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Bow hunter's syndrome successfully treated with a posterior surgical decompression approach: A case report and review of literature

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Abstract

BACKGROUND

Bow hunter's syndrome (BHS) is a rare but surgically treatable cause of vertebro-basilar insufficiency due to dynamic rotational occlusion of the vertebral artery. Typically, patients present with posterior circulation transient ischaemic symptoms such as presyncope, syncope, vertigo, diplopia, and horizontal nystagmus, but irreversible deficits, including medullary and cerebellar infarctions, have also been described.

CASE SUMMARY

A 70-year-old patient presented an acute onset of vertigo and gait instability triggered by right head rotation. His medical history included previous episodes of unilateral left neck and occipital pain followed by light-headedness, sweating, and blurred vision when turning his head, and these episodes were associated

with severe degenerative changes in the atlanto-dens and left atlanto-axial facet joints and right rotation of the C2 cervical vertebrae. Brain magnetic resonance imaging revealed the presence of acute bilateral cerebellar ischaemic lesions, while static vascular imaging did not reveal any vertebral artery abnormalities. Dynamic ultrasonography and angiography were performed and confirmed the presence of a dynamic occlusion of the vertebral artery V3-V4 segment when the head was rotated to the right secondary to left C1-C2 bone spur compression. Surgical decompression led to complete resolution of paroxysmal symptoms without neurological sequelae.

CONCLUSION

BHS should be considered in cases of repeated posterior circulation transient ischaemic attack or ischaemic stroke, particularly when associated with high cervical spine abnormalities.

Key Words: Bow hunter's syndrome; Stroke; Non-invasive duplex ultrasonography; Dynamic angiography; Neurosurgery; Case report

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Core Tip: Bow hunter's syndrome (BHS) represents a paradigmatic example of vertebrobasilar insufficiency. It is an uncommon but potentially harmful condition whose clinical manifestations encompass posterior circulation transient ischaemic symptoms and irreversible deficits, including medullary and cerebellar infarctions. We present herein a case of BHS resulting from rotational occlusion of a nondominant left vertebral artery by C1-C2 bone spur compression that was successfully treated with posterior cervical decompression. This case highlights the role of dynamic vertebral digital subtraction angiography and neurosurgery in BHS diagnosis and treatment, respectively.

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INTRODUCTION

Bow hunter's syndrome (BHS) or rotational vertebral artery occlusion syndrome (RVAO) is an uncommon case of vertebrobasilar stroke and represents a paradigmatic example of vertebrobasilar circulation insufficiency (VBI) resulting from rotational stenosis or dynamic occlusion of a dominant vertebral artery (VA)[1]. Rare cases of nondominant VA involvement[2-4] or bilateral vertebral compression[5-7] have also been reported. The pathogenesis of BHS is strictly associated with the anatomical course of VAs, which can be affected by head motion and compressed by several cervical structures, typically at the atlantoaxial level[1]. Therefore, repetitive shear stress, thrombus formation due to blood flow stasis with artery-to artery embolism and vessel dissection have been suggested as possible underlying mechanisms[8]. Due to the limited number of cases described in literature, the exact incidence of BHS is still unknown[8]. Male in the 5th-7th decade of life with concurrent cerebrovascular risk factors represent the prototype of BHS patients[1,8-10], nevertheless cases in pediatric age have been described too[11-13]. Since its first description in 1978[14], several conditions have been listed among BHS etiologies, such as osteophytes, fibrous bands, or lateral disc herniation. Other less common causes included neck muscle hypertrophy[15], cervical tumours[16,17] and contralateral/ipsilateral VA dissection with or without pseudoaneurysm[18-20]. Clinical manifestations can range from posterior circulation transient ischaemic symptoms (*e.g.*, dizziness and vertigo[21,22], isolated or transitional nystagmus[23,24] and loss of consciousness) to irreversible deficits, including medullary and cerebellar infarctions, depending on the amount of compensatory flow and the duration of dynamic occlusion. Consequently, all other possible etiologies of posterior ischaemic stroke[25] as well as episodic causes of vestibular disorders and vertigo[26,27] should be included in the differential diagnosis of BHS. Diagnosis relies mainly on dynamic digital subtraction cerebral angiography (DSA)[1,10], even if a diagnostic algorithm based on non-invasive duplex ultrasonography has been recently proposed[28]. Finally, BHS treatment relies either on conservative or neurosurgical therapeutic approaches[29].

