Review

The Overlooked Significance of the Ponticulus Posticus in Whiplash Patients

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The Overlooked Clinical Significance of the Ponticulus Posticus in Whiplash Patients

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Abstract

Because of its anatomical complexity, the cervical spine is highly susceptible to injury, especially the blunt acceleration/deceleration trauma of which the most frequent mechanism, is "whiplash", commonly referred to as Whiplash Associated Disorder (WAD). Despite this knowledge the significance and complexity of whiplash injuries are widely underestimated. This underestimation of the significance of this injury is the widely held belief that it is a benign self-limiting soft tissue injury that frequently has monetary gain attached. This negative framing of the injury which has largely been shaped by the insurance industry rather than by clinicians frequently causes medical providers to view the injury with skepticism. Adding to the problem faced by clinicians are the more recently imposed guidelines for diagnosing and treating acute whiplash, especially in the area of imaging that has placed both the provider and the patient at increased risk.

Keywords: cervical spine; chiropractic; ponticulus posticus; whiplash; vertebral artery dissection; X-rays

Introduction and Background

In 1955 Severy et al. reported that motor vehicle collisions, even at 20 km/h, (Approximately 12 mph) can cause cervical spine injury and related symptoms. [1] Nonetheless, the insurance industry has been able to codify no damage, no injury with the MIST (Minor Impact Soft Tissue) protocol. MIST is an insurance industry claims-handling strategy that assumes, based on low-speed impact, that minimal vehicle damage (often >$1000) equals little to no bodily injury. It is commonly used to flag claims for potential fraud.

Adjusters often use this method to deny or drastically reduce payouts, regardless of medical evidence, but it has been widely criticized by medical professionals as scientifically invalid. [2]

Because of the pervasive dissemination of misinformation regarding the severity that can occur from rear end low impact motor vehicle accidents , as well as the pressure to reduce unnecessary imaging imposed by governmental regulatory agencies and professional associations-ostensibly to minimize radiation exposure and healthcare costs [3] despite concerns about an over-reliance on them, this is especially true in the elderly where the potential to miss fractures, including that of the odontoid which are more common in older patients. [4] Clinicians are confronted by a complex clinical scenario wherein an inflexible or dogmatic adherence to guidelines designed to reduce imaging could result in missed diagnoses and/or delayed treatment of significant cervical injuries. The two dominant guidelines used in emergency and trauma settings in North America to decide on cervical spine imaging are the NEXUS National Emergency Radiography Utilization Study and the Canadian C-Spine Rule (CCR) which was developed and validated in Canada. [5] These guidelines are purported to rely on settled science, and while unnecessary radiation exposure should be of concern, the issue regarding the dangers of X-rays is far from settled. Arone et.al noted "a threshold level of radiation exposure that leads to adverse health effects has not, and likely cannot be, determined", [6] and numerous other authors questioning if in fact low level radiation exposer is as detrimental to the body as originally thought, [7] with others noting the process of hormesis which

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can mitigate risk from exposure is also inconclusive. [8] Oakley et al. have labeled this X-ray hesitancy as "radiation fearmongering" [9]

When a patient who has sustained an acute cervical spine injury is summarily dismissed by an emergency room or family physician because of insufficient damage to the vehicle or because there are no neurological deficits on examination, without first obtaining a minimum 3-view X-ray series (although a 5-view series, including flexion and extension, if safe to perform) and should be included), puts both the clinician and the patient at risk. [10] Unfortunately, in the absence of neurological findings, this omission of imaging has become more frequent. While it is assumed that the neurologically intact patient has a low-level risk for fracture, this is not the only information that is available on a plain cervical spine X-ray. To fail to obtain post trauma X-rays of the cervical spine is to ignore often overlooked or ignored anatomical variants and other structural findings that indicate serious injury. [11]

Davis noted that "During injury, there is a sudden unexpected stretching force of the skeletal muscles induced by a barrage of impulses from receptors in muscles and joint capsules that travel to the central nervous system …this is known as the jolt syndrome" [12]. The effects of jolt syndrome can cause cervical symptoms related to whiplash-type trauma due to a stretching of the vertebral artery during injury [13] however, on physical examination, the patient appears neurologically intact. Frequently visualized on the lateral cervical X-ray as is a loss of the lordotic curve, this is often dismissed as "muscle spasm" when, in fact loss of cervical lordosis has been shown to alter vertebral artery hemodynamics. [14] Other studies have determined that cervical curvature straightening and inverse arch are the causes of atlantoaxial instability: the smaller the cervical curvature, the more serious the atlantoaxial instability. [15]

The failure to obtain post trauma X-rays of the cervical spine even in low impact, neurologically intact patients risk overlooking anatomical variants and other structural findings that could indicate risk for serious injury such as ponticulus posticus (PP). [16] The literature describes the PP as "a relatively common anatomic variation in the atlas vertebra," but in fact has the potential to cause significant pathology. Under the current guidelines that eliminate cervical spine X-rays in the neurologically intact patient, it would be missed.

