American College of Radiology
ACR Appropriateness Criteria®
Back Pain-Child

Variant: 1 Child. Back pain. No clinical red flags. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
Radiography complete spine	Usually Not Appropriate	☢☢☢
US spine area of interest	Usually Not Appropriate	O
Radiography spine area of interest	Usually Not Appropriate	Varies
MRI complete spine with IV contrast	Usually Not Appropriate	O
MRI complete spine without and with IV contrast	Usually Not Appropriate	O
MRI complete spine without IV contrast	Usually Not Appropriate	O
MRI spine area of interest with IV contrast	Usually Not Appropriate	O
MRI spine area of interest without and with IV contrast	Usually Not Appropriate	O
MRI spine area of interest without IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT area of interest	Usually Not Appropriate	☢☢☢☢
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢☢
CT complete spine with IV contrast	Usually Not Appropriate	☢☢☢☢
CT complete spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT complete spine without IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography complete spine	Usually Not Appropriate	☢☢☢☢
CT myelography spine area of interest	Usually Not Appropriate	Varies
CT spine area of interest with IV contrast	Usually Not Appropriate	Varies
CT spine area of interest without and with IV contrast	Usually Not Appropriate	Varies
CT spine area of interest without IV contrast	Usually Not Appropriate	Varies

Variant: 2 Child. Back pain. With at least one clinical red flag. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
Radiography spine area of interest	Usually Appropriate	Varies
Radiography complete spine	May Be Appropriate	☢☢☢
MRI complete spine without and with IV contrast	May Be Appropriate	O
MRI complete spine without IV contrast	May Be Appropriate (Disagreement)	O
MRI spine area of interest without and with IV contrast	May Be Appropriate (Disagreement)	O
MRI spine area of interest without IV contrast	May Be Appropriate (Disagreement)	O
CT spine area of interest with IV contrast	May Be Appropriate	Varies
CT spine area of interest without IV contrast	May Be Appropriate	Varies
US spine area of interest	Usually Not Appropriate	O
MRI complete spine with IV contrast	Usually Not Appropriate	O
MRI spine area of interest with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT area of interest	Usually Not Appropriate	☢☢☢☢

Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢☢
CT complete spine with IV contrast	Usually Not Appropriate	☢☢☢☢
CT complete spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT complete spine without IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography complete spine	Usually Not Appropriate	☢☢☢☢
CT myelography spine area of interest	Usually Not Appropriate	Varies
CT spine area of interest without and with IV contrast	Usually Not Appropriate	Varies

Variant: 3 Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.

Procedure	Appropriateness Category	Peds Relative Radiation Level
MRI spine area of interest without and with IV contrast	Usually Appropriate	O
MRI spine area of interest without IV contrast	Usually Appropriate	O
MRI complete spine with IV contrast	May Be Appropriate (Disagreement)	O
MRI complete spine without and with IV contrast	May Be Appropriate (Disagreement)	O
MRI complete spine without IV contrast	May Be Appropriate (Disagreement)	O
MRI spine area of interest with IV contrast	May Be Appropriate (Disagreement)	O
CT complete spine with IV contrast	May Be Appropriate	☢☢☢☢
CT complete spine without IV contrast	May Be Appropriate	☢☢☢☢
CT spine area of interest with IV contrast	May Be Appropriate	Varies
CT spine area of interest without IV contrast	May Be Appropriate	Varies
US spine area of interest	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT area of interest	Usually Not Appropriate	☢☢☢☢
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢☢
CT complete spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography complete spine	Usually Not Appropriate	☢☢☢☢
CT myelography spine area of interest	Usually Not Appropriate	Varies
CT spine area of interest without and with IV contrast	Usually Not Appropriate	Varies

Variant: 4 Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
MRI complete spine without and with IV contrast	Usually Appropriate	O
Radiography complete spine	May Be Appropriate (Disagreement)	☢☢☢
Radiography spine area of interest	May Be Appropriate (Disagreement)	Varies
MRI complete spine with IV contrast	May Be Appropriate (Disagreement)	O

MRI complete spine without IV contrast	May Be Appropriate	O
CT complete spine with IV contrast	May Be Appropriate (Disagreement)	☢☢☢☢
CT complete spine without and with IV contrast	May Be Appropriate (Disagreement)	☢☢☢☢
CT complete spine without IV contrast	May Be Appropriate	☢☢☢☢
CT spine area of interest with IV contrast	May Be Appropriate (Disagreement)	Varies
CT spine area of interest without and with IV contrast	May Be Appropriate (Disagreement)	Varies
CT spine area of interest without IV contrast	May Be Appropriate	Varies
US spine area of interest	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT area of interest	Usually Not Appropriate	☢☢☢☢
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢☢
CT myelography complete spine	Usually Not Appropriate	☢☢☢☢
CT myelography spine area of interest	Usually Not Appropriate	Varies

<u>Variant: 5</u> Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.

