American College of Radiology
ACR Appropriateness Criteria®
Horner Syndrome

Variant 1: **Adult. Acute onset Horner syndrome with or without localizing neurological signs or symptoms. History of recent trauma or painful. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CTA head and neck with IV contrast	Usually Appropriate	☢☢☢
CT head without IV contrast and CTA head and neck with IV contrast	Usually Appropriate	☢☢☢☢
MRA head and neck with IV contrast	Usually Not Appropriate	O
MRA head and neck without and with IV contrast	Usually Not Appropriate	O
MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine with IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine without and with IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
MRI cervical spine without and with IV contrast	Usually Not Appropriate	O
MRI cervical spine without IV contrast	Usually Not Appropriate	O
MRI head and orbits with IV contrast	Usually Not Appropriate	O
MRI head and orbits without and with IV contrast	Usually Not Appropriate	O
MRI head and orbits without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRI head with IV contrast and MRA head and neck with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck without and with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRI head without IV contrast and MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI neck with IV contrast	Usually Not Appropriate	O
MRI neck without and with IV contrast	Usually Not Appropriate	O
MRI neck without IV contrast	Usually Not Appropriate	O
MRI orbits with IV contrast	Usually Not Appropriate	O
MRI orbits without and with IV contrast	Usually Not Appropriate	O
MRI orbits without IV contrast	Usually Not Appropriate	O

MRI thoracic spine with IV contrast	Usually Not Appropriate	O
MRI thoracic spine without and with IV contrast	Usually Not Appropriate	O
MRI thoracic spine without IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
CT neck with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without and with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without IV contrast	Usually Not Appropriate	☢☢☢

Variant 2: **Adult. Acute onset Horner syndrome with localizing brain or cranial nerve neurological signs or symptoms. No history of trauma. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CTA head and neck with IV contrast	Usually Appropriate	☢☢☢
CT head without IV contrast and CTA head and neck with IV contrast	Usually Appropriate	☢☢☢☢
MRA head and neck without and with IV contrast	May Be Appropriate	O
MRA head and neck without IV contrast	May Be Appropriate	O
MRI head without and with IV contrast	May Be Appropriate	O
MRI head without and with IV contrast and MRA head and neck with IV contrast	May Be Appropriate (Disagreement)	O
MRI head without and with IV contrast and MRA head and neck without and with IV contrast	May Be Appropriate (Disagreement)	O
MRI head without and with IV contrast and MRA head and neck without IV contrast	May Be Appropriate (Disagreement)	O
MRI head without IV contrast and MRA head and neck without IV contrast	May Be Appropriate (Disagreement)	O
MRA head and neck with IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine with IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine without and with IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
MRI cervical spine without and with IV contrast	Usually Not Appropriate	O
MRI cervical spine without IV contrast	Usually Not Appropriate	O
MRI head and orbits with IV contrast	Usually Not Appropriate	O
MRI head and orbits without and with IV contrast	Usually Not Appropriate	O
MRI head and orbits without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRI head with IV contrast and MRA head and neck with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRI neck with IV contrast	Usually Not Appropriate	O
MRI neck without and with IV contrast	Usually Not Appropriate	O
MRI neck without IV contrast	Usually Not Appropriate	O
MRI orbits with IV contrast	Usually Not Appropriate	O
MRI orbits without and with IV contrast	Usually Not Appropriate	O
MRI orbits without IV contrast	Usually Not Appropriate	O
MRI thoracic spine with IV contrast	Usually Not Appropriate	O
MRI thoracic spine without and with IV contrast	Usually Not Appropriate	O

MRI thoracic spine without IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
CT neck with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without and with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without IV contrast	Usually Not Appropriate	☢☢☢

Variant 3: **Adult. Acute or nonacute onset Horner syndrome with localizing spinal cord neurological signs or symptoms. No history of trauma. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI cervical and thoracic spine without and with IV contrast	Usually Appropriate	O
MRI cervical and thoracic spine without IV contrast	May Be Appropriate (Disagreement)	O
MRI cervical spine without and with IV contrast	May Be Appropriate	O
MRI cervical spine without IV contrast	May Be Appropriate	O
MRA head and neck with IV contrast	Usually Not Appropriate	O
MRA head and neck without and with IV contrast	Usually Not Appropriate	O
MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine with IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
MRI head and orbits with IV contrast	Usually Not Appropriate	O
MRI head and orbits without and with IV contrast	Usually Not Appropriate	O
MRI head and orbits without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRI head with IV contrast and MRA head and neck with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck without and with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRI head without IV contrast and MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI neck with IV contrast	Usually Not Appropriate	O
MRI neck without and with IV contrast	Usually Not Appropriate	O
MRI neck without IV contrast	Usually Not Appropriate	O
MRI orbits with IV contrast	Usually Not Appropriate	O
MRI orbits without and with IV contrast	Usually Not Appropriate	O
MRI orbits without IV contrast	Usually Not Appropriate	O
MRI thoracic spine with IV contrast	Usually Not Appropriate	O
MRI thoracic spine without and with IV contrast	Usually Not Appropriate	O
MRI thoracic spine without IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢

CT head without IV contrast	Usually Not Appropriate	☢☢☢
CT neck with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without and with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without IV contrast	Usually Not Appropriate	☢☢☢
CTA head and neck with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast and CTA head and neck with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant 4: **Adult. Nonacute onset Horner syndrome with localizing brain or cranial nerve neurological signs or symptoms. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI head and orbits without and with IV contrast	May Be Appropriate (Disagreement)	O
MRI head and orbits without IV contrast	May Be Appropriate (Disagreement)	O
MRI head without and with IV contrast	May Be Appropriate	O
MRI head without and with IV contrast and MRA head and neck without and with IV contrast	May Be Appropriate (Disagreement)	O
MRI head without IV contrast and MRA head and neck without IV contrast	May Be Appropriate (Disagreement)	O
MRI head without IV contrast	May Be Appropriate	O
MRI orbits without and with IV contrast	May Be Appropriate (Disagreement)	O
MRI orbits without IV contrast	May Be Appropriate	O
CT head without IV contrast and CTA head and neck with IV contrast	May Be Appropriate	☢☢☢☢
MRA head and neck with IV contrast	Usually Not Appropriate	O
MRA head and neck without and with IV contrast	Usually Not Appropriate	O
MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine with IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine without and with IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
MRI cervical spine without and with IV contrast	Usually Not Appropriate	O
MRI cervical spine without IV contrast	Usually Not Appropriate	O
MRI head and orbits with IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRI head with IV contrast and MRA head and neck with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI neck with IV contrast	Usually Not Appropriate	O
MRI neck without and with IV contrast	Usually Not Appropriate	O
MRI neck without IV contrast	Usually Not Appropriate	O
MRI orbits with IV contrast	Usually Not Appropriate	O
MRI thoracic spine with IV contrast	Usually Not Appropriate	O
MRI thoracic spine without and with IV contrast	Usually Not Appropriate	O
MRI thoracic spine without IV contrast	Usually Not Appropriate	O

CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
CT neck with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without and with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without IV contrast	Usually Not Appropriate	☢☢☢
CTA head and neck with IV contrast	Usually Not Appropriate	☢☢☢

Variant 5: **Adult. Nonacute onset Horner syndrome nonlocalizable, not otherwise specified. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CTA head and neck with IV contrast	Usually Appropriate	☢☢☢
MRA head and neck with IV contrast	Usually Not Appropriate	O
MRA head and neck without and with IV contrast	Usually Not Appropriate	O
MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine with IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine without and with IV contrast	Usually Not Appropriate	O
MRI cervical and thoracic spine without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
MRI cervical spine without and with IV contrast	Usually Not Appropriate	O
MRI cervical spine without IV contrast	Usually Not Appropriate	O
MRI head and orbits with IV contrast	Usually Not Appropriate	O
MRI head and orbits without and with IV contrast	Usually Not Appropriate	O
MRI head and orbits without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRI head with IV contrast and MRA head and neck with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck without and with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast and MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRI head without IV contrast and MRA head and neck without IV contrast	Usually Not Appropriate	O
MRI neck with IV contrast	Usually Not Appropriate	O
MRI neck without and with IV contrast	Usually Not Appropriate	O
MRI neck without IV contrast	Usually Not Appropriate	O
MRI orbits with IV contrast	Usually Not Appropriate	O
MRI orbits without and with IV contrast	Usually Not Appropriate	O
MRI orbits without IV contrast	Usually Not Appropriate	O
MRI thoracic spine with IV contrast	Usually Not Appropriate	O
MRI thoracic spine without and with IV contrast	Usually Not Appropriate	O
MRI thoracic spine without IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	☢☢☢

CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
CT neck with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without and with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast and CTA head and neck with IV contrast	Usually Not Appropriate	☢☢☢☢

HORNER SYNDROME

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Summary of Literature Review

Introduction/Background

Horner syndrome is a combination of clinical signs and symptoms caused by abnormalities in the oculosympathetic pathway, initially described by Johann Friedrich Horner. Typically, patients present with ipsilateral miosis, ptosis, and anhidrosis. Sometimes, other signs, such as pseudoenophthalmos, can also be seen [1]. Because the disruption of the anatomic pathways invoked traverse many distinct sites in the head and neck, Horner syndrome may be a diagnostic challenge, particularly isolated Horner syndrome, which is not associated with other localizing signs or symptoms. Understanding the anatomic pathways is critical for guiding appropriate imaging workup. The affected pathways include central pathways (first-order neurons beginning in the hypothalamus, then coursing through the brainstem, cervical and upper thoracic cord), preganglionic (second-order neurons, beginning with the C8-T2 nerve roots, then coursing through the paraspinal, mediastinal, sympathetic chain, along the subclavian artery, pulmonary apex regions, and then synapsing at superior cervical ganglia around the carotid bifurcation), or postganglionic (third-order neurons, after the synapse at superior cervical ganglia coursing along internal carotid artery, then cavernous sinus, and into the orbit via superior orbital fissure) [1,2]. A detailed history and physical examination are necessary to evaluate the underlying etiology of Horner syndrome. A prior study investigated how often a cause of clinically clear diagnosis of Horner syndrome could be identified, by comparing patients who underwent pharmacologic testing (conducted by ophthalmologists) to patients who did not undergo such testing (seen by nonophthalmologists) [3]. In this study, among patients with a convincing clinical presentation of Horner syndrome not requiring pharmacologic testing (the latter group), the authors reported an identifiable cause in 91% of patients. In contrast, the authors reported an identifiable cause of Horner syndrome in 61% of patients who were diagnosed by pharmacologic testing, without a clear clinical presentation. Iatrogenic causes, cervical carotid dissection, and tumors are some of the most common causes [3]. Imaging has had variable yield in identifying the cause of isolated Horner syndrome. Some studies have shown a 20% yield, with carotid artery dissection as the most common cause [4], and other studies have shown wide variation in diagnostic yield ranging from 0% to 68%. This variability calls for further research before standardized guidelines can be established [5].