CASE PRESENTATION

Chief complaints

A 70-year-old man who presented to the emergency department with an acute onset of vertigo and gait instability triggered by rotating his head to the right. The main differences in comparison with previous episodes of imbalance triggered by head rotation were the duration of symptoms (several hours) and the presence of mild signs of cerebellar involvement at the neurological examination.

History of present illness

He denied having any cervical trauma or injuries. His vascular risk factors also included moderate smoking, dyslipidaemia and arterial hypertension.

History of past illness

His medical history included peripheral chronic arteriopathy and previous episodes of left neck and occipital pain followed by light-headedness, sweating and blurred vision triggered by rotating his head and associated with severe spondylotic changes in the cervical spine and foramen magnum stenosis. Previously performed cervical spine computed tomography (CT) and magnetic resonance imaging (MRI) identified degenerative changes in the atlantoaxial and left-axial facet joints with right rotation of the C2 cervical vertebrae (Figure 1A and B). However, given the imbalance between perioperative risks and clinical paucisintomaticity, a neurosurgical approach was discouraged.

Personal and family history

No other relevant events were reported in his personal and family history.

Physical examination

At hospital admission, his neurological examination was normal except for a significant left lateropulsion in the Romberg position and a wide-based gait. No other signs of brainstem involvement were appreciable.

Laboratory examinations

Routine blood tests were unremarkable, apart from moderate dyslipidaemia as an additional cerebrovascular risk factor.

Imaging examinations

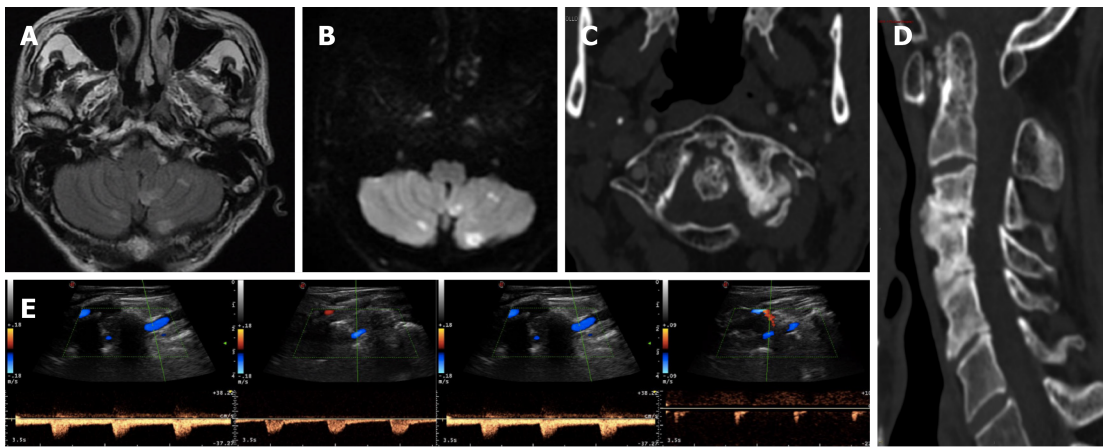
Static neuroimaging: Brain CT and MRI identified subacute bilateral cerebellar ischaemic lesions (with left prevalence) involving the area supplied by the posterior inferior cerebellar artery, while magnetic resonance angiography (MRA) showed right VA dominance. Moderate carotid atheromasia was also appreciable. Ultrasound examination of the neck arteries in the neutral position and CT angiography (CTA) did not show haemodynamic abnormalities in the Vas and excluded signs of arterial dissections or severe stenosis of the vertebrobasilar system, confirming a right VA predominance (Figure 1C and D). Conversely, ultrasound examination of the left VA in both the V1-V2 and V3-V4 segments with slight contralateral head rotation (approximately 20°) showed a Doppler waveform demodulation known as stump flow, which suggested distal VA steno-occlusion (Figure 1E).