Procedure	Appropriateness Category	Peds Relative Radiation Level
MRI complete spine without and with IV contrast	Usually Appropriate	O
MRI spine area of interest without and with IV contrast	Usually Appropriate	O
MRI complete spine without IV contrast	May Be Appropriate (Disagreement)	O
MRI spine area of interest with IV contrast	May Be Appropriate (Disagreement)	O
MRI spine area of interest without IV contrast	May Be Appropriate (Disagreement)	O
Bone scan whole body with SPECT or SPECT/CT area of interest	May Be Appropriate	☢☢☢☢
Bone scan whole body with SPECT or SPECT/CT complete spine	May Be Appropriate (Disagreement)	☢☢☢☢
CT complete spine with IV contrast	May Be Appropriate (Disagreement)	☢☢☢☢
CT complete spine without IV contrast	May Be Appropriate	☢☢☢☢
FDG-PET/CT whole body	May Be Appropriate (Disagreement)	☢☢☢☢
CT spine area of interest with IV contrast	May Be Appropriate	Varies
CT spine area of interest without IV contrast	May Be Appropriate	Varies
US spine area of interest	Usually Not Appropriate	O
MRI complete spine with IV contrast	Usually Not Appropriate	O
CT complete spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography complete spine	Usually Not Appropriate	☢☢☢☢
CT myelography spine area of interest	Usually Not Appropriate	Varies
CT spine area of interest without and with IV contrast	Usually Not Appropriate	Varies

<u>Variant: 6</u> Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
Radiography spine area of interest	Usually Appropriate	Varies
Radiography complete spine	May Be Appropriate (Disagreement)	☢☢☢
MRI spine area of interest without IV contrast	May Be Appropriate (Disagreement)	O
Bone scan whole body with SPECT or SPECT/CT area of interest	May Be Appropriate	☢☢☢☢
CT spine area of interest without IV contrast	May Be Appropriate	Varies
US spine area of interest	Usually Not Appropriate	O
MRI complete spine with IV contrast	Usually Not Appropriate	O
MRI complete spine without and with IV contrast	Usually Not Appropriate	O
MRI complete spine without IV contrast	Usually Not Appropriate	O
MRI spine area of interest with IV contrast	Usually Not Appropriate	O
MRI spine area of interest without and with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢☢
CT complete spine with IV contrast	Usually Not Appropriate	☢☢☢☢
CT complete spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT complete spine without IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography complete spine	Usually Not Appropriate	☢☢☢☢
CT myelography spine area of interest	Usually Not Appropriate	Varies
CT spine area of interest with IV contrast	Usually Not Appropriate	Varies
CT spine area of interest without and with IV contrast	Usually Not Appropriate	Varies

<u>Variant: 7</u> Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
US spine area of interest	Usually Appropriate	O
MRI spine area of interest without and with IV contrast	Usually Appropriate	O
MRI spine area of interest without IV contrast	Usually Appropriate	O
MRI complete spine without and with IV contrast	May Be Appropriate (Disagreement)	O
MRI complete spine without IV contrast	May Be Appropriate (Disagreement)	O
MRI spine area of interest with IV contrast	May Be Appropriate (Disagreement)	O
Radiography complete spine	Usually Not Appropriate	☢☢☢
Radiography spine area of interest	Usually Not Appropriate	Varies
MRI complete spine with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT area of interest	Usually Not Appropriate	☢☢☢☢
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢☢

CT complete spine with IV contrast	Usually Not Appropriate	☢☢☢☢
CT complete spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT complete spine without IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography complete spine	Usually Not Appropriate	☢☢☢☢
CT myelography spine area of interest	Usually Not Appropriate	Varies
CT spine area of interest with IV contrast	Usually Not Appropriate	Varies
CT spine area of interest without and with IV contrast	Usually Not Appropriate	Varies
CT spine area of interest without IV contrast	Usually Not Appropriate	Varies

Panel Members

Hisham Dahmoush, MBBCh[a], Durga Sivacharan Gaddam, MD[b], Mai-Lan Ho, MD[c], David F. Bauer, MD, MPH[d], Thangamadhan Bosemani, MD[e], Jeffrey Buchhalter, MD, PhD[f], Roshni A. Dasgupta, MD[g], Orit A. Glenn, MD[h], Carolina V. Guimaraes, MD[i], Helen R. Nadel, MD[j], Cory M. Pfeifer, MD, MS, MPH, MBA[k], Rupa Radhakrishnan, MBBS, MS[l], Charles Reitman, MD[m], Anna K. Thomas, MD[n], Unni K. Udayasankar, MD[o], Jessica J. Wall, MD, MPH, MSCE[p], Jason N. Wright, MD[q], Courtney J. Wusthoff, MD, MS[r], Sumit Pruthi, MD, MBBS[s]

Summary of Literature Review

Introduction/Background

Nontraumatic back pain is a common chief complaint encountered in the pediatric population. Historically, studies have demonstrated a low prevalence of pediatric back pain, but more recent investigations show a much higher prevalence, ranging between 30% and 50% [1-4]. Furthermore, incidence of back pain increases with pubertal development and linear growth [5]. Female sex, childhood obesity, increased time spent sitting, repetitive activity, congenital abnormalities, and family history of back pain are also attributable risk factors of pediatric back pain [6]. Although there are many etiologies for pediatric back pain, most cases are attributable to benign mechanical causes such as musculature strain [2]. In recent decades, factors such as childhood obesity and increased intensity of youth sports are likely contributing to the rise in incidence of mechanical causes of pediatric back pain [7]. Serious conditions causing back pain such as inflammatory, infectious, and neoplastic etiologies are much less common. but missing these pathologies can lead to severe consequences.