In summary, at least 40% of cases of Horner syndrome are idiopathic or of uncertain etiology [3]. Overall common etiologies include surgical or postprocedural complications [3,6-8], carotid dissection [9-11], trauma (with injury to skull base, cavernous sinus, cervical spine, and neck) [12-14], cluster headache [3], tumor, (paraspinal, mediastinal, head, cervical regions) [15-19], infarction [20-22], demyelination [23-25], and infection or inflammation [3,26,27].

Imaging the oculosympathetic pathway can be complex due to its extensive course, differences in optimal imaging modalities for different anatomical regions along this pathway, the need for targeted protocols, and the wide range of pathology that can result in abnormalities along this pathway. The time course can also be variable, including acute, chronic, or insidious onset, such as when Horner syndrome is incidentally identified on routine examination

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[28]. Associated clinical features and history can often effectively narrow down the diagnosis to the primary region of interest. In addition, acuity of onset can assist in prioritizing imaging to detect time sensitive abnormalities with severe consequences such as dissection, stroke, pseudoaneurysm, spinal cord injury, etc. For this document, we focus our attention on workup guidelines based on clinical features: 1) acuity (acute, nonacute including chronic, insidious, and unknown onset), 2) painless or painful (for example, neck pain, occipital region pain, or headaches), 3) whether there is a history of trauma (any form of injury to the chest, neck or head area, including iatrogenic injury from recent procedure or surgery), and 4) absence or presence of localizing brain, cranial nerve, or spinal cord neurological signs or symptoms.

Special Imaging Considerations

Based on the clinical scenario, high-resolution orbital MRI protocols can be performed. An orbital protocol with high-resolution pre- and postcontrast T1-weighted sequences and heavily fluid-sensitive sequences such as constructive interference in steady-state or fast imaging employing steady-state acquisition can allow assessment of the orbital apex, including superior orbital fissure, cavernous sinus, cranial nerves, and skull base regions. Rarely, targeted brachial plexus evaluation may be needed, requiring a dedicated brachial plexus MRI.

Also, modified MR orbit protocols, performed with high-resolution sequences through the orbits and central skull base can yield additional information about skull base causes for Horner syndrome. In addition, inclusion of a T1 fat saturation sequence in MRA neck can significantly increase the detection of intramural hematoma and enhance the sensitivity for detection of acute dissection.

Please note that CT angiography (CTA) head and neck with intravenous (IV) contrast most often includes noncontrast CT (NCCT) imaging of the head at many institutions. Sometimes, if NCCT head has been performed within 6 to 12 hours of performing CTA, then NCCT head may not be repeated. The imaging recommendations provided here include the use of NCCT head together with CTA head and neck when evaluating Horner syndrome Based on institutional practice pattern, these may be performed as a combination procedure or separately.

For the purpose of Horner syndrome evaluation, we recommend that the CTA head and neck coverage should extend inferiorly to cover the carina, to allow simultaneous assessment of extravascular causes in the neck and mediastinum that may result in Horner syndrome.

Carotid duplex US can be used to assess carotid arteries, but given its extremely limited scope and clinical applicability in relation to Horner syndrome, it has not been considered in this document.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Adult. Acute onset Horner syndrome with or without localizing neurological signs or symptoms. History of recent trauma or painful. Initial imaging.

Carotid dissection is the most important cause of acute onset Horner syndrome. Particularly, posttraumatic Horner syndrome is commonly due to acute carotid dissection. Rarely, other entities such as brachial plexus injury, expanding neck hematoma, skull base, rib fractures, cavernous sinus, and cervical cord injuries may be the cause [12-14,29]. However, in the emergent setting of acute onset, or painful or posttraumatic Horner syndrome, the most important diagnosis that requires consideration is carotid dissection, due to potentially catastrophic consequences with a delay in diagnosis.

CT Head With IV Contrast

CT head with IV contrast is usually not useful for initial imaging, even though it has some benefit in terms of evaluating brain parenchyma for infarcts, masses, or other lesions. However, contrast-enhanced CT is not the most suitable modality, because the presence of contrast can lower sensitivity to detection of hemorrhage, which can be seen in the setting of trauma. Also, it is limited in the assessment of vascular structures because contrast is not in the arterial phase, including the assessment of acute carotid dissection, commonly seen in the setting of trauma and Horner syndrome, and does not cover the neck.

CT Head Without and With IV Contrast
CT head without IV and with IV contrast is usually not useful for initial imaging. CT head without contrast is very important in the initial workup for acute stroke that can occur as a sequela of acute carotid dissection, a common cause of acute onset Horner syndrome in the setting of trauma. However, it is limited in the assessment of vascular structures, does not cover the neck, and with IV contrast component is not performed in the arterial phase to allow assessment of arterial structures.

CT Head Without IV Contrast
CT head without IV contrast is usually not useful for initial imaging. CT head without contrast is very important in the initial workup for acute stroke that can occur as a sequela of acute carotid dissection, a common cause of acute onset Horner syndrome in the setting of trauma. However, it is limited in the assessment of vascular structures and does not cover the neck.

CT Head Without IV Contrast and CTA Head and Neck With IV Contrast
CT head without IV contrast and CTA head and neck with IV contrast combination of imaging is usually the most useful for the initial workup. Carotid dissection is a common etiology of acute onset Horner syndrome, particularly in the setting of recent trauma or in association with pain [4,9-11,30,31]. CTA head and neck with IV contrast is an excellent diagnostic tool for the assessment of carotid dissection due to its high resolution and short acquisition time. Imaging coverage extends from the carina to the vertex and can thus also provide adequate assessment of extravascular findings, including bones, soft tissues of the neck, skull base, and orbits. In the emergency room, a noncontrast head CT is often performed just before the CTA head and neck to evaluate for associated infarction (as a sequela of carotid dissection or a primary brain stem infarction) and hemorrhage (in the setting of trauma). Although MRI can also provide similar information, the ability to simultaneously assess for extravascular abnormalities in neck and superior mediastinum is superior with CT, giving a CT-based imaging algorithm a slightly greater overall advantage.

CT Neck With IV Contrast
There is no relevant literature to support the use of CT neck with IV contrast in this clinical scenario.

CT Neck Without and With IV Contrast
There is no relevant literature to support the use of CT neck without and with IV contrast in this clinical scenario.

CT Neck Without IV Contrast
There is no relevant literature to support the use of CT neck without IV contrast in this clinical scenario.

CTA Head and Neck With IV Contrast
CTA head and neck with IV contrast can also be useful for the initial workup; however, adding noncontrast head CT before injecting contrast for CTA head and neck is recommended to exclude intracranial hemorrhage in the setting of trauma, particularly if there may be a clinical indication for starting antiplatelet or systemic anticoagulation. Presence of IV contrast can lower sensitivity for the detection of intracranial hemorrhage. Carotid dissection is a common etiology of acute onset Horner syndrome, particularly in the setting of recent trauma or in association with pain [4,9-11,30,31]. Overall, CTA head and neck with IV contrast is an excellent diagnostic tool for the assessment of carotid dissection due to its high resolution and short acquisition time. Imaging coverage extends from the carina to the vertex and can thus also provide adequate assessment of extravascular findings, including bones, soft tissues of the neck, skull base, and orbits. In the emergency room, a noncontrast head CT is often performed just before the CTA head and neck to evaluate for associated ischemia, infarction, and hemorrhage. Although MRI can also provide similar information, the ability to simultaneously assess for extravascular abnormalities in neck and superior mediastinum is superior with CT, giving a CT-based imaging algorithm a slightly greater overall advantage.

A CTA head and neck with IV contrast alone does not allow for simultaneous assessment of intracranial traumatic causes or associated intracranial complications of carotid dissections, such as hemorrhage or infarction. Thus, the more complete approach would be to perform a noncontrast head CT before injecting IV contrast for CTA head and neck, similar to the imaging algorithm employed for acute stroke.

MRA Head and Neck With IV Contrast
MR angiography (MRA) head and neck with IV contrast is usually not useful for initial imaging. It can provide good diagnostic information, but in the acute setting of trauma, CT is preferred over MRI due to rapid acquisition. MRA may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact. In addition, the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures including venous structures and soft tissue structures.