Dynamic ultrasonography and angiography

After having his head mobilized following CTA execution, the patient presented an episode of loss of consciousness without prodromic symptoms. Thus, dynamic causes of vertebral occlusion and related symptoms were considered, and the absence of a flow signal in the left V3-V4 VA was documented by ultrasound examination while the head was turned to the right. Dynamic vertebral DSA with anteroposterior and lateral projections secondary to left C1-C2 bone spur compression confirmed the clinical suspicion of BHS[1,10]. Moreover, the left V3 and VA appeared elongated and exhibited irregular luminal injection and focal parietal ectasia, probably due to repeated microtrauma of the artery wall (Figure 2A and B).

FINAL DIAGNOSIS

The final diagnosis of the case presented was left dynamic vertebral artery occlusion (Bow Hunter's syndrome) resulting from left C1-C2 bone spur compression.



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Figure 1 Neuroradiological and neurosonological evaluation. A and B: Axial fluid-attenuated inversion-recovery and diffusion-weighted imaging (DWI) brain magnetic resonance imaging sequences with subacute bilateral cerebellar ischaemic lesions involving the area supplied by the posterior inferior cerebellar artery; C and D: Axial and sagittal cervical computed tomography scan showing marked degenerative joint alterations with atlo-axial instability and retroposition of dens, spinal canal stenosis and ankylosis of lateral left zygo-apophyseal joints with underlying congenital partial atlo-occipital fusion; E: Vertebral ultrasound examination documenting regular blood flow in the left VA in the neutral position (left side) and “stump flow” demodulation in both the V1-V2 and V3-V4 segments (right side) in cases of slight contralateral head rotation (20°).

TREATMENT

After neurosurgical reevaluation, surgical decompression of the left VA at the C1-C2 Level was performed, including removal of the aforementioned C1-C2 osteophyte as well as partial removal of the C1 posterior arch and opening of the transverse foramen through a posterior approach (Video).

The patient was placed in the three-quarter prone position on the right side, with the head slightly flexed *via* pin fixation (segment 1). Through a hockey stick incision in the left retromastoid region, the occipital squama, foramen magnum and C1-C2 posterior arches were sequentially exposed (segment 2). After identification and isolation of the left V3 segment above C1, a lateral dissection C1-C2 bone spur (BS) was exposed and gradually removed (segments 3-6). Finally, the C1 posterior arch and its transverse foramen were partially opened until the V2 and V3 segments were isolated (segments 7-8). Postoperative cervical CT excluded signs of vertebral instability, confirming the marked degenerative joint alterations at the atlo-axials and atlo-occipital levels previously described.