In the past, isolated pediatric back pain has been an indication for imaging, but there has been a recent paradigm shift to judicious use of diagnostic imaging resources [2,8]. Most often, isolated pediatric back pain is self-limiting with a thorough history and physical examination yielding a proper diagnosis. For example, radiologic imaging in children with transient back pain without neurologic deficit, normal physical examination, and minor or no history of trauma will unlikely be beneficial [9]. Clinical and laboratory findings suggesting an infectious or neoplastic etiology requires prompt imaging evaluation [2].

Please note, the evaluation of back pain in the setting of suspected spine trauma and scoliosis are discussed the ACR Appropriateness Criteria® topics on "Suspected Spine Trauma-Child” [10] and "Scoliosis-Child” [11].

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 wherein each procedure provides unique clinical information to effectively manage the patient’s care).

Discussion of Procedures by Variant

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.

Pediatric back pain is a commonly encountered complaint and has become more prevalent in recent decades. The prevalence rates vary widely, with more recent epidemiological studies showing prevalence between 30% and 50% [1-4]. Although pediatric back pain can be due to a wide number of etiologies, the higher prevalence has been attributed to increasing intensity in youth sports, childhood obesity, and physical inactivity including increased sitting time [2,3,12]. Despite the increasing prevalence, back pain in children is most commonly due to a benign process, albeit in many cases the exact etiology is not clear. Though historically, muscle strain, spondylolysis, and spondylolisthesis have been the most common etiologies, with the increasing use of MRI, disk herniations and disk degenerative diseases are identified more frequently [2,3,13]. In the absence of red flags of morning stiffness, gait abnormalities, night pain, neurologic deficit, radiating pain, fever, unintentional weight loss, pain lasting >4 weeks, tachycardia, lymphadenopathy, or abnormal spinal curvature, a thorough clinical history and physical examination alone can suggest an appropriate diagnosis and treatment [3,12,14,15]. An accurate history for differentiating back pain includes timing, onset, location, frequency, presence of neurologic symptoms, and psychological history [12,14]. A thorough targeted physical examination includes neurological examination, palpation of the spinous processes, curvature, gait testing, range of motion, and evaluation for skin abnormalities [12]. If clinical history and physical examination along with conservative management improve the patient’s symptoms, there is no additional role for imaging in these patients.

In the discussion below, "area of interest” can refer to the following: cervical, lumbar, and thoracic spine. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT area of interest

There is no relevant literature to support the use of bone scan whole body with single-photon emission CT (SPECT) or SPECT/CT of the area of interest in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
B. Bone scan whole body with SPECT or SPECT/CT complete spine

There is no relevant literature to support the use of bone scan whole body with SPECT or SPECT/CT of the whole spine in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
C. CT complete spine with IV contrast

There is no relevant literature to support the use of CT complete spine with intravenous (IV) contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
D. CT complete spine without and with IV contrast

There is no relevant literature to support the use of CT complete spine without and with IV contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
E. CT complete spine without IV contrast

There is no relevant literature to support the use of CT complete without IV contrast spine in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
F. CT myelography complete spine

There is no relevant literature to support the use of CT myelography complete spine in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
G. CT myelography spine area of interest

There is no relevant literature to support the use of CT myelography spine area of interest in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
H. CT spine area of interest with IV contrast

There is no relevant literature to support the use of CT spine area of interest with IV contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
I. CT spine area of interest without and with IV contrast

There is no relevant literature to support the use of CT spine area of interest without and with IV contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
J. CT spine area of interest without IV contrast

There is no relevant literature to support the use of CT spine area of interest without IV contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
K. MRI complete spine with IV contrast

There is no relevant literature to support the use of MRI complete spine with IV contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
L. MRI complete spine without and with IV contrast

There is no relevant literature to support the use of MRI complete spine without and with IV contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
M. MRI complete spine without IV contrast

There is no relevant literature to support the use of MRI complete spine without IV contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
N. MRI spine area of interest with IV contrast

There is no relevant literature to support the use of MRI spine area of interest with IV contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
O. MRI spine area of interest without and with IV contrast

There is no relevant literature to support the use of MRI spine area of interest without and with IV contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
P. MRI spine area of interest without IV contrast

There is no relevant literature to support the use of MRI spine area of interest without IV contrast in the evaluation of pediatric back pain without clinical red flags.

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
Q. Radiography complete spine

There is little evidence for use of radiographs to evaluate acute uncomplicated back pain without associated traumatic event or clinical red flags [3,12,16].

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
R. Radiography spine area of interest

There is little evidence for use of radiographs to evaluate acute uncomplicated back pain without associated traumatic event or clinical red flags [3,12,16].

Variant 1: Child. Back pain. No clinical red flags. Initial imaging.
S. US spine area of interest

There is no relevant literature to support the use of ultrasound (US) spine area of interest in the evaluation of pediatric back pain without clinical red flags.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.