MRA Head and Neck Without and With IV Contrast
MRA head and neck without and with IV contrast is usually not useful for initial imaging. It can provide good diagnostic information in terms of vascular integrity, but in the acute setting of trauma CT, it is preferred over MRI due to rapid acquisition. MRA may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact. In addition, the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures including venous structures and soft tissue structures.

MRA Head and Neck Without IV Contrast
MRA head and neck without IV contrast is usually not useful for initial imaging. Presence of contrast on MRA can assist with vessel wall morphology particularly in segments that are prone to in-plane saturation or to flow or tortuosity-related artifact on noncontrast technique. Also, in the acute setting of trauma, CT is preferred over MRI due to rapid acquisition. MRA may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact. In addition, the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures including venous structures and soft tissue structures.

MRI Cervical and Thoracic Spine With IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine without and with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine Without IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine without IV contrast in this clinical scenario.

MRI Cervical Spine With IV Contrast
There is no relevant literature to support the use of MRI cervical spine without and with IV contrast in this clinical scenario.

MRI Cervical Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI cervical spine without and with IV contrast in this clinical scenario.

MRI Cervical Spine Without IV Contrast
There is no relevant literature to support the use of MRI cervical spine without IV contrast in this clinical scenario.

MRI Head and Orbits With IV Contrast
There is no relevant literature to support the use of MRI head and orbits with IV contrast in this clinical scenario. Specifically, this does not evaluate for vascular causes such as dissection, and noncontrast sequences are essential to characterize intrinsic T1 properties, so the impact of gadolinium-related T1 shortening can be adequately evaluated.

MRI Head and Orbits Without and With IV Contrast
There is no relevant literature to support the use of MRI head and orbits without and with IV contrast in this clinical scenario. Specifically, this does not evaluate for vascular causes such as dissection.

MRI Head and Orbits Without IV Contrast
There is no relevant literature to support the use of MRI head and orbits without IV contrast in this clinical scenario. Specifically, this does not evaluate for vascular causes such as dissection.

MRI Head With IV Contrast
There is no relevant literature to support the use of MRI head with IV contrast in this clinical scenario. Specifically, this does not evaluate for vascular causes such as dissection, and noncontrast sequences are essential to characterize intrinsic T1 properties, so the impact of gadolinium-related T1 shortening can be adequately evaluated.

MRI Head With IV Contrast and MRA Head and Neck With IV Contrast
MRI head with IV contrast and MRA head and neck with IV contrast is not the best approach for initial imaging. Noncontrast sequences are essential to characterize intrinsic T1 properties, so the impact of gadolinium-related T1 shortening can be adequately evaluated. This includes adequate assessment for intramural hematoma, which can be seen with acute dissection.

MRI Head Without and With IV Contrast
There is no relevant literature to support the use of MRI head without and with IV contrast in this clinical scenario. Specifically, this does not evaluate for vascular causes such as dissection.

MRI Head Without and With IV Contrast and MRA Head and Neck With IV Contrast
MRI head without and with IV contrast and MRA head and neck with IV contrast is not useful for initial imaging in this clinical scenario. Only contrast MRA will lower sensitivity by limiting the assessment for intramural hematoma, best seen on noncontrast technique. Overall, noncontrast sequences are essential to characterize intrinsic T1 properties, so the impact of gadolinium-related T1 shortening can be adequately evaluated. Also, in the acute setting, particularly when there is history of trauma, CT is preferred over MRI due to rapid acquisition. MR may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact. In addition, the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures including venous structures and soft tissue structures. Also, lack of noncontrast MRA technique limits assessment for intramural hematoma needed for the evaluation of dissection.

MRI Head Without and With IV Contrast and MRA Head and Neck Without and With IV Contrast
MRI head without and with IV contrast and MRA head and neck without and with IV contrast is the not the best approach for initial imaging in this clinical scenario. In the acute setting, CT is preferred over MRI due to rapid acquisition and ability to visualize extracranial abnormalities in the neck. MR can provide good diagnostic information but may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact. In addition, the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures including venous structures and soft tissue structures.

MRI Head Without and With IV Contrast and MRA Head and Neck Without IV Contrast
MRI head without and with IV contrast and MRA head without IV contrast is the not the best approach for initial imaging in this clinical scenario. Presence of contrast on MRA can assist with vessel wall morphology particularly in segments that are prone to in-plane saturation or to flow or tortuosity-related artifact on noncontrast technique. Also, as stated above, in the acute setting CT is preferred over MRI due to rapid acquisition. MR may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact. In addition, the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures including venous structures and soft tissue structures.

MRI Head Without IV Contrast
There is no relevant literature to support the use of MRI head without IV contrast in this clinical scenario.

MRI Head Without IV Contrast and MRA Head and Neck Without IV Contrast
MRI Head without IV contrast and MRA Head and neck without IV contrast is the not the best approach for initial imaging in this clinical scenario. In the acute setting particularly in the setting of trauma CT is preferred over MRI

due to rapid acquisition. The presence of contrast also improves the sensitivity to abnormalities in vessel morphology, particularly along segments that are prone to artifacts from in-plane saturation, vascular tortuosity, and flow artifacts. MRI also has limited sensitivity to extracranial nonvascular abnormalities in the neck, particularly with noncontrast time of flight approach where signal outside of arterial vascular structures is saturated.

MRI Neck With IV Contrast
There is no relevant literature to support the use of MRI neck with IV contrast in this clinical scenario.

MRI Neck Without and With IV Contrast
There is no relevant literature to support the use of MRI neck without and with IV contrast in this clinical scenario.

MRI Neck Without IV Contrast
There is no relevant literature to support the use of MRI neck without IV contrast in this clinical scenario.

MRI Orbits With IV Contrast
There is no relevant literature to support the use of MRI orbits with IV contrast in this clinical scenario. Specifically, this does not evaluate for vascular causes such as dissection. Also, performing MRI only with contrast severely limits for assessment of intrinsic T1 properties needed for adequate assessment of postcontrast T1 shortening. This is specifically applicable in the setting of dissection for the evaluation of intramural hematoma.

MRI Orbits Without and With IV Contrast
There is no relevant literature to support the use of MRI orbits with IV contrast in this clinical scenario. Specifically, this does not evaluate for vascular causes such as dissection.

MRI Orbits Without IV Contrast
There is no relevant literature to support the use of MRI orbits without IV contrast in this clinical scenario. Specifically, this does not evaluate for vascular causes such as dissection.

MRI Thoracic Spine With IV Contrast
There is no relevant literature to support the use of MRI thoracic spine with IV contrast in this clinical scenario.

MRI Thoracic Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI thoracic spine without and with IV contrast in this clinical scenario.

MRI Thoracic Spine Without IV Contrast
There is no relevant literature to support the use of MRI thoracic spine without IV contrast in this clinical scenario.

Variant 2: Adult. Acute onset Horner syndrome with localizing brain or cranial nerve neurological signs or symptoms. No history of trauma. Initial imaging.

Acute onset Horner syndrome with localizing brain and cranial nerve abnormalities can be seen with involvement of central pathways (first-order neurons, hypothalamus, or brainstem) or the postganglionic segment (third-order neurons, after the synapse at superior cervical ganglia coursing along internal carotid artery, then cavernous sinus, and into the orbit via superior orbital fissure) [1,2]. Carotid dissection, brain stem infarction or ischemia, suprasellar tumors, lesions within the cavernous sinus, and demyelination are examples of etiologies that can result in such abnormalities [3,23,32]. Of these, carotid dissection is the most catastrophic acute etiology, and hence the initial workup is focused on first excluding this diagnosis and its associated complications.

CT Head With IV Contrast
CT head with IV contrast is not the most useful test for initial imaging. It has limited benefit in terms of evaluating brain parenchyma for infarcts, masses, or other lesions. It is not the most suitable because presence of contrast can lower sensitivity to detection of hemorrhage, which is critical to the initial management of acute stroke, which may present as acute onset Horner syndrome with localizing brain or cranial nerve abnormalities.

CT Head Without and With IV Contrast
CT head without IV and with IV contrast is not the most useful test for initial imaging. CT head without contrast is very important in the initial workup for acute stroke, which may present as acute onset Horner syndrome with localizing brain or cranial nerve abnormalities; however, it is limited in assessment of vascular structures, including the assessment of acute dissection.

CT Head Without IV Contrast

CT head without IV contrast is not the most useful test for initial imaging even though it is very important in the initial workup for acute stroke, which may present as acute onset Horner syndrome with localizing brain or cranial nerve abnormalities; however, it is limited in assessment of vascular structures, including the assessment of acute dissection.

CT Head Without IV Contrast and CTA Head and Neck With IV Contrast

CT head without IV contrast and CTA head and neck with IV contrast combination of imaging is usually the most useful for the initial workup. In the setting of acute onset Horner syndrome with neurological symptoms, an emergent stroke workup with initial noncontrast head CT followed by CTA head and neck is the most suitable approach. Commonly carotid dissection is seen in the setting of trauma and with pain; however, painless spontaneous carotid dissection is also a possible etiology of Horner syndrome [33,34]. Noncontrast head CT is the initial test in clinical settings given with this presentation an acute stroke is suspected, following which a CTA head and neck with IV contrast is performed. This is an excellent combined tool for assessment of carotid dissection, which can result in Horner syndrome and associated intracranial complications of hemorrhage or infarction/ischemia.

That said, demyelination, inflammation, infection, and small vessel infarcts or ischemia may not be adequately assessed with CT. MRI is more sensitive for these pathologies, and may be used as a next-step evaluation. Prioritization of the exclusion of carotid dissection is due to its being the most common nonprocedure-related cause of Horner syndrome, and due to the potentially catastrophic consequences of delayed diagnosis of carotid dissection with its accompanying neurological sequela such as infarction or hemorrhage. MRI can have similar diagnostic capabilities, but due to speed of acquisition and sensitivity to abnormalities in neck and superior mediastinum, a CT-based imaging algorithm has a slightly greater overall advantage.

