9] Lee *et al.* evaluated the impact of advanced maternal age on both vascular and autonomic functions during all three trimesters. [27] Compared with younger pregnant women, those of advanced maternal age demonstrated increased arterial stiffness and elevated carotid intima-media thickness, along with impaired autonomic regulation throughout pregnancy, even though there was no significant variation in endothelial function. This could imply that older pregnant women might have early latent changes affected vascular function. However, no large studies have shown a strong age-specific increase in the risk of cervical artery dissection during pregnancy or the postpartum period.

Although vascular changes associated with advanced maternal age offer a plausible biological explanation for increased susceptibility, this association has not been confirmed by clinical outcome studies.

Hormonal level

Hormonal changes during pregnancy may influence arterial wall structure and function and potentially modify susceptibility to dissection. Hormones, especially: estradiol**,** progesterone, and relaxin play a significant role for maintaining the integrity of the arterial wall.

During pregnancy, elevated estradiol levels have complex effects on arteries: they may weaken the arterial wall structurally, but also improve vascular compliance and reduce hemodynamic stress. As a result, the net effect on arterial dissection risk depends on individual susceptibility. Arterial wall mechanics and endothelial function critically influence both dissection behaviour and repair capacity. [28, 29]

Progesterone exerts protective effects on the cardiovascular system through its anti-inflammatory actions on blood vessels and modulation of vascular function. [30] It influences collagen and elastin synthesis, thereby contributing to the maintenance of arterial wall stability. Furthermore, progesterone affects placental arteries and veins by promoting endothelium-independent relaxation, which supports adequate uteroplacental blood circulation. [31]

In turn, relaxin is a hormone that, during pregnancy, confers cardiovascular benefits. [32] It modulates arterial wall structure by influencing collagen synthesis and maintaining elastin integrity, thereby preventing excessive stiffening while promoting vascular flexibility. It also relaxes vascular smooth muscle to enhance blood flow, dilate vessels, lower arterial pressure, and reduce the risk of arterial wall dissection. [33]

Overall, hormonal influences should be regarded as modifiers of vascular vulnerability rather than independent causal factors for cervical artery dissection.

Hypertension

Arterial hypertension is regarded as a major risk factor for arterial dissection. Pregnancy combined with hypertension elevates the risk of cervical artery dissection encompassing both carotid and vertebral artery dissection. [34] Pezzini *et al.* identified a correlation between arterial hypertension and increased risk of spontaneous cervical artery dissection when compared to the control group. [35] The association was particularly pronounced in patients who also experienced cerebral infarction, especially in cases of vertebral artery dissections. In turn, Arnold *et al.* found that the overall frequency of hypertension did not differ significantly between patients affected with spontaneous cervical artery dissection and controls. [36]

Hypertension, particularly in the form of hypertensive disorders of pregnancy such as preeclampsia or eclampsia and gestational hypertension, appears to be a recurrent and clinically relevant comorbidity in reported cases of pregnancy-related and postpartum cervical artery dissection. Although the available evidence is largely derived from case reports and small case series, the systematic review suggests that elevated blood pressure may contribute to arterial wall vulnerability through hemodynamic stress and endothelial dysfunction during pregnancy and the postpartum period. [23] Roberts *et al.*, in their analysis of population-based trends in hypertensive disorders of pregnancy, reported considerable variation in absolute rates across populations; [37] however, overall prevalence estimates indicate that gestational hypertension affects approximately 3–9% of pregnancies, preeclampsia occurs in 1.4–4%, and eclampsia is comparatively rare.

According to Beyer *et al.* gestational hypertension and preeclampsia/eclampsia were significantly more prevalent among pregnant women with arterial dissection compared with pregnant women without arterial dissection (6.0% vs. 0.6% and 2.7% vs. 0.4%, respectively). [9] Moreover, Omran *et al.* observed that 45% of women diagnosed with postpartum cervical artery dissection had a documented history of hypertensive disorders of pregnancy. [17]

Consequently, precise role of hypertension in dissecting cervical artery remains intricate and needs further studies due to conflicting findings from clinical research. Therefore, the aim of future research should be to establish what the most critical combined effect of hypertension and additional factors is in raising the risk of cervical artery dissection during pregnancy.