Clinical red flags in pediatric back pain include morning stiffness, gait abnormalities, night pain, neurologic deficit, radiating pain, fever, unintentional weight loss, pain lasting >4 weeks, tachycardia, lymphadenopathy, or abnormal spinal curvature [3]. If one of these red flags is apparent and/or conservative treatment and physiotherapy fails to alleviate the symptoms, diagnostic imaging can be helpful for further evaluation. Studies have shown a 9% to 22% yield in accurate diagnosis when radiography was performed along with a detailed history and physical examination [1,17]. In cases in which the clinical presentation is suggestive of serious pathologies involving spinal and paraspinal soft tissues, such as discitis/osteomyelitis, neoplasm, myelitis, or tethered cord, other imaging can be obtained in lieu of conventional radiography.

In the discussion below, "area of interest” can refer to the following: cervical, lumbar, and thoracic spine. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT area of interest

There is no relevant literature to support the use of bone scan whole body with SPECT or SPECT/CT of the area of interest in the initial evaluation of pediatric back pain with clinical red flags.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
B. Bone scan whole body with SPECT or SPECT/CT complete spine

There is no relevant literature to support the use of bone scan whole body with SPECT or SPECT/CT bone scan of the whole spine in the initial evaluation of pediatric back pain with clinical red flags.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
C. CT complete spine with IV contrast

CT complete spine with IV contrast is usually not useful as a first-line imaging test in this clinical scenario because IV contrast is not required when assessing osseous etiologies of back pain and IV contrast is typically used in the localized region of interest only. Although radiographs are helpful for evaluating back pain, radiographs alone may be inadequate in diagnosing pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags [12]. If there is suspicion for osseous pathology and initial radiographic imaging is inadequate for diagnosis, CT of the spine can be obtained as a suitable next step. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. CT is superior to conventional radiography in determining soft tissue extension of tumor, however, soft tissue pathology is usually not evaluated with CT because MRI has superior soft tissue resolution. CT also has increased sensitivity for detection of mineralized matrix or nondisplaced fractures [18]. More recently, technologies such as dual-energy CT, allows for the evaluation of bone marrow edema [19]. IV contrast is not required when assessing osseous etiologies of back pain, however, CT spine with IV contrast can be performed for evaluation of the soft tissues in the region of interest including epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
D. CT complete spine without and with IV contrast

There is no relevant literature to support the use of CT complete spine without and with IV contrast in the initial evaluation of pediatric back pain with at least one clinical red flag.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
E. CT complete spine without IV contrast

CT complete spine without IV contrast is usually not useful as a first-line imaging test in this clinical scenario. Although radiographs are helpful for evaluating back pain, radiographs alone may be inadequate in diagnosing pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags [12]. If there is suspicion for osseous pathology and initial radiographic imaging is inadequate for diagnosis, CT of the spine can be obtained as a suitable next step. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. CT is superior to conventional radiography in determining soft tissue extension of tumor, however, soft tissue pathology is usually not evaluated with CT because MRI has superior soft tissue resolution. CT also has increased sensitivity for detection of mineralized matrix or nondisplaced fractures [18]. More recently, technologies such as dual-energy CT, allows for the evaluation of bone marrow edema [19].

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
F. CT myelography complete spine

There is no relevant literature to support the use of CT myelography complete spine in the initial evaluation of pediatric back pain with at least one clinical red flag.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
G. CT myelography spine area of interest

There is no relevant literature to support the use of CT myelography spine area of interest in the initial evaluation of pediatric back pain with at least one clinical red flag.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
H. CT spine area of interest with IV contrast

CT complete spine with IV contrast may be useful as a first-line imaging test in this clinical scenario because IV contrast can be helpful in the evaluation of the soft tissues in the region of interest such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20]. IV contrast is not required when assessing osseous etiologies of back pain. Although radiographs are helpful for evaluating back pain, radiographs alone may be inadequate in diagnosing pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags [12]. If there is suspicion for osseous pathology and initial radiographic imaging is inadequate for diagnosis, CT of the spine can be obtained as a suitable next step. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. CT is superior to conventional radiography in determining soft tissue extension of tumor, however, soft tissue pathology is usually not evaluated with CT because MRI has superior soft tissue resolution. CT also has increased sensitivity for detection of mineralized matrix or nondisplaced fractures [18]. More recently, technologies such as dual-energy CT, allows for the evaluation of bone marrow edema [19].

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
I. CT spine area of interest without and with IV contrast

Although radiographs remain helpful for evaluating back pain, radiographs alone may be inadequate in the diagnosis of severe pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags. If there is suspicion for osseous pathology and initial radiographic imaging is inadequate for diagnosis, CT of the spine can be obtained as a suitable next step. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case. CT is superior to conventional radiography in determining soft tissue extension of tumor. Furthermore, CT has increased sensitivity for detection of mineralized matrix or nondisplaced fractures [18]. More recently, technologies such as dual-energy CT, allows for evaluation of bone marrow edema, for example, in the setting of an underlying osteochondral lesion [19]. IV contrast is not required when assessing osseous etiologies of back pain. Soft tissue pathology is usually not evaluated with CT because MRI has superior soft tissue resolution. However, CT spine with IV contrast can be performed for localized evaluation of the soft tissues in the region of interest including epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.