CT Neck With IV Contrast

There is no relevant literature to support the use of CT neck with IV contrast in this clinical scenario.

CT Neck Without and With IV Contrast

There is no relevant literature to support the use of CT neck without and with IV contrast in this clinical scenario.

CT Neck Without IV Contrast

There is no relevant literature to support the use of CT neck without IV contrast in this clinical scenario.

CTA Head and Neck With IV Contrast

CTA head and neck with IV contrast can also be useful for the initial workup; however, adding noncontrast head CT before injecting contrast for CTA head and neck is recommended to exclude intracranial hemorrhage or infarction, particularly if there may be a clinical indication for starting antiplatelet or systemic anticoagulation. Overall, in the setting of acute onset Horner syndrome with neurological symptoms, an emergent stroke workup with initial noncontrast head CT followed by CTA head and neck is preferred as the most suitable approach. Commonly carotid dissection is seen in the setting of trauma and with pain; however, painless spontaneous carotid dissection is also a possible etiology of Horner syndrome [33,34].

Whereas performing only a CTA head and neck with IV contrast (without including noncontrast head CT) is excellent for assessment of vascular structures, it does not allow for adequate assessment of acute hemorrhage and stroke. A noncontrast head CT is the initial test in the imaging algorithm of acute stroke, which can present as Horner syndrome with neurological symptoms. Noncontrast head CT is needed for adequate assessment of infarction and hemorrhage. Therefore, noncontrast head CT followed by a CTA head and neck with IV contrast is a better combined tool for assessment of carotid dissection, which can result in Horner syndrome and associated intracranial complications of hemorrhage or infarction/ischemia.

That said, demyelination, inflammation, infection, and small vessel infarcts or ischemia may not be adequately assessed with CT. MRI is more sensitive for these pathologies, and may be used as a next-step evaluation. Prioritization of the exclusion of carotid dissection is due to its being the most common nonprocedure-related cause of Horner syndrome, and due to the potentially catastrophic consequences of delayed diagnosis of carotid dissection with its accompanying neurological sequela such as infarction or hemorrhage. MRI can have similar diagnostic capabilities, but due to the speed of acquisition and sensitivity to abnormalities in the neck and superior mediastinum, a CT-based imaging algorithm has a slightly greater overall advantage.

MRA Head and Neck With IV Contrast
MRA head and neck with IV contrast is not the most useful modality for initial imaging. MRA alone is very limited in the assessment of infarction or hemorrhage; both of which can be seen as a complication of carotid dissection, a common etiology of acute onset Horner Syndrome. In the acute setting, CT is preferred over MRI due to rapid acquisition. MR may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact. In addition, the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures including venous structures and soft tissue structures. Also, a lack of noncontrast technique limits assessment for intramural hematoma needed for the evaluation of dissection.

MRA Head and Neck Without and With IV Contrast
MRA head and neck without and with IV contrast is not the most useful modality for initial imaging. MRA alone is very limited in the assessment of infarction or hemorrhage; both of which can be seen as a complication of carotid dissection, a common etiology of acute onset Horner Syndrome. In the acute setting, CT is preferred over MRI due to rapid acquisition. MR may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact. In addition, the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures, including venous structures and soft tissue structures.

MRA Head and Neck Without IV Contrast
MRA head and neck without IV contrast is not the most useful modality for initial imaging. MRA alone is very limited in assessment of infarction or hemorrhage; both of which can be seen as a complication of carotid dissection, a common etiology of acute onset Horner Syndrome. Presence of contrast on MRA can assist with vessel wall morphology, particularly in segments that are prone to in-plane saturation or to flow or tortuosity-related artifact on noncontrast technique. Also, in the acute setting, CT is preferred over MRI due to rapid acquisition. MR may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact. In addition, the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures, including venous structures and soft tissue structures.

MRI Cervical and Thoracic Spine With IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine without and with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine Without IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine without IV contrast in this clinical scenario.

MRI Cervical Spine With IV Contrast
There is no relevant literature to support the use of MRI cervical spine with IV contrast in this clinical scenario.

MRI Cervical Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI cervical spine without and with IV contrast in this clinical scenario.

MRI Cervical Spine Without IV Contrast
There is no relevant literature to support the use of MRI cervical spine without IV contrast in this clinical scenario.

MRI Head and Orbits With IV Contrast
MRI head and orbits with IV contrast is not the most useful modality for initial imaging. It does not evaluate adequately for vascular or extracranial pathologies, and noncontrast sequences are essential to characterize intrinsic T1 properties, so the impact of gadolinium-related T1 shortening can be adequately evaluated.

MRI Head and Orbits Without and With IV Contrast

MRI head and orbits without and with IV contrast is not the most useful modality for initial imaging. It is an excellent for assessment of acute demyelination, inflammation, orbital apex lesions, cavernous sinus abnormalities, and acute infarction, including small vessel brainstem or lenticulostriate infarcts, which can result in Horner syndrome [35]. However, MRI head and orbit does not evaluate adequately for extracranial abnormalities in the neck. Because of the time sensitive nature of carotid dissection and acute infarction, CTA head and neck with a preceding noncontrast head CT remains the best approach for initial imaging. Upon exclusion of dissection and large or medium-sized vessel infarction, MRI head and orbits without and with IV contrast is suitable for next-step evaluation of other potential acute causes.

MRI Head and Orbits Without IV Contrast

MRI head and orbits without IV contrast is not the most useful modality for initial imaging. It may aid in the assessment of demyelination, inflammation, orbital apex lesions, cavernous sinus abnormalities, and acute infarction, but the absence of contrast will lower sensitivity for small tumors and limit the evaluation of acute inflammatory or demyelinating conditions. Carotid dissection and extracranial abnormalities are not optimally assessed using this technique.

MRI Head With IV Contrast

MRI head with IV contrast is not the most useful modality for initial imaging. It may aid in the assessment of demyelination, inflammation, and acute infarction, but noncontrast sequences are essential to characterize intrinsic T1 properties, so the impact of gadolinium-related T1 shortening can be adequately evaluated. Carotid dissection and extracranial abnormalities cannot be assessed using this technique.

MRI Head With IV Contrast and MRA Head and Neck With IV Contrast

There is no relevant literature to support the use of MRI head with IV contrast and MRA head and neck with IV contrast in this clinical scenario.

MRI Head Without and With IV Contrast

MRI head without and with IV contrast is not the most useful modality for initial imaging. It may aid assessment of demyelination and acute infarction. The resolution may not be sufficient for adequate assessment of the orbital apex and cavernous sinus. Carotid dissection, other vascular causes, or extracranial neck findings are not optimally assessed using this technique.

MRI Head Without and With IV Contrast and MRA Head and Neck With IV Contrast

MRI head without and with IV contrast and MRA head and neck with IV contrast is not the most useful modality for initial imaging. It can provide good diagnostic information, but the lack of noncontrast MRA will lower sensitivity by limiting the assessment for intramural hematoma, best seen on noncontrast technique. Also, as stated above, in the acute setting CT is preferred over MRI due to rapid acquisition. MR may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact. Also, lack of noncontrast technique limits the assessment for intramural hematoma needed for evaluation of dissection.

MRI Head Without and With IV Contrast and MRA Head and Neck Without and With IV Contrast

MRI head without and with IV contrast and MRA head and neck without and with IV contrast may be useful for initial imaging. It is an excellent diagnostic tool for the assessment of carotid dissection with intracranial complications. It will also allow assessment of demyelination, inflammation, infection, and small vessel infarcts or ischemia. This procedure is also an excellent approach for initial imaging in the current clinical scenario. However, the speed of acquisition of a CT is much higher than an MRI and MRA. Also, CT has a greater sensitivity of extracranial nonvascular causes of Horner syndrome. Hence, CT-based initial imaging is a favored approach over MRI-based evaluation in acute onset Horner syndrome.

MRI Head Without and With IV Contrast and MRA Head and Neck Without IV Contrast

MRI head without and with IV contrast and MRA head and neck without IV contrast may be useful for initial imaging. It can provide good diagnostic information, but presence of contrast on MRA can assist with vessel wall morphology particularly in segments that are prone to in-plane saturation or to flow or tortuosity-related artifact on noncontrast technique. Also as stated above, in the acute setting CT is preferred over MRI due to rapid acquisition. MR may result in delayed diagnoses due to longer acquisition times. Long acquisition times may also be challenging for patients in an acute clinical scenario, especially if in pain or distress, and may lead to motion artifact.

MRI Head Without IV Contrast
MRI head without IV contrast is not the most useful modality for initial imaging. It may aid in the assessment of demyelination, inflammation, and acute infarction, but an absence of contrast will lower sensitivity for small tumors and limit evaluation of acute inflammatory or demyelinating conditions. The resolution may not be sufficient for an adequate assessment of the orbital apex and cavernous sinus. In addition, carotid dissection, other vascular causes, or extracranial neck findings are not optimally assessed using this technique.