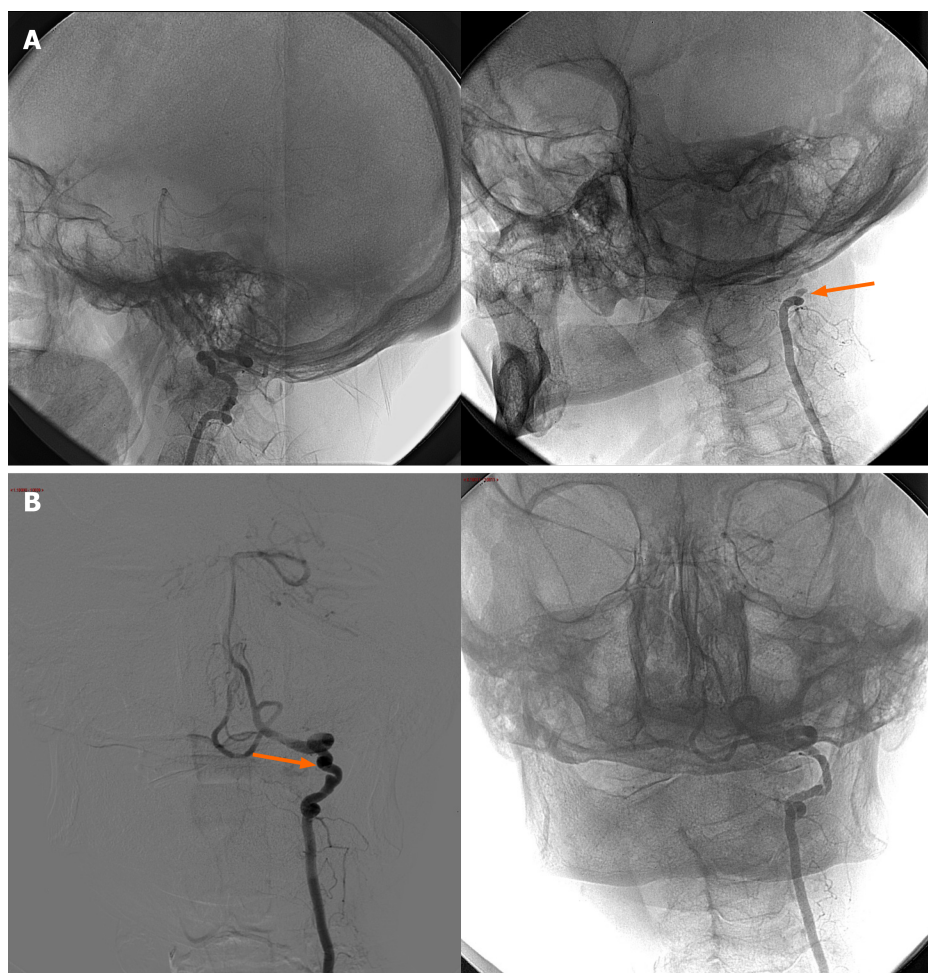
OUTCOME AND FOLLOW-UP

The patient tolerated the procedure well, and on day 5 post surgery, cervical spine CT excluded signs of vertebral instability. He was discharged with antiplatelet treatment as a secondary prevention due to several vascular risks.

A follow-up angiography 12 months after the procedure documented no evidence of significant stenosis, compression or occlusion of the left VA along its course either in the neutral position or in cases of bilateral head turning. The patient also denied any other focal neurological deficit and remained completely asymptomatic.

DISCUSSION

BHS is a rare cause of stroke that represents a paradigmatic example of VBI. This term, which was first coined in the 1950's[30], has been widely adopted for decades to denote a pattern of recurrent symptomatic ischaemia to regions irrigated by posterior circulation, reflecting hypoperfusion of poorly collateralized structures due to haemodynamically significant stenosis or artery-to artery embolism[31]. However, it has recently been argued that VBI should actually be limited to vertebrobasilar ischaemia related to direct vertebral artery compression induced by head movement, reflecting the physiopathological mechanism occurring in BHS[32]. Specifically, compression has frequently been noted to occur at the most dynamic portions of VAs, either C5-C7 (V1-V2)[33] or C1-C2 (V3-V4)[1,10,34]. In these sections, the vessel is progressively stretched between the two transverse foramina during head turning, becoming particularly susceptible to microtrauma.



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Figure 2 Digital subtraction angiography. A: Lateral cerebral angiography projections without stenosis of the left vertebral artery in the neutral position (left side) and with complete occlusion of the V3 segment at the C2 Level upon turning the head to the right at 40° (right side; arrow); B: Anteroposterior cerebral angiography projections confirming the dynamic occlusion of the left VA in case of right head rotation (right side). Please note left VA irregular luminal injection and focal parietal ectasia in the neutral position (left side; arrow).