J. CT spine area of interest without IV contrast

Although radiographs remain helpful for evaluating back pain, radiographs alone may be inadequate in the diagnosis of severe pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags. If there is suspicion for osseous pathology and initial radiographic imaging is inadequate for diagnosis, CT of the spine can be obtained as a suitable next step. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case. CT is superior to conventional radiography in determining soft tissue extension of the tumor. Furthermore, CT has increased sensitivity for detection of mineralized matrix or nondisplaced fractures [18]. More recently, technologies such as dual-energy CT, allows for evaluation of bone marrow edema, for example, in the setting of an underlying osteochondral lesion [19].

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
K. MRI complete spine with IV contrast

MRI complete spine with IV contrast is not useful as a first-line imaging test in this clinical scenario because precontrast images are helpful to accurately assess enhancement after contrast administration. Although radiographs help evaluate back pain, radiographs alone may be inadequate in diagnosing pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags. Targeted noncontrast MRI of the spine can increase the diagnostic yield with some studies demonstrating identifiable diagnoses in an additional 25% to 34% of cases [2]. Historically, spondylolysis and spondylolisthesis has been the most common cause of pediatric back pain; more recent studies have shown intervertebral disk pathology to be more common due to increased usefulness of MRI in recent years [13,17,21]. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
L. MRI complete spine without and with IV contrast

MRI complete spine without and with IV contrast may be useful as a first-line imaging test in this clinical scenario depending on the red flag present. Although radiographs are helpful for evaluating back pain, radiographs alone may be inadequate in diagnosis of severe pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags. Targeted noncontrast MRI of the spine can increase the diagnostic yield with some studies demonstrating identifiable diagnoses in an additional 25% to 34% of cases [2]. Historically, spondylolysis and spondylolisthesis has been the most common cause of pediatric back pain; more recent studies have shown intervertebral disk pathology to be more common due to increased usefulness of MRI in recent years [13,17,21]. Furthermore, MRI is useful when there is clinical suspicion for soft tissue pathology including spinal cord, intraspinal contents, and paraspinal soft tissues [16,17]. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. Gadolinium contrast administration can be useful in certain scenarios such as suspected neoplasm or discitis/osteomyelitis [20,22]. If contrast is administered, precontrast imaging is helpful to assess enhancement.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
M. MRI complete spine without IV contrast

MRI complete spine without IV contrast may be useful as a first-line imaging test in this clinical scenario depending on the red flag present. Although radiographs are helpful for evaluating back pain, radiographs alone may be inadequate in diagnosis of severe pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags. Targeted noncontrast MRI of the spine can increase the diagnostic yield with some studies demonstrating identifiable diagnoses in an additional 25% to 34% of cases [2]. Historically, spondylolysis and spondylolisthesis has been the most common cause of pediatric back pain; more recent studies have shown intervertebral disk pathology to be more common due to increased usefulness of MRI in recent years [13,17,21]. Furthermore, MRI is useful when there is clinical suspicion for soft tissue pathology including spinal cord, intraspinal contents, and paraspinal soft tissues [16,17]. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
N. MRI spine area of interest with IV contrast

MRI spine area of interest with IV contrast is not useful as a first-line imaging test in this clinical scenario because precontrast images are helpful to accurately assess enhancement after contrast administration. Although radiographs are helpful for evaluating back pain, radiographs alone may be inadequate in diagnosis of severe pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags. Targeted noncontrast MRI of the spine can increase the diagnostic yield with some studies demonstrating identifiable diagnoses in an additional 25% to 34% of cases [2]. Historically, spondylolysis and spondylolisthesis has been the most common cause of pediatric back pain, more recent studies have shown intervertebral disk pathology to be more common due to increased usefulness of MRI in recent years [13,17,21]. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
O. MRI spine area of interest without and with IV contrast

MRI spine area of interest without and with IV contrast may be useful as a first-line imaging test in this clinical scenario depending on the red flag present. Although radiographs are helpful for evaluating back pain, radiographs alone may be inadequate in diagnosis of severe pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags. Targeted noncontrast MRI of the spine can increase the diagnostic yield with some studies demonstrating identifiable diagnoses in an additional 25% to 34% of cases [2]. Historically, spondylolysis and spondylolisthesis has been the most common cause of pediatric back pain, more recent studies have shown intervertebral disk pathology to be more common due to increased usefulness of MRI in recent years [13,17,21]. Furthermore, MRI is useful when there is clinical suspicion for soft tissue pathology including spinal cord, intraspinal contents, and paraspinal soft tissues [16,17]. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. Gadolinium contrast administration can be useful in certain scenarios such as suspected neoplasm or discitis/osteomyelitis [20,22]. If contrast is administered, precontrast imaging is helpful to assess enhancement.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
P. MRI spine area of interest without IV contrast

MRI spine area of interest without IV contrast may be useful as a first-line imaging test in this clinical scenario depending on the red flag present. Although radiographs are helpful for evaluating back pain, radiographs alone may be inadequate in diagnosis of severe pathologies, which warrant further investigation with cross-sectional imaging, particularly when the patient presents with red flags. Targeted noncontrast MRI of the spine can increase the diagnostic yield with some studies demonstrating identifiable diagnoses in an additional 25% to 34% of cases [2]. Historically, spondylolysis and spondylolisthesis has been the most common cause of pediatric back pain; more recent studies have shown intervertebral disk pathology to be more common due to increased usefulness of MRI in recent years [13,17,21]. Furthermore, MRI is useful when there is clinical suspicion for soft tissue pathology including spinal cord, intraspinal contents, and paraspinal soft tissues [16,17]. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
Q. Radiography complete spine