MRI Head Without IV Contrast and MRA Head and Neck Without IV Contrast
MRI head without contrast and MRA head and neck without IV contrast may be useful for initial imaging. It is an excellent diagnostic tool for the assessment of carotid dissection with intracranial complications. It will also allow assessment of demyelination, inflammation, infection, and small vessel infarcts or ischemia. However, the lack of contrast lowers sensitivity toward the detection of enhancing lesions and small masses and lowers sensitivity of MRA in regions prone to in-plane saturation on noncontrast technique. Also, the speed of acquisition of a CT is much higher than an MRI and MRA. Furthermore, CT has a greater sensitivity of extracranial nonvascular causes of Horner syndrome. In addition, absence of contrast will lower sensitivity for the assessment of acute dissection, small tumors, and acute inflammatory or acute demyelination. Hence, CT-based initial imaging is a favored approach over MRI-based evaluation in the initial evaluation of acute onset Horner syndrome.

MRI Neck With IV Contrast
There is no relevant literature to support the use of MRI neck with IV contrast in this clinical scenario.

MRI Neck Without and With IV Contrast
There is no relevant literature to support the use of MRI neck without and with IV contrast in this clinical scenario.

MRI Neck Without IV Contrast
There is no relevant literature to support the use of MRI neck without IV contrast in this clinical scenario.

MRI Orbits With IV Contrast
MRI Orbit with IV contrast is not the most useful modality for initial imaging. It may be used for the assessment of orbital apex lesions and cavernous sinus abnormalities, and based on specific MRI protocol used, it can assess for acute infarction, including small vessel brainstem infarcts, which can result in Horner syndrome [35]. However, performing MRI orbit only with contrast severely limits the assessment of vascular structures and intrinsic T1 properties needed for adequate assessment of postcontrast T1 shortening. This is specifically true in the setting of dissection for evaluation of intramural hematoma. Also, it does not evaluate adequately for extracranial abnormalities in the neck and does not provide a comprehensive evaluation of the brain, which can often coexist in conditions such as inflammation, demyelination, and neoplasms. Lastly, because of the time sensitive nature of carotid dissection and acute infarction, CTA head and neck with a preceding noncontrast head CT remains the best approach for initial imaging.

MRI Orbits Without and With IV Contrast
MRI orbits without IV contrast is not the most useful modality for initial imaging. It is an excellent tool for the assessment of orbital apex lesions and cavernous sinus abnormalities, and based on specific MRI protocol used, it can assess for acute infarction, including small vessel brainstem infarcts, which can result in Horner syndrome [35]. However, it does not evaluate adequately for vascular structures or extracranial abnormalities in the neck and does not provide a comprehensive evaluation of the brain, which can often coexist in conditions such as inflammation, demyelination, and neoplasms. Because of the time sensitive nature of carotid dissection and acute infarction, CTA head and neck with a preceding noncontrast head CT remains the best approach for initial imaging. Upon exclusion of dissection and large or medium-sized vessel infarction, MRI head and orbits without and with IV contrast is suitable for evaluation of other potential causes.

MRI Orbits Without IV Contrast
MRI orbits without IV contrast is not the most useful modality for initial imaging. It is an excellent tool or assessment of orbital apex lesions and cavernous sinus abnormalities, and based on specific MRI protocol used, it can assess for acute infarction, including small vessel brainstem infarcts, which can result in Horner syndrome [35]. However, it does not evaluate adequately for enhancing lesions such as inflammation, neoplasm, or active demyelination or extracranial abnormalities in the neck and does not provide a comprehensive evaluation of the brain, which can often coexist in conditions such as inflammation, demyelination, and neoplasms. Because of the time sensitive nature of carotid dissection and acute infarction, CTA head and neck with a preceding noncontrast head CT remains the best approach for initial imaging. Upon exclusion of dissection and large or medium-sized

vessel infarction, MRI head and orbits without and with IV contrast is suitable for evaluation of other potential causes.

MRI Thoracic Spine With IV Contrast
There is no relevant literature to support the use of MRI thoracic spine with IV contrast in this clinical scenario.

MRI Thoracic Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI thoracic spine without and with IV contrast in this clinical scenario.

MRI Thoracic Spine Without IV Contrast
There is no relevant literature to support the use of MRI thoracic spine without IV contrast in this clinical scenario.

Variant 3: Adult. Acute or nonacute onset Horner syndrome with localizing spinal cord neurological signs or symptoms. No history of trauma. Initial imaging.

Presence of localizing abnormalities to the spinal cord can significantly narrow the scope of imaging. The possible affected regions include central pathways (first-order neurons, cervical and upper thoracic cord) or the preganglionic segment (second-order neurons, C8-T2 nerve roots, paraspinal, cervical sympathetic chain). Candidate causative lesions include spinal cord injury [36], epidural hematoma [37,38], epidural abscess [39], disc herniation [40,41], syringomyelia [42], spinal cord infarction [43], and inflammation/demyelination [25].

CT Head With IV Contrast
There is no relevant literature to support the use of CT head with IV contrast in this clinical scenario.

CT Head Without and With IV Contrast
There is no relevant literature to support the use of CT head without and with IV contrast in this clinical scenario.

CT Head Without IV Contrast
There is no relevant literature to support the use of CT head without IV contrast in this clinical scenario.

CT Head Without IV Contrast and CTA Head and Neck With IV Contrast
There is no relevant literature to support the use of CT head without IV contrast and CTA head and neck with IV contrast in this clinical scenario.

CT Neck With IV Contrast
There is no relevant literature to support the use of CT neck with IV contrast in this clinical scenario.

CT Neck Without and With IV Contrast
There is no relevant literature to support the use of CT neck without and with IV contrast in this clinical scenario.

CT Neck Without IV Contrast
There is no relevant literature to support the use of CT neck without IV contrast in this clinical scenario.

CTA Head and Neck With IV Contrast
There is no relevant literature to support the use of CTA head and neck with IV contrast in this clinical scenario.

MRA Head and Neck Without IV Contrast
There is no relevant literature to support the use of MRA Head and Neck without IV contrast in this clinical scenario.

MRA Head and Neck Without and With IV Contrast
There is no relevant literature to support the use of MRA Head and Neck without and with IV contrast in this clinical scenario.

MRA Head and Neck With IV Contrast
There is no relevant literature to support the use of MRA Head and Neck with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine With IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine Without and With IV Contrast
MRI cervical and thoracic spine is an excellent tool for diagnosis of etiologies causing Horner syndrome with localizing abnormalities to the spinal cord. It allows adequate evaluation of central pathways (first-order neurons, cervical and upper thoracic cord), preganglionic (second-order neurons, C8-T2 nerve roots, paraspinal, cervical

sympathetic chain), and some postganglionic segment causes in the paraspinal region that secondarily involve the spinal cord.

MRI Cervical and Thoracic Spine Without IV Contrast
MRI cervical and thoracic spine without IV contrast is not the most useful modality for initial imaging. It is an excellent tool for the assessment of cord signal and morphology and the appearance of the epidural and paraspinal regions, but the lack of contrast limits assessment and characterization of acute demyelination, inflammation, or small neoplasms.

MRI Cervical Spine With IV Contrast
MRI cervical spine with IV contrast is not the most useful modality for initial imaging. It allows evaluation of central pathways (first-order neurons, cervical and upper thoracic cord). However, lack of precontrast limits the assessment for intrinsic T1 properties such as seen with hemorrhagic lesions. Also, often the field-of-view (FOV) may not cover the upper thoracic cord, and thus there is an incomplete evaluation of preganglionic causes (second-order neurons, C8-T2 nerve roots, paraspinal, cervical sympathetic chain). If the FOV of the cervical spine MRI is extended to completely cover the T1 to T2 levels, it may be adequate, with the exception of abnormalities that span other areas of thoracic spine or paraspinal regions in addition to the upper thoracic cord. Hence, we propose a combined cervical and thoracic spine MRI as a more comprehensive evaluation. This would also evaluate some of the postganglionic causes along the cervical sympathetic chain and in the paraspinal regions that secondarily involve the spinal cord.

MRI Cervical Spine Without and With IV Contrast
MRI cervical spine is not the most useful modality for initial imaging. It is an excellent tool for the diagnosis of etiologies causing Horner syndrome with localizing abnormalities to the spinal cord. It allows for adequate evaluation of central pathways (first-order neurons, cervical and upper thoracic cord). However, often the FOV may not cover the upper thoracic cord, and thus there is an incomplete evaluation of preganglionic causes (second-order neurons, C8-T2 nerve roots, paraspinal, cervical sympathetic chain). If the FOV of the cervical spine MRI is extended to completely cover the T1 to T2 levels, it may be adequate, with the exception of abnormalities that span other areas of thoracic spine or paraspinal regions in addition to the upper thoracic cord. Hence, we propose a combined cervical and thoracic spine MRI as a more comprehensive evaluation. This would also evaluate some of the postganglionic causes along the cervical sympathetic chain and in the paraspinal regions that secondarily involve the spinal cord.

MRI Cervical Spine Without IV Contrast
MRI cervical spine without IV contrast is not the most useful modality for initial imaging. Although it is an excellent tool for the assessment of cord signal and morphology, and the appearance of the epidural and paraspinal regions. However, the lack of contrast limits assessment of acute demyelination, inflammation, or small neoplasms. Additionally, the FOV of an MRI cervical spine may not include the upper thoracic cord, which would lead to an incomplete evaluation of preganglionic causes (second-order neurons, C8-T2 nerve roots, paraspinal, cervical sympathetic chain). Unless the FOV is extended to completely cover the T1 to T2 levels, a combined cervical and thoracic spine MRI is more suitable.

MRI Head and Orbits With IV Contrast
There is no relevant literature to support the use of MRI head and orbits with IV contrast in this clinical scenario.

MRI Head and Orbits Without and With IV Contrast
There is no relevant literature to support the use of MRI head and orbits without and with IV contrast in this clinical scenario.

MRI Head and Orbits Without IV Contrast
There is no relevant literature to support the use of MRI head and orbits without IV contrast in this clinical scenario.