Review

Definition of PP

A PP can be classified into four distinct forms: (1) A complete PP is a continuous bridge that extends from the posterior aspect of the lateral mass to the anterior aspect of the posterior tubercle, (2) A partial PP is one that does not extend fully from the posterior lateral mass to the posterior tubercle, (3) A partial upper PP is one that extends partway from the posterior aspect of the lateral mass toward-but not touching-the posterior tubercle, (4) A partial lower PP is one that extends partway from the posterior tubercle toward-but not touching-, the posterior aspect of the lateral mass.

In this paper, the abbreviation PP is used to refer to any of the above forms.

Some of the earliest writings on PP date back to 1906 and the work of the Dutch anatomist Louis Bolk [17] and physical evidence of PP has been found in human skeletons from the 12th century. [18] PP, also known as arcuate foramen, is a bony bridge which arises from the lateral mass of the atlas, transforming the groove of the vertebral artery into a canal on the posterior arch of the atlas (Figure *1*).

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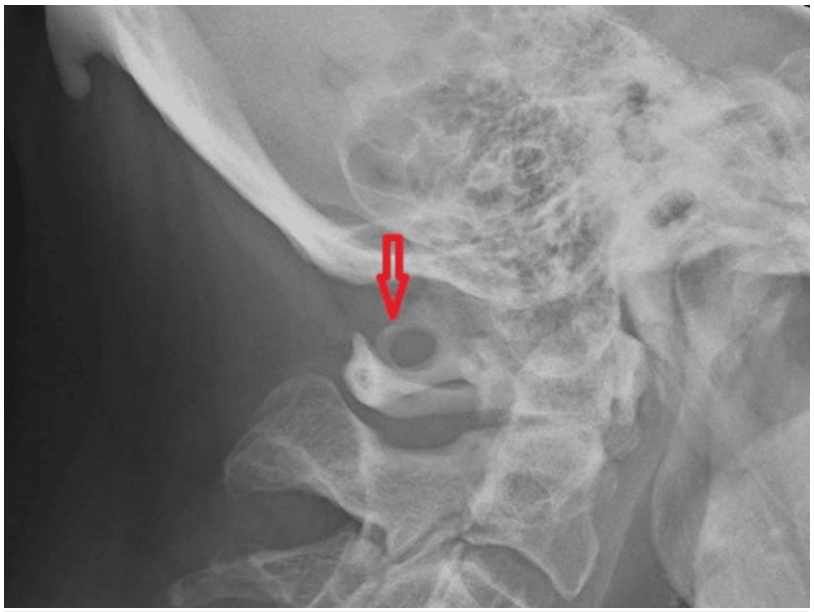

FIGURE 1: Lateral x-ray of the cervical spine with a clearly visible Ponticulus Posticus

[Case courtesy of Rob Foley, Radiopedia.org, rID:80115]

Foley R, Ponticulus posticus. Case study, Radiopaedia.org (Accessed

The medical literature describes the presence of PP as an anatomical variant originating with the ossification of the lateral segment of the posterior atlanto-occipital ligament. Its significance lies in its relationship with the vertebral artery. The vertebral artery travels through the transverse foramen of the atlas and follows the posterior arch to pass through the fibro-osseous foramen toward the posterior atlanto-occipital membrane, where it then penetrates the vertebral canal. [19] (Figure 2)

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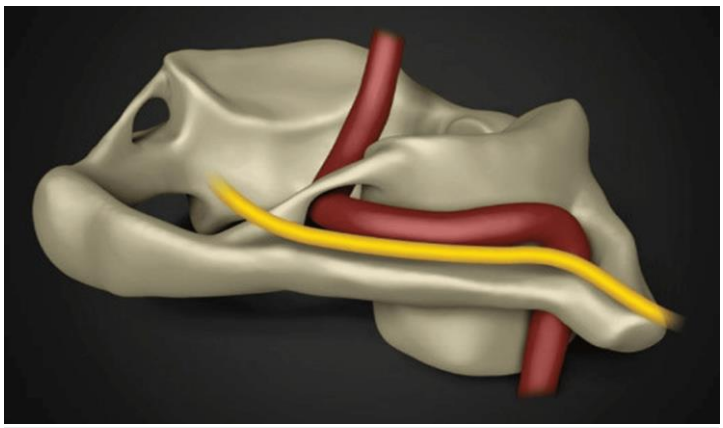

FIGURE 2: Ligamentous upper cervical instability can cause the vertebral artery and C 1 nerve root to become encroached upon by the ossification of the ligamentous structures of the Atlas known as a Ponticulus Posticus

[Used by permission of Matthew R. Skalski, DC, DACBR] Skalski M, Posterior ponticle -

The presence of the PP variant has been implicated in a number of what appear to be unrelated and often unexplained symptoms including vertebral artery elongation, dissection, dental symptoms (including those of temporomandibular joint), visual disturbances accompanied by headache and neck pain [20], and hearing loss [21]. This collection of symptoms, often referred to as Barré-Liéou syndrome, is thought to be caused by the alteration of the blood flow within the vertebral arteries and an associated disturbance of the periarterial nerve plexus causing hyperactivation of the autonomic nervous system, typically due to trauma [22,23].