Anteroposterior and lateral radiographs remain the standard of care for initial imaging evaluation of pediatric back pain [2,12,16]. Additional oblique radiography contributes little diagnostic information and is not useful [9,12]. Prospective studies have shown a 9% to 22% yield in accurate diagnosis when radiography was performed along with a detailed history and physical examination [1,17]. In most instances, if the initial radiographs identify a cause for back pain, specific treatment can be initiated without the need for additional imaging. However, in scenarios requiring further evaluation of soft tissues or an incompletely evaluated bony tumor, additional investigation with cross-sectional imaging can be performed [2]. The decision to perform a targeted versus complete spine radiograph depends on the clinical question and will vary for each case. Negative radiographs are not adequate to exclude pathology but can initiate further investigation with advanced imaging [2,12,17].

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
R. Radiography spine area of interest

Anteroposterior and lateral radiographs remain the standard of care for initial imaging evaluation of pediatric back pain [2,12,16]. Additional oblique radiography contributes little diagnostic information and is not useful [9,12]. Prospective studies have shown a 9% to 22% yield in accurate diagnosis when radiography was performed along with a detailed history and physical examination [1,17]. In most instances, if the initial radiographs identify a cause for back pain, specific treatment can be initiated without the need for additional imaging. However, in scenarios requiring further evaluation of soft tissues or an incompletely evaluated bony tumor, additional investigation with cross-sectional imaging can be performed [2]. The decision to perform a targeted versus complete spine radiograph depends on the clinical question and will vary for each case. Negative radiographs are not adequate to exclude pathology but can initiate further investigation with advanced imaging [2,12,17].

Variant 2: Child. Back pain. With at least one clinical red flag. Initial imaging.
S. US spine area of interest

There is no relevant literature to support the use of US spine in the evaluation of pediatric back pain as an initial imaging modality in the setting of a clinical red flag.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.

Clinical red flags in pediatric back pain include morning stiffness, gait abnormalities, night pain, neurologic deficit, radiating pain, fever, unintentional weight loss, pain lasting >4 weeks, tachycardia, lymphadenopathy, or abnormal spinal curvature [3]. If one of these red flags are apparent and/or conservative treatment and physiotherapy fails to alleviate the symptoms, diagnostic imaging can be helpful for further evaluation. Anteroposterior and lateral radiographs remain the standard of care for initial imaging evaluation of pediatric back pain [2,12,16]. However, in many cases conventional radiography does not elucidate an appropriate diagnosis which requires follow-up with additional imaging [17].

In the discussion below, "area of interest" can refer to the following: cervical, lumbar, and thoracic spine. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
A. Bone scan whole body with SPECT or SPECT/CT area of interest

Radiographs alone may be inadequate in diagnosing pathologies resulting in back pain with clinical red flags, which may warrant further investigation with additional imaging [12]. Tc-99m whole body bone scan with SPECT or SPECT/CT through the region of interest may be a suitable next step [15,18] when clinical suspicion or initial radiography suggests bony pathology such as spondylolysis or osseous neoplasms.

Tc-99m SPECT is particularly useful when radiographs and CT fail to identify occult stress injuries without spondylolysis in the region of the pars interarticularis [23]. Although MRI is useful when neurologic symptoms are present, SPECT or SPECT/CT may be a suitable next step to evaluate for spondylolysis given its high sensitivity [15,23]. SPECT, along with co-registered CT, provides added advantage of precise localization of abnormal radiotracer uptake and concomitantly identifying osseous abnormalities.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
B. Bone scan whole body with SPECT or SPECT/CT complete spine

Radiographs alone may be inadequate in diagnosing pathologies resulting in back pain with clinical red flags, which may warrant further investigation with additional imaging [12]. Tc-99m whole body bone scan with SPECT or SPECT/CT through the region of interest and not through the whole spine may be a suitable next step [15,18] when clinical suspicion or initial radiography suggests bony pathology such as spondylolysis or osseous neoplasms.

Tc-99m SPECT is particularly useful when radiographs and CT fail to identify occult stress injuries without spondylolysis in the region of the pars interarticularis [23]. SPECT, along with co-registered CT, provides added advantage of precise localization of abnormal radiotracer uptake and concomitantly identifying osseous abnormalities.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
C. CT complete spine with IV contrast

CT complete spine with IV contrast may be useful as a next step imaging test in this clinical scenario depending on the red flag present. IV contrast can be helpful in the evaluation of the soft tissues such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20]. CT spine has increased sensitivity for detecting nondisplaced fractures and spondylolysis when compared to conventional radiography [18,23]. However, CT is less sensitive in detecting stress injuries involving the pars interarticularis without lysis, which is frequently seen in pediatric patients. In these cases, CT has been found to be complementary to SPECT and MRI for higher specificity and sensitivity [2,23]. Furthermore, CT can be used in follow-up imaging of spondylolysis if clinically warranted [23].