MRI Head With IV Contrast
There is no relevant literature to support the use of MRI head with IV contrast in this clinical scenario.

MRI Head With IV Contrast and MRA Head and Neck With IV Contrast
There is no relevant literature to support the use of MRI head with IV contrast and MRA head and neck with IV contrast in this clinical scenario.

MRI Head Without and With IV Contrast
There is no relevant literature to support the use of MRI head without and with IV contrast in this clinical scenario.

MRI Head Without and With IV Contrast and MRA Head and Neck With IV Contrast
There is no relevant literature to support the use of MRI head without and with IV contrast and MRA head and neck with IV contrast in this clinical scenario.

MRI Head Without and With IV Contrast and MRA Head and Neck Without and With IV Contrast
There is no relevant literature to support the use of MRI head without and with IV contrast and MRA head and neck without and with IV contrast in this clinical scenario.

MRI Head Without and With IV Contrast and MRA Head and Neck Without IV Contrast
There is no relevant literature to support the use of MRI head without and with IV contrast and MRA head and neck without IV contrast in this clinical scenario.

MRI Head Without IV Contrast
There is no relevant literature to support the use of MRI head without IV contrast in this clinical scenario.

MRI Head Without IV Contrast and MRA Head and Neck Without IV Contrast
There is no relevant literature to support the use of MRI head without IV contrast and MRA head and neck without IV contrast in this clinical scenario.

MRI Neck With IV Contrast
There is no relevant literature to support the use of MRI neck with IV contrast in this clinical scenario.

MRI Neck Without and With IV Contrast
There is no relevant literature to support the use of MRI neck without and with IV contrast in this clinical scenario.

MRI Neck Without IV Contrast
There is no relevant literature to support the use of MRI neck without IV contrast in this clinical scenario.

MRI Orbits Without IV Contrast
There is no relevant literature to support the use of MRI orbit without IV contrast in this clinical scenario.

MRI Orbits With IV Contrast
There is no relevant literature to support the use of MRI orbit with IV contrast in this clinical scenario.

MRI Orbits Without and With IV Contrast
There is no relevant literature to support the use of MRI orbit without and with IV contrast in this clinical scenario.

MRI Thoracic Spine With IV Contrast
There is no relevant literature to support the use of MRI thoracic spine with IV contrast in this clinical scenario. It does not cover the cervical spine, and hence has an inadequate FOV for comprehensive assessment. Lack of noncontrast technique also limits assessment of intrinsic T1 properties.

MRI Thoracic Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI thoracic spine without and with IV contrast in this clinical scenario. It does not cover the cervical spine, and hence has an inadequate FOV for comprehensive assessment.

MRI Thoracic Spine Without IV Contrast
There is no relevant literature to support the use of MRI thoracic spine without IV contrast in this clinical scenario. It does not cover the cervical spine, and hence has an inadequate FOV for comprehensive assessment.

Variant 4: Adult. Nonacute onset Horner syndrome with localizing brain or cranial nerve neurological signs or symptoms. Initial imaging.

Nonacute onset Horner syndrome with localizing brain and cranial nerve abnormalities can be seen with the involvement of central pathways (first-order neurons, hypothalamus, or brainstem) or the postganglionic segment (third-order neurons, cavernous sinus, superior orbital fissure). Brain stem lesions such as inflammation [44], demyelination [23,45], tumors [19,46], and infection [47], as well as lesions involving the cavernous sinus [48], pituitary, and skull base [27,49,50], may be relevant in this clinical scenario.

CT Head With IV Contrast
There is no relevant literature to support the use of CT head with IV contrast in this clinical scenario.

CT Head Without and With IV Contrast
There is no relevant literature to support the use of CT head without and with IV contrast in this clinical scenario.

CT Head Without IV Contrast
There is no relevant literature to support the use of CT head without IV contrast in this clinical scenario.

CT Head Without IV Contrast and CTA Head and Neck With IV Contrast
MRI is most suited for evaluation of nonacute or chronic onset neurological signs and symptoms. The presence of associated Horner syndrome follows similar approach for workup. Hence, CT evaluation may not be the best approach, even though it has some benefits; MRI will provide greater contrast resolution, parenchymal detail, and ability to visualize the cranial nerves.

CT Neck With IV Contrast
There is no relevant literature to support the use of CT neck with IV contrast in this clinical scenario.

CT Neck Without and With IV Contrast
There is no relevant literature to support the use of CT neck without and with IV contrast in this clinical scenario.

CT Neck Without IV Contrast
There is no relevant literature to support the use of CT neck without IV contrast in this clinical scenario.

CTA Head and Neck With IV Contrast
There is no relevant literature to support the use of CTA head and neck with IV contrast in this clinical scenario.

MRA Head and Neck Without IV Contrast
There is no relevant literature to support the use of MRA head and neck without IV contrast in this clinical scenario.

MRA Head and Neck Without and With IV Contrast
There is no relevant literature to support the use of MRA head and neck without and with IV contrast in this clinical scenario.

MRA Head and Neck With IV Contrast
There is no relevant literature to support the use of MRA head and neck with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine With IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine without and with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine Without IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine without IV contrast in this clinical scenario.

MRI Cervical Spine With IV Contrast
There is no relevant literature to support the use of MRI cervical with IV contrast in this clinical scenario.

MRI Cervical Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI cervical spine without and with IV contrast in this clinical scenario.

MRI Cervical Spine Without IV Contrast
There is no relevant literature to support the use of MRI cervical spine without IV contrast in this clinical scenario.

MRI Head and Orbits With IV Contrast
There is no relevant literature to support the use of MRI head and orbits with IV contrast in this clinical scenario.

MRI Head and Orbits Without and With IV Contrast
MRI head and orbits without and with IV contrast alone is not the most comprehensive approach for initial imaging. It is excellent for the assessment for demyelinating and inflammatory disease and lesions in the orbital apex, cavernous sinus, sellar/suprasellar region, brain stem, and skull base, which can result in Horner syndrome. The high-resolution MRI orbit sequences are particularly suited for abnormalities in the orbital apex, cavernous sinus,

and skull base, which can result in insidious onset of chronic Horner syndrome. However, MRA head and neck without and with IV contrast can give additional information about vascular etiologies including rare manifestation of nonacute or chronic dissection [51,52]. Therefore, for the initial workup, MRI head and MRA head and neck without and with IV contrast are more suitable. The high-resolution orbital sequences can be added to MRI brain protocol or may be performed as a subsequent study if needed, depending on the results of initial imaging.

MRI Head and Orbits Without IV Contrast
MRI head and orbits without IV contrast is alone is not the most comprehensive approach for initial imaging. It is an excellent modality for assessment for demyelination, inflammation, orbital apex, cavernous sinus, sellar/suprasellar, brain stem, and skull base abnormalities, which can result in insidious or chronic Horner syndrome. However, MRA head and neck without and with IV contrast can give additional information about vascular etiologies including rare manifestation of nonacute or chronic dissection [51,52]. Therefore, for the initial workup, MRI head and MRA head and neck without and with IV contrast are more suitable. The high-resolution orbital sequences can be added to MRI brain protocol, or may be performed as a subsequent study if needed, depending on the results of initial imaging. The lack of IV contrast lowers the capability for detection and characterization of inflammation, infection, and neoplasms.

MRI Head With IV Contrast
MRI head with IV contrast in this clinical scenario alone is not the most comprehensive approach for initial imaging. MRA head and neck without and with IV contrast can give additional information about vascular etiologies including rare manifestation of nonacute or chronic dissection [51,52]. Therefore, for the initial workup, MRI head and MRA head and neck without and with IV contrast are more suitable. The high-resolution orbital sequences can be added to MRI brain protocol or may be performed as a subsequent study if needed, depending on the results of initial imaging. The lack of noncontrast technique also severely limits the assessment for intrinsic T1 properties.

MRI Head With IV Contrast and MRA Head and Neck With IV Contrast
MRI head with IV contrast and MRA head and neck with IV contrast is alone is not the most comprehensive approach for initial imaging in this clinical scenario. The lack of noncontrast technique severely limits the assessment for intrinsic T1 properties and particularly limits detection for intramural hematoma that can be seen with dissection.

MRI Head Without and With IV Contrast
MRI head without and with IV contrast is alone is not the most comprehensive approach for initial imaging in this clinical scenario. It is an excellent modality for the assessment for demyelination, inflammation, sellar/suprasellar, and brain stem abnormalities, which can result in insidious or chronic Horner syndrome. However, this approach does not allow adequate evaluation of vascular etiologies.

MRI Head Without and With IV Contrast and MRA Head and Neck With IV Contrast
MRI head without and with IV contrast and MRA head and neck with IV contrast can provide good diagnostic information, but lack of noncontrast MRA will lower sensitivity by limiting assessment for intramural hematoma, best seen on noncontrast technique.

MRI Head Without and With IV Contrast and MRA Head and Neck Without and With IV Contrast
MRI head without and with IV contrast is the most comprehensive initial imaging approach for this variant. It is an excellent modality for assessment for demyelination, inflammation, sellar/suprasellar, and brain stem abnormalities, which can result in insidious or chronic Horner syndrome. MRA head and neck without and with IV contrast can give additional information about vascular etiologies including rare manifestation of nonacute or chronic dissection [51,52]. Although high-resolution MRI orbit sequences are more suited for assessment of the orbital apex, cavernous sinus, and skull base regions, MRI head without and with IV contrast may still provide some diagnostic information in these regions. Therefore, for the initial workup, MRI head and MRA head and neck without and with IV contrast are more suitable. The high-resolution orbital sequences can either be added to MRI brain as special imaging considerations or be performed as a subsequent study if needed based on the results of initial imaging.