Hyperlipidaemia

Several studies have explored hyperlipidaemia as a potential risk factor for cervical artery dissection. However, only a limited number have directly compared serum lipid levels between patients with spontaneous cervical artery dissection and control groups, and these investigations used heterogeneous lipid profiles and assessment methods.

Arnold *et al.* reported that major vascular risk factors including hypercholesterolemia, hypertension, diabetes, and smoking did not differ significantly between patients that experienced cervical artery dissection comparing to the control group. [36] In turn, Abdelnour *et al.* reported in a meta-analysis an inverse association between spontaneous cervical artery dissection and hyperlipidaemia in the general population. [38] However, the authors noted that this association lost statistical significance in sensitivity analyses and that definitions of hyperlipidaemia varied across studies. Although hyperlipidaemia is a well-established risk factor for atherosclerotic cardiovascular disease, it has not, to date, been regarded as a significant direct risk factor for cervical artery dissection during pregnancy or the postpartum period. Instead, hyperlipidaemia appears as potential contributing factor that may interact with physiological factors related to pregnancy which in combination may amplify the risk of vascular changes. The relationship between spontaneous cervical artery dissection and hyperlipidaemia remains unclear, emphasizing the need for well-designed studies and meta-analyses to draw more definitive conclusions. Thereby, further prospective studies are warranted to better define the strength and nature of this association, particularly in the context of cervical artery dissection occurring during pregnancy.

Connective tissue disorders

Connective tissue disorders have been suggested as a potential underlying condition contributing to the aetiology of spontaneous cervical artery dissection. [39] The Ehlers-Danlos syndrome, Marfan syndrome or fibromuscular dysplasia may increase the risk of arterial dissection. Patients with Ehlers-Danlos syndrome have a significantly increased likelihood of hospitalization for carotid and vertebral artery dissection compared with the general population, despite low absolute event rates. [40] Nevertheless, associations with spontaneous cervical artery dissection were also reported as very rare, accounting for less than 2% of all cervical artery dissections in vascular Ehlers-Danlos syndrome, whereas in Marfan syndrome it was less than 1%. [41, 42] Only, fibromuscular dysplasia is more likely to lead to the occurrence of spontaneous cervical arterial dissections. [43, 44] These conditions are all relatively rare genetic disorders, therefore the number of pregnant women who have any of these diseases is relatively low.

Arterial malformations

Cervical arterial malformations, including coils, loops, and elongated segments, significantly alter hemodynamics and increase mechanical strain on the arterial wall making it susceptible to dissection. Kim *et al.* identified a clear link between internal carotid artery tortuosity (reported as loops, kinks or coils) and spontaneous dissection. [45] As reported Giossi *et al.* patients exhibited cervical artery dissection had increased arterial tortuosity. Greater tortuosity of the cervical artery may indicate an increased risk of arterial dissection. [46] The prevalence of any tortuosities of the extracranial portion of the internal carotid artery was higher in the patients with spontaneous

cervicocerebral artery dissection. [47] Furthermore, Barbour *et al.* found a significant correlation between internal carotid artery redundancy and dissection, particularly if redundancy is present bilaterally. [48]

In pregnant women, the risk posed by the arterial malformations can be exacerbated by the combined influence of hemodynamic and hormonal changes. The increased blood volume and blood pressure fluctuations characteristic of pregnancy, particularly in the context of preeclampsia, put additional strain on weakened arterial wall from malformation. Under these conditions, even routine neck motion can act as a mechanical trigger, precipitating a dissection of the compromised arterial wall.

Migraine

Migraine is a common disorder affecting approximately 18% of the female population. The prevalence of migraine increases until approximately the age of 40, after which it begins to decrease. [49] Multiple studies have shown that individuals with a history of migraine have increased (approximately a two-fold) risk of cerebral ischemic events, particularly among young individuals compared to those without migraine, regardless of gender, though few studies presented gender-specific data. [25, 26, 50] Pregnancy usually reduces the frequency and severity of migraine attacks. Rising estrogen and endorphin levels suppress migraines, and post-pregnancy breastfeeding can extend this benefit. Sex hormones affect both migraine types, but in slightly different ways. [51, 52] Approximately 60–70% of women suffering from migraine experience improvement during pregnancy, especially in the second and third trimesters. [53] However, a small percentage of women may experience their first migraine during pregnancy or postpartum period.

Because the incidence of migraine coincides with advanced maternal age (30–40 years), it should be considered a potential contributing factor to cervical artery dissection, particularly in in conjunction with other pathophysiological conditions.