The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case. When infection or tumor is suspected, CT is more sensitive than radiography for soft tissue involvement, mineralization, and evaluation of bony architecture [18]. Dual-energy CT can render virtual unenhanced images [19]. IV contrast is not required when assessing osseous etiologies of back pain. Soft tissue pathology is usually not evaluated with CT because MRI has superior soft tissue resolution. However, CT spine with IV contrast can be performed for localized evaluation of the soft tissues in the region of interest including epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
D. CT complete spine without and with IV contrast

There is no relevant literature to support the use of CT complete spine without and with IV contrast as the next imaging step in the evaluation of pediatric back pain in the setting of a clinical red flag with negative radiographs.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
E. CT complete spine without IV contrast

CT complete spine without IV contrast may be useful as a next step imaging test in this clinical scenario depending on the red flag present. IV contrast is not required for assessing osseous pathology.

Pediatric back pain with clinical red flags and negative radiographs requires further evaluation with cross-sectional imaging. CT spine has increased sensitivity for detecting nondisplaced fractures and spondylolysis when compared to conventional radiography [18,23]. However, CT is less sensitive in detecting stress injuries involving the pars interarticularis without lysis, which is frequently seen in pediatric patients. In these cases, CT has been found to be complementary to SPECT and MRI for higher specificity and sensitivity [2,23]. Furthermore, CT can be used in follow-up imaging of spondylolysis if clinically warranted [23].

The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case. When infection or tumor is suspected, CT is more sensitive than radiography for soft tissue involvement, mineralization, and evaluation of bony architecture [18].

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
F. CT myelography complete spine

There is no relevant literature to support the use of CT myelography complete spine as the next imaging step in the imaging evaluation of pediatric back pain in the setting of a clinical red flag with negative radiographs. Historically, this technique played an important role in the evaluation of intraspinal pathologies; however, the usefulness of myelography has decreased in recent decades.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
G. CT myelography spine area of interest

There is no relevant literature to support the use of CT myelography complete spine. CT myelography is not useful as the next imaging step in the imaging evaluation of pediatric back pain in the setting of a clinical red flag with negative radiographs. Historically, this technique played an important role in the evaluation of intraspinal pathologies; however, the usefulness of myelography has decreased in recent decades.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
H. CT spine area of interest with IV contrast

CT spine area of interest with IV contrast may be useful as a next step imaging test in this clinical scenario depending on the red flag present. IV contrast can be helpful in the evaluation of the soft tissues such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

Pediatric back pain with clinical red flags and negative radiographs requires further evaluation with cross-sectional imaging. CT spine has increased sensitivity for detecting nondisplaced fractures and spondylolysis when compared to conventional radiography [18,23]. However, CT is less sensitive in detecting stress injuries involving the pars interarticularis without lysis, which is frequently seen in pediatric patients. In these cases, CT has been found to be complementary to SPECT and MRI for higher specificity and sensitivity [2,23]. Furthermore, CT can be used in follow-up imaging of spondylolysis if clinically warranted [23].

The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case. When infection or tumor is suspected, CT is more sensitive than radiography for soft tissue involvement, mineralization, and evaluation of bony architecture [18]. IV contrast is not required when assessing osseous etiologies of back pain. Soft tissue pathology is usually not evaluated with CT because MRI has superior soft tissue resolution. However, CT spine with IV contrast can be performed for localized evaluation of the soft tissues in the region of interest including epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

If there is a question of calcifications, limited CT images of the area of interest can be obtained for further evaluation. Dual-energy technique can be employed to render virtual unenhanced images to avoid multiple scans [19].

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
I. CT spine area of interest without and with IV contrast

Pediatric back pain with clinical red flags and negative radiographs requires further evaluation with cross-sectional imaging. CT spine has increased sensitivity for detecting nondisplaced fractures and spondylolysis when compared to conventional radiography [18,23]. However, CT is less sensitive in detecting stress injuries involving the pars interarticularis without lysis, which is frequently seen in pediatric patients. In these cases, CT has been found to be complementary to SPECT and MRI for higher specificity and sensitivity [2,23]. Furthermore, CT can be used in follow-up imaging of spondylolysis if clinically warranted [23].

The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case. When infection or tumor is suspected, although CT is more sensitive than radiography for soft tissue involvement, mineralization, and evaluation of bony architecture [18], MRI remains useful. IV contrast is not required when assessing osseous etiologies of back pain. Soft tissue pathology is usually not evaluated with CT because MRI has superior soft tissue resolution. However, CT spine with IV contrast can be performed for localized evaluation of the soft tissues in the region of interest including epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

If there is a question of calcifications, limited CT images of the area of interest can be obtained for further evaluation.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
J. CT spine area of interest without IV contrast

CT spine area of interest without IV contrast may be useful as a next step imaging test in this clinical scenario depending on the red flag present. IV contrast is not required for assessing osseous pathology.

Pediatric back pain with clinical red flags and negative radiographs requires further evaluation with cross-sectional imaging. CT spine has increased sensitivity for detecting nondisplaced fractures and spondylolysis when compared to conventional radiography [18,23]. However, CT is less sensitive in detecting stress injuries involving the pars interarticularis without lysis, which is frequently seen in pediatric patients. In these cases, CT has been found to be complementary to SPECT and MRI for higher specificity and sensitivity [2,23]. Furthermore, CT can be used in follow-up imaging of spondylolysis if clinically warranted [23].

The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case. When infection or tumor is suspected, CT is more sensitive than radiography for soft tissue involvement, mineralization, and evaluation of bony architecture [18].