MRI Head Without and With IV Contrast and MRA Head and Neck Without IV Contrast
MRI head without and with IV contrast and MRA head and neck without IV contrast is not the most comprehensive approach for initial imaging in this clinical scenario. Contrast-enhanced MRA technique can assist with vessel wall morphology particularly in segments that are prone to in-plane saturation or to flow or tortuosity-related artifact on noncontrast technique.

MRI Head Without IV Contrast
MRI head without IV contrast alone is not the most comprehensive approach for initial imaging in this clinical scenario. It is useful for assessment for demyelination, inflammation, sellar/suprasellar, and brain stem abnormalities, which can result in insidious or chronic Horner syndrome. However, in the absence of MRA, assessment of vascular structures is limited. Furthermore, the lack of IV contrast lowers capability for detection and characterization of infection, inflammation, and neoplasms.

MRI Head Without IV Contrast and MRA Head and Neck Without IV Contrast
MRI head without IV contrast and MRA head and neck without IV contrast is alone is not the most comprehensive approach for initial imaging in this clinical scenario. It is useful for assessment of demyelination, inflammation, sellar/suprasellar, and brain stem abnormalities, which can result in insidious or chronic Horner syndrome. MRA head and neck without IV contrast can give additional information about vascular etiologies including rare manifestation of nonacute or chronic carotid dissection [51,52]. However, the lack of IV contrast lowers the sensitivity to detect and characterize vascular abnormalities, infection, inflammation, and neoplasms.

MRI Neck With IV Contrast
There is no relevant literature to support the use of MRI neck with IV contrast in this clinical scenario.

MRI Neck Without and With IV Contrast
There is no relevant literature to support the use of MRI neck without and with IV contrast in this clinical scenario.

MRI Neck Without IV Contrast
There is no relevant literature to support the use of MRI neck without IV contrast in this clinical scenario.

MRI Orbits With IV Contrast
MRI orbits with IV contrast alone is not the most comprehensive approach for initial imaging in this clinical scenario. It may be used for the assessment of orbital apex lesions and cavernous sinus abnormalities, and based on specific MRI protocol used, it can assess for acute infarction, including small vessel brainstem or lenticulostriate infarcts, which can result in Horner syndrome [35]. However, performing MRI orbit only with contrast severely limits for assessment of intrinsic T1 properties needed for adequate assessment of postcontrast T1 shortening. Also, it does not provide a comprehensive evaluation of the brain, which can often coexist in conditions such as inflammation, demyelination, and neoplasms. Therefore, for initial workup, MRI head and MRA head and neck without and with IV contrast are more suitable. The high-resolution orbital sequences can either be added to MRI brain as special imaging considerations or be performed as a subsequent study if needed based on the results of initial imaging.

MRI Orbits Without and With IV Contrast
MRI orbits without and with IV contrast alone is not the most comprehensive approach for initial imaging in this clinical scenario. It is an excellent tool for assessment of orbital apex lesions or cavernous sinus abnormalities, and based on specific MRI protocol used, it can assess for acute infarction, including small vessel brainstem or lenticulostriate infarcts, which can result in Horner syndrome [35]. However, it does not provide a comprehensive evaluation of the brain, which can often coexist in conditions such as inflammation, demyelination, and neoplasms. Therefore, for the initial workup, MRI head and MRA head and neck without and with IV contrast are more suitable. The high-resolution orbital sequences can either be added to MRI brain as special imaging considerations or be performed as a subsequent study if needed based on the results of initial imaging.

MRI Orbits Without IV Contrast
MRI orbits without IV contrast alone is not the most comprehensive approach for initial imaging in this clinical scenario. It is an excellent tool for assessment of orbital apex lesions and cavernous sinus abnormalities, and based on the specific MRI protocol used, it can assess for acute infarction, including small vessel brainstem or lenticulostriate infarcts, which can result in Horner syndrome [35]. However, it does not evaluate adequately for enhancing lesions such as inflammation, neoplasm or active demyelination, and does not provide a comprehensive evaluation of the brain. Therefore, for the initial workup, MRI head and MRA head and neck without and with IV contrast are more suitable. The high-resolution orbital sequences can either be added to MRI brain as special imaging considerations or be performed as a subsequent study if needed based on the results of initial imaging.

MRI Thoracic Spine With IV Contrast
There is no relevant literature to support the use of MRI thoracic spine with IV contrast in this clinical scenario.

MRI Thoracic Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI thoracic spine without and with IV contrast in this clinical scenario.

MRI Thoracic Spine Without IV Contrast
There is no relevant literature to support the use of MRI thoracic spine without IV contrast in this clinical scenario.

Variant 5: Adult. Nonacute onset Horner syndrome nonlocalizable, not otherwise specified. Initial imaging.

Nonacute, nonlocalizable, and not otherwise specified Horner syndrome can pose a significant diagnostic challenge. The affected pathways can involve central pathways in the brain and spinal cord, preganglionic pathways along C8-T2 nerve roots, neck, paraspinal, mediastinal, pulmonary apex regions, and postganglionic pathways along the internal auditory canal, cavernous sinus, and orbital apex [1,2]. At least 40% of cases may not have an identifiable cause, with idiopathic or uncertain etiology [3]. Other common etiologies that can be nonacute and nonlocalizable include cluster headache [3], tumor [15-19,53], aneurysm [54], and infection or inflammation [3].

Initial imaging may be focused on evaluation of the most common causes, including vascular abnormalities and lesions in the neck, paraspinal, and mediastinal regions [28].

CT Head With IV Contrast
There is no relevant literature to support the use of CT head with IV contrast in this clinical scenario.

CT Head Without and With IV Contrast
There is no relevant literature to support the use of CT head without and with IV contrast in this clinical scenario.

CT Head Without IV Contrast
There is no relevant literature to support the use of CT head without IV contrast in this clinical scenario.

CT Head Without IV Contrast and CTA Head and Neck With IV Contrast
This approach is not the most useful procedure for initial imaging. Although CTA head and neck with IV contrast is an excellent tool for initial imaging, and can provide comprehensive evaluation of vascular structures, neck soft tissues, upper mediastinum, and lung apex. However, a noncontrast head CT is of little additional value in the nonacute nonlocalizable cases of Horner syndrome, where acute stroke as a cause of Horner syndrome is not the prime consideration. Hence this combined approach is not warranted in this clinical scenario.

CT Neck With IV Contrast
This approach is not the most suitable for initial imaging. CT neck with IV contrast can aid the evaluation of the preganglionic pathways along C8-T2 nerve roots, neck, paraspinal, mediastinal, pulmonary apex regions, and postganglionic pathways along the internal auditory canal, cavernous sinus, and orbital apex [1,2]. However, the assessment is incomplete given it does not adequately evaluate the vascular structures, which are commonly involved in cases of Horner syndrome [9-11]. Missed vascular abnormalities such as chronic dissection can have significant morbidity and mortality. CTA head and neck is the preferred approach because it provides a more comprehensive evaluation with excellent assessment of vascular structures and adequate assessment of the soft tissues of the neck, superior mediastinum, and pulmonary apex.

CT Neck Without and With IV Contrast
CT neck without IV contrast does not add much additional value to CT neck with IV contrast.

CT Neck Without IV Contrast
This approach is not the most suitable for initial imaging. CT neck without IV contrast provides some benefit for the assessment of soft tissue structures in the neck, paraspinal, mediastinal, pulmonary apex regions [1,2]. However, the sensitivity to soft tissue detail is limited due to a lack of IV contrast. Also, it does not adequately evaluate the vascular structures, which are commonly involved in cases of Horner syndrome [9-11]. Missed vascular abnormalities such as chronic dissection can have significant morbidity and mortality. CTA head and neck is the preferred approach since it provides a more comprehensive evaluation with excellent assessment of vascular structures and adequate assessment of the soft tissues of the neck, superior mediastinum, and pulmonary apex.

CTA Head and Neck With IV Contrast
CTA head and neck with IV contrast is the best approach for initial imaging and can provide comprehensive evaluation of vascular structures, neck soft tissues, upper mediastinum, and lung apex. There is also some diagnostic assessment of the skull base, orbital, and intracranial regions. Hence, this approach provides the most thorough

evaluation in nonacute, nonlocalizable, not otherwise specified cases of Horner syndrome, including assessment for vascular etiologies, which can be nonacute in presentation [51,52] and result in significant morbidity and mortality. MRI Brain and Orbit without and with IV contrast can be considered for second line workup if needed but are not the most comprehensive approach for initial workup.

MRA Head and Neck With IV Contrast
This approach is not the most useful procedure for initial imaging. MRA head and neck with IV contrast can provide good diagnostic information, but the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures including venous structures and soft tissue structures.

MRA Head and Neck Without and With IV Contrast
This approach is not the most useful procedure for initial imaging. MRA head and neck without and with IV contrast can provide good diagnostic information, but the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures including venous structures and soft tissue structures.

MRA Head and Neck Without IV Contrast
This approach is not the most useful procedure for initial imaging. MRA head and neck without IV contrast can provide good diagnostic information about vascular causes, but presence of contrast on MRA can assist with vessel wall morphology particularly in segments that are prone to in-plane saturation or to flow or tortuosity-related artifact on noncontrast technique. In addition, the ability to visualize extracranial structures may be limited with MRA techniques that often saturate signal from stationary spins or use saturation bands to suppress signal from nonarterial structures including venous structures and soft tissue structures.

MRI Cervical and Thoracic Spine With IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine without and with IV contrast in this clinical scenario.