Traumatic factors that can trigger cervical artery dissection

Adverse head position and rapid movements

Prolonged adverse head positioning, rapid head and neck movements have been proposed as potential risk factors for cervical artery dissection. [6] However, such activities during pregnancy can be rather incidental so their role in triggering cervical carotid artery dissection seem to be marginal. For a healthy pregnant woman, avoiding extreme neck movements is more about general comfort, rather than being a direct precaution against cervical artery dissection.

Neck injuries

Neck injuries in pregnant women may result from postural changes. Pregnancy may elevate the risk of certain injuries because of altered body mechanics and the increased weight of the enlarging uterus. As pregnancy advances, the centre of gravity in a woman's body changes position due to the abdominal growth, thereby increasing strain on the cervical musculature and making pregnant women more vulnerable to neck injuries. Studies have shown that pregnancy significantly increases the spine curvatures, especially between the second and third trimesters. [54]

Automobile accidents represent an additional source of neck injuries; therefore, this should be considered for pregnant women as a potential situation that may result in arterial dissection. Injury severity, and fatality rate were significantly lower in pregnant women than in non-pregnant women as found by Koh *et al.* [55] However, this observation should not be regarded as a universal standard in all countries.

Chiropractic manipulation

Chiropractic manipulation (cervical spine manipulation), during pregnancy can be used to help alleviate back pain, pelvic discomfort. There is a potential risk of cervical artery dissection from chiropractic manipulation, especially the vertebral artery. [24, 56] The number of cases is extremely low, and many of these cases involved people with pre-existing vascular risks, such as a history of arterial disease or trauma. According to Curch *et al.* there is no convincing evidence to support a causal link between chiropractic manipulation and cervical artery dissection. [57] Therefore, it's not considered a significant factor for most pregnant women, especially those without pre-existing health conditions like arterial disease or trauma. To minimize risks, pregnant women should consult their healthcare provider before seeing a chiropractor.

Elongated styloid process

An elongated styloid process, and ossified stylohyoid ligament can increase likelihood of dissection in extracranial portion of the internal carotid artery compared with people having normal styloid process. [58] Due to close proximity between these structures, an elongated styloid process or ossified stylohyoid ligament can lead to irritation or compression of the carotid artery, and such condition may trigger dissection of its wall. The prevalence of a styloid process that is elongated (exceeding 30 mm in length) may fluctuate from 1.4% to 30%, based on the criteria for length evaluation and population study. [59] However, only a small proportion (4%) of individuals with an elongated styloid process develop clinical manifestations of Eagle's syndrome. [60] Therefore, its role as a causative factor in internal carotid artery dissection during pregnancy appears to be highly unlikely.

Pressure-inducing activities and physical exercises

Physical activities such as: carrying heavy objects, breath-holding (Valsalva manoeuvre), forceful coughing, vomiting, have been recorded as conditions that probably triggered arterial dissection Nevertheless, there is no strong evidence that everyday activities or physical exercises meaningfully increase the risk of cervical artery dissection. [61] During pregnancy, hormonal and hemodynamic changes may predispose to sudden increases in blood pressure; thus, intense physical exertion or lifting heavy objects may be risky, particularly in women with additional factors predisposing to cervical artery dissection.

Limitations of the study

The present study did not address the following issues:

- Risk of recurrent cervical artery dissection during pregnancy, childbirth and postpartum.
- The risk of cervical artery dissection recurrence in future pregnancies.

- Long-term risk of repeated cervical artery dissection and stroke following pregnancy.
- Spontaneous multiple cervical artery dissection in the pregnancy and postpartum period.
- Cervical artery dissection in women after caesarean delivery during the postpartum period.

Conclusions

Cervical artery dissection is a multi-factorial disorder, particularly in pregnancy and the postpartum period because of physiological changes, which include elevated blood volume, and hormonal imbalance that contribute to stiffening of arterial walls. Additionally, the risk of cervical artery dissection may be amplified by advanced maternal age, arteriopathies and physical traumatic events, as well. Multiple reports suggest that cervical artery dissection may contribute to pregnancy-related or postpartum stroke. The early identification of cervical artery dissection in pregnant women will enable prompt intervention and minimize related neurological complications.

Conflict of interest

The authors declare no conflict of interest, nor any financial interest associated with the current study.

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