From an evolutionary standpoint, PP is commonly present in monkeys and in quadrupeds, in which the superior margin of the posterior bridge provides a larger area for the attachment of the posterior atlanto-occipital membrane, helping to support the weight of the head. In humans, this support has come to be supplied by the superior articular facets of the atlas, which has caused the PP bridge to essentially disappear [24].

Dangers of Whiplash-Associated Disorder and the Ponticulus Posticus

While motor vehicle crashes are not the sole cause of whiplash-associated disorder they are by far the most common and are usually accompanied by a collection of symptoms arising after acceleration injury due to an unaware victim being struck in a stationary vehicle, usually from behind. Symptoms frequently include neck pain, dizziness, and headaches, which may persist up to months or years after the accident. During a rearend collision, the cervical spine is subjected not only to hyperextension and hyperflexion of the spine but also to axial rotation and shear forces [25].

Hasan et al. noted that the vertebral artery is particularly vulnerable to compression during extreme rotation of head and neck movements and that the presence of PP may further compromise the caliber of an already-stretched vertebral artery [26] (Figure 3). Additionally, Cushing et al. found there to be an association between PP and the tethering of the vertebral artery within it, contributing to its dissection from repetitive trauma with movement of the neck [27]. According to Tubbs et al., PP may cause external pressure on the vertebral artery as the latter passes through it to the foramen magnum [28].

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In 1997, Nibu et.al. quantified vertebral artery elongation due to whiplash using an in vitro simulation. Their findings suggested that this elongation during trauma constitutes the pathomechanism for certain aspects of the whiplash symptom complex and that during whiplash, mechanisms other than simple flexion/extension of the cervical spine cause arterial elongation [29]. Although it has been demonstrated that whiplash can cause intracranial vertebral artery dissection, in isolation or combined with extracranial extension, even in the absence of PP [30], (Figure 3)

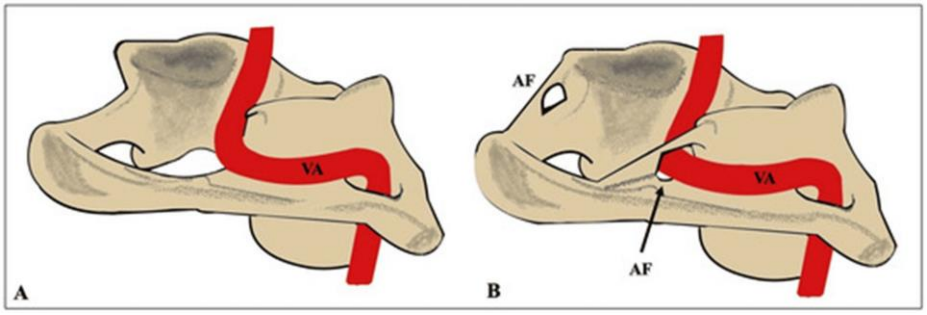

FIGURE 3: The vertebral artery is particularly vulnerable to compression during extreme rotation of head and neck movements and that the presence of PP can compromise the caliber of an already-stretched vertebral artery.

[Used by permission Mary Piagkou, MD and MDPI Publishing) [13]

Closs et al. suggested that there is an increased likelihood of this occurring if the foramen diameter is reduced, such as in cases of PP, where ischemic compression of the vertebral artery can occur, resulting in a reduction in cerebral blood flow [31]. This finding has been confirmed by Gul and Atik [32]. Additionally, research indicates that ponticulus posticus is actually a known risk factor for the development of type 2 odontoid fractures following cervical trauma [33].

Given what is known, the finding of a PP on a plain-film X-ray has several implications in the treatment of the whiplash patient, requiring careful evaluation and awareness by the clinician. This is especially true for those practitioners who practice a form of manual therapy, such as chiropractors. While the exact percentage of the patients who suffer a whiplash injury and receive treatment from a chiropractor is not available, studies show that chiropractors do treat a significant proportion of whiplash patients [34].

Conclusions

Given the very high number of manipulations performed annually, the absolute risk for arterial dissection is extremely low. Nonetheless, for the chiropractor, and other manual practitioners, the paramount concern is the risk of vertebral artery injury. High-velocity, low-amplitude (HVLA) manipulation of the cervical spine requires a comprehensive risk assessment to identify suitable patients and minimize potential complications, including vertebral artery injury and the practitioner may want to adopt a more cautious, modified approach to cervical manipulation rather than routine HVLA techniques such as gentler mobilization, instrument-assisted, or specific upper cervical protocols.

For the emergency room clinician, obtaining at minimum a 3-view cervical spine X-ray series should remain the standard of care, even in the presence of a normal neurological examination. These radiographs can not only help rule out osseous pathology but can also identify the severity of ligamentous injury or underlying congenital abnormalities (such as ponticulus posticus), which may significantly influence subsequent patient management and treatment decision.

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