MRI Cervical and Thoracic Spine Without IV Contrast
There is no relevant literature to support the use of MRI cervical and thoracic spine without IV contrast in this clinical scenario.

MRI Cervical Spine With IV Contrast
There is no relevant literature to support the use of MRI cervical spine with IV contrast in this clinical scenario.

MRI Cervical Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI cervical spine without and with IV contrast in this clinical scenario.

MRI Cervical Spine Without IV Contrast
There is no relevant literature to support the use of MRI cervical spine without IV contrast in this clinical scenario.

MRI Head and Orbits With IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach may be of some benefit in the assessment of central, orbital apex, and cavernous sinus causes, it is severely limited for the evaluation of vascular etiologies such as chronic dissection and extracranial causes in the neck, chest, and mediastinum. Also, MRI with contrast only does not adequately assess for intrinsic T1 properties and enhancement.

MRI Head and Orbits Without and With IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach may be of some benefit in the assessment of central, orbital apex, and cavernous sinus causes, it is severely limited for the evaluation of vascular etiologies such as chronic dissection and extracranial causes in the neck, chest, and mediastinum.

MRI Head and Orbits Without IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach may be of some benefit in the assessment of central, orbital apex, and cavernous sinus causes, it is severely limited for the evaluation of

vascular etiologies such as chronic dissection and extracranial causes in the neck, chest, and mediastinum. Also, lack of IV contrast lowers sensitivity for central pathologies such as inflammation, neoplasms, and active demyelination.

MRI Head With IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach may be of some benefit in the assessment of central causes, it is severely limited for the evaluation of vascular etiologies such as chronic dissection and extracranial causes in the neck. Also, MRI with contrast only does not adequately assess for intrinsic T1 properties and enhancement.

MRI Head With IV Contrast and MRA Head and Neck With IV Contrast
This approach is not the most suitable for initial imaging. Although this approach may be of some benefit in the assessment of central, and vascular causes, it is severely limited for evaluation of extracranial causes in the neck, chest, and mediastinum.

MRI Head Without and With IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach may be of some benefit in the assessment of central causes, it is severely limited for the evaluation of vascular etiologies such as chronic dissection and extracranial causes in the neck, chest, and mediastinum.

MRI Head Without and With IV Contrast and MRA Head and Neck With IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach evaluates for vascular etiologies and central causes, it does not allow adequate evaluation of the neck, chest, and mediastinal regions, which can commonly be involved in nonacute, nonlocalizable cases of Horner syndrome.

MRI Head Without and With IV Contrast and MRA Head and Neck Without and With IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach evaluates for vascular etiologies and central causes, it does not allow adequate evaluation of the neck, chest, and mediastinal regions, which can commonly be involved in nonacute, nonlocalizable cases of Horner syndrome.

MRI Head Without and With IV Contrast and MRA Head and Neck Without IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach evaluates for vascular etiologies and central causes, it does not allow adequate evaluation of the neck, chest, and mediastinal regions, which can commonly be involved in nonacute, nonlocalizable cases of Horner syndrome.

MRI Head Without IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach may be of some benefit in the assessment of central causes, it is severely limited for the evaluation of vascular etiologies such as chronic dissection and extracranial causes in the neck, chest, and mediastinum. Lack of IV contrast further lowers its sensitivity to pathology.

MRI Head Without IV Contrast and MRA Head and Neck Without IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach evaluates for vascular etiologies and central causes, it does not allow adequate evaluation of the neck, chest, and mediastinal regions, which can commonly be involved in nonacute, nonlocalizable cases of Horner syndrome. Lack of IV contrast further lowers its sensitivity to pathology.

MRI Neck With IV Contrast
There is no relevant literature to support the use of MRI neck with IV contrast in this clinical scenario.

MRI Neck Without and With IV Contrast
This approach is not the most useful procedure for initial imaging. MRI neck without and with IV contrast can aid the evaluation of the second- and third-order pathways. However, the assessment is incomplete given it does not adequately evaluate the vascular structures, which are commonly involved in cases of Horner syndrome. Missed vascular abnormalities such as chronic dissection can have significant morbidity and mortality. CTA head and neck is the preferred approach because it provides a more comprehensive evaluation with excellent assessment of vascular structures and adequate assessment of the soft tissues of the neck, superior mediastinum, and pulmonary apex.

MRI Neck Without IV Contrast
This approach is not the most useful procedure for initial imaging. MRI neck without IV contrast can aid the evaluation of the second- and third-order pathways. However, the assessment is incomplete given it does not adequately evaluate the vascular structures, which are commonly involved in cases of Horner syndrome. Missed vascular abnormalities such as chronic dissection can have significant morbidity and mortality. Lack of IV contrast further lowers diagnostic usefulness. Hence, CTA head and neck is the preferred approach because it provides a more comprehensive evaluation with excellent assessment of vascular structures and adequate assessment of the soft tissues of the neck, superior mediastinum, and pulmonary apex.

MRI Orbits With IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach may be of some benefit in assessment of orbital apex and cavernous sinus causes, it is limited for the evaluation of central causes, vascular etiologies such as chronic dissection, and extracranial causes in the neck, chest, and mediastinum. Also lack of noncontrast technique limits the assessment of intrinsic T1 properties, including detection of intramural hematoma and accurate characterization of postcontrast T1 shortening.

MRI Orbits Without and With IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach may be of some benefit in the assessment of orbital apex and cavernous sinus causes, it is limited for evaluation of central causes, vascular etiologies such as chronic dissection, and extracranial causes in the neck, chest, and mediastinum.

MRI Orbits Without IV Contrast
This approach is not the most useful procedure for initial imaging. Although this approach may be of some benefit in the assessment of orbital apex and cavernous sinus causes, it is limited for evaluation of central causes, vascular etiologies such as chronic dissection, and extracranial causes in the neck, chest, and mediastinum. Also a lack of IV contrast lowers the sensitivity for central pathologies such as inflammation, neoplasms, and active demyelination.

MRI Thoracic Spine With IV Contrast
There is no relevant literature to support the use of MRI thoracic spine with IV contrast in this clinical scenario.

MRI Thoracic Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI thoracic spine without and with IV contrast in this clinical scenario.

MRI Thoracic Spine Without IV Contrast
There is no relevant literature to support the use of MRI thoracic spine without IV contrast in this clinical scenario.

Summary of Highlights

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- **Variant 1 and 2:** For acute onset Horner syndrome with or without localizing neurological signs or symptoms, with or without recent trauma or pain, a CT head without IV contrast and CTA head and neck with IV contrast combination or CTA head and neck with IV contrast alone are both usually appropriate for the initial workup. Carotid dissection is the most common etiology in such scenarios and CTA head and neck with IV contrast is an excellent diagnostic tool for assessment of carotid dissection due to its high resolution and short acquisition time. A noncontrast head CT is often performed just before the CTA head and neck to evaluate for associated infarction (as a sequela of carotid dissection or a primary brain stem infarction) and hemorrhage (in the setting of trauma). MRI head and MRA head and neck without or with and without IV contrast may also provide similar information; however, the ability to simultaneously assess for extravascular abnormalities in neck and superior mediastinum is superior with CT, giving a CT-based imaging algorithm a slightly greater overall advantage.

- **Variant 3:** For acute or nonacute onset Horner syndrome with localizing spinal cord neurological signs or symptoms, initial imaging with MRI cervical and thoracic spine without and with IV contrast is an excellent tool for the diagnosis of etiologies causing Horner syndrome. It allows adequate evaluation of central pathways (first-order neurons, cervical and upper thoracic cord), preganglionic (second-order neurons, C8-T2 nerve roots, paraspinal, cervical sympathetic chain), and some postganglionic segment causes in the paraspinal region that secondarily involve the spinal cord. MRI cervical spine only without or without and without IV contrast may not include causes due to upper thoracic second-order neuron involvement, unless widened FOV to include upper thoracic cord is used. Similarly, MRI thoracic spine alone may miss the central pathways in the cervical spine that may result in Horner syndrome.

- **Variant 4:** There was no expert consensus on a single most appropriate imaging test in the scenario of nonacute onset Horner syndrome with localizing brain or cranial nerve neurological signs or symptoms. In general, MRI-based initial assessment is favored in this scenario, and MRI head without and with IV contrast along with MRA neck without and with IV contrast may be the most comprehensive initial imaging approach for this variant. It is an excellent modality for assessment for demyelination, inflammation, sellar/suprasellar, and brain stem abnormalities, which can result in insidious or chronic Horner syndrome. High-resolution MRI orbit sequences may be appropriate when assessment needs to target the orbital apex, cavernous sinus, and skull base regions. The high-resolution orbital sequences can either be added to MRI brain as special imaging considerations or be performed as a subsequent separate study. CT head without IV contrast and CTA head and neck with IV contrast may also be appropriate if a vascular etiology is suspected, to assess for dissection and associated intracranial complications.

- **Variant 5:** For nonacute onset Horner syndrome nonlocalizable, not otherwise specified, CTA head and neck with IV contrast is the best approach for initial imaging and can provide comprehensive evaluation of vascular structures, neck soft tissues, upper mediastinum, and lung apex. There is also some diagnostic assessment of the skull base, orbital, and intracranial regions. Hence, this approach provides the most thorough initial evaluation in nonacute, nonlocalizable, not otherwise specified cases of Horner syndrome, including assessment for vascular etiologies, which can be nonacute in presentation and result in significant morbidity and mortality. Findings on this initial imaging study can help guide more targeted imaging of anatomical sites with the most appropriate imaging modality.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, click here.

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that pre-dates the use of the current understanding of language inclusive of diversity in sex, intersex, gender and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health [55].

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [56].

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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