Differential diagnosis may potentially be difficult, leading to unrecognized cases with harmful consequences. Indeed, posterior circulation Transient ischaemic attack (TIA) or minor stroke can result in a considerable risk of stroke recurrence[35], especially in cases of vertebrobasilar stenosis[36,37] or in combination with other cerebrovascular risks. BHS is mainly related to dominant VA compression, whereas the contralateral vessel is frequently hypoplastic, atresic and stenotic[38]. These predisposing factors, which can lead to the limitation of collateral flow during head turning, represent a potential clue for further evaluations of cases where BHS is highly suspected, such as patients with recurrent posterior TIA/stroke and cervical spine abnormalities. In cases of nondominant VA-induced BHS, Iida *et al*[3] proposed head rotation-induced downbeating nystagmus (DBN) as another clinical clue, although we did not observe DBN in our patient. Furthermore, instrumental investigations may lead to inconclusive results if inadequately performed. Indeed, a pathognomonic finding in BHS is the improvement in symptoms when the patient is in a neutral position, since the VAs are not compressed. Therefore, diagnosis with static vascular imaging (*e.g.*, CTA and MRA) is not feasible. Dynamic ultrasound is a non-invasive and potentially useful diagnostic tool, but it can lead to false results even when performed in highly specialized neurological institutes[1]. However, when BHS is suspected, a number of authors have recommended DSA as the definitive diagnostic modality[1,29,33,34].

Proper recognition is of the utmost importance, as secondary stroke prevention should start with deciphering the most likely stroke mechanism to establish tailored and potentially resolutive therapies [39]. Regarding treatment, due to the paucity of BHS reports in the neurological and neurosurgical literature, international guidelines for its management have not yet been validated. According to the underlying etiology, a management algorithm including conservative and surgical treatment has been proposed[29]. On the one hand, conservative treatment methods include avoidance of head rotation, cervical collars and antiplatelet/anticoagulation therapy. Despite its safety, a conservative approach does not guarantee complete clinical remission or allow long-term outcomes to be assessed. On the other hand, a surgical approach can lead to definitive results and is advised in cases of high and

impending cerebrovascular risk[1,29]. In particular, Zaidi *et al*[1] suggested that patients should be offered surgical intervention when (1) Symptoms interfere with quality of life; (2) there is angiographic evidence of a severe reduction in VA flow during head rotation combined with insufficient compensatory collateral circulation; and (3) medical treatment has failed. Depending on the mechanism of VA occlusion, cervical fusion or decompression represent the most well-known surgical methods, which share the same success rate in achieving the resolution of symptoms[40]. However, the question of which type of surgical approach should be performed (*e.g.*, posterior[1,41], anterior or antero-lateral [19,42,43]) is still debated. Independent of the surgical approach, in a recent review of 153 patients with BHS, surgery was associated with a higher number of favourable outcomes than those with conservative treatment[10]. Finally, endovascular approaches have been proposed in recent years, with limited evidence and experience in comparison to surgery[44-46]. However, as suggested by a few authors, a multidisciplinary approach could be used in selected cases to further increase the efficacy of surgical decompression[47-50].

CONCLUSION

Bow hunter's syndrome is a rare, potentially severe but treatable condition that should be considered in the diagnostic flow-chart for repeated posterior circulation TIA or ischaemic stroke, especially when associated with high cervical spine abnormalities. Furthermore, our case proves the safety and long-term outcomes of surgery in BHS management, further demonstrating its appropriate indication for selected patients.

FOOTNOTES

Author contributions: Orlandi N, Cavallieri F, Valzania F and Zedde M reviewed the literature, designed the work and drafted and reviewed the manuscript critically; Grisendi I reviewed the literature and the manuscript critically; Romano A and Ghadirpour R were the patient's neurosurgeons and reviewed the literature and the manuscript critically; Napoli M, Moratti C, Zanichelli M, and Pascarella R analysed and interpreted the imaging findings and reviewed the manuscript critically; all authors issued final approval for the version to be submitted.

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