If there is a question of calcifications, limited CT images of the area of interest can be obtained for further evaluation.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
K. MRI complete spine with IV contrast

MRI complete spine with IV contrast is not useful as a next step imaging test in this clinical scenario because precontrast images are helpful to accurately assess enhancement after contrast administration. Whereas CT spine can be useful in determining mineralization and bony architecture, MRI has increased sensitivity in detecting marrow edema indicating microtrabecular injuries or in the setting of inflammatory spondyloarthropathy [17,19,24]. Several studies have demonstrated a significant increase in specific diagnosis when an MRI of the spine was obtained following a thorough physical examination and radiographs. For example, a retrospective study analyzing a large cohort of 261 pediatric patients demonstrated definitive diagnosis in an additional 34% of patients [2]. In these patients, the most common clinical red flags were constant pain, night pain, and abnormal neurologic examination with the most common diagnoses of herniated disks or degenerative disk disease [17]. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next

imaging study.

L. MRI complete spine without and with IV contrast

MRI complete spine without and with IV contrast is useful as a next step imaging test in this clinical scenario depending on the red flag present. MRI is considered useful for evaluating pediatric back pain when further imaging is required [12,19,25,26]. MRI of the spine is useful when there is clinical suspicion for soft tissue pathology including intervertebral disks, spinal cord, intraspinal contents, and paraspinal soft tissues [16,17]. Whereas CT spine can be useful in determining mineralization and bony architecture, MRI has increased sensitivity in detecting marrow edema indicating microtrabecular injuries or in the setting of inflammatory spondyloarthropathy [17,19,24]. Several studies have demonstrated a significant increase in specific diagnosis when MRI of the spine was obtained following a thorough physical examination and radiographs. For example, a retrospective study analyzing a large cohort of 261 pediatric patients demonstrated definitive diagnosis in an additional 34% of patients [2]. In these patients, the most common clinical red flags were constant pain, night pain, and abnormal neurologic examination with the most common diagnoses of herniated disks or degenerative disk disease [17]. Contrast can be helpful in evaluating pediatric back pain when there is clinical suspicion for infection, inflammation, or tumor [17,25]. If contrast is administered, precontrast imaging is helpful to assess enhancement. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.

M. MRI complete spine without IV contrast

MRI complete spine without IV contrast is useful as a next step imaging test in this clinical scenario depending on the red flag present. Pediatric back pain with clinical red flags and negative radiographs requires further evaluation with cross-sectional imaging. MRI is considered useful for evaluating pediatric back pain when further imaging is required [12,19,25,26]. MRI of the spine is useful when there is clinical suspicion for soft tissue pathology including spinal cord, intraspinal contents, and paraspinal soft tissues [16,17]. Whereas CT spine can be useful in determining mineralization and bony architecture, MRI has increased sensitivity in detecting marrow edema indicating microtrabecular injuries or in the setting of inflammatory spondyloarthropathy [17,19,24]. Several studies have demonstrated a significant increase in specific diagnosis when MRI of the spine was obtained following a thorough physical examination and radiographs. For example, a retrospective study analyzing a large cohort of 261 pediatric patients demonstrated definitive diagnosis in an additional 34% of patients [2]. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.

N. MRI spine area of interest with IV contrast

MRI spine area of interest with IV contrast is not useful as a next step imaging test in this clinical scenario because precontrast images are helpful to accurately assess enhancement after contrast administration. Pediatric back pain with clinical red flags and negative radiographs requires further evaluation with cross-sectional imaging. Whereas CT spine can be useful in determining mineralization and bony architecture, MRI has increased sensitivity in detecting marrow edema indicating microtrabecular injuries or in the setting of inflammatory spondyloarthropathy [17,19,24]. Several studies have demonstrated a significant increase in specific diagnosis when MRI of the spine was obtained following a thorough physical examination and radiographs. For example, a retrospective study analyzing a large cohort of 261 pediatric patients demonstrated definitive diagnosis in an additional 34% of patients [2]. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
O. MRI spine area of interest without and with IV contrast

Pediatric back pain with clinical red flags and negative radiographs requires further evaluation with cross-sectional imaging. MRI is considered useful for evaluating pediatric back pain when further imaging is required [12,19,25,26]. MRI of the spine is useful when there is clinical suspicion for soft tissue pathology including spinal cord, intraspinal contents, and paraspinal soft tissues [16,17]. Whereas CT spine can be useful in determining mineralization and bony architecture, MRI has increased sensitivity in detecting marrow edema indicating microtrabecular injuries or in the setting of inflammatory spondyloarthropathy [17,19,24]. Several studies have demonstrated a significant increase in specific diagnosis when MRI of the spine was obtained following a thorough physical examination and radiographs. For example, a retrospective study analyzing a large cohort of 261 pediatric patients demonstrated definitive diagnosis in an additional 34% of patients [2]. Contrast can be helpful in evaluating pediatric back pain when there is clinical suspicion for infection, inflammation, or tumor [17,25]. If contrast is administered, precontrast imaging is helpful to assess enhancement. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
P. MRI spine area of interest without IV contrast

MRI spine area of interest without IV contrast is useful as a next step imaging test in this clinical scenario depending on the red flag present. Pediatric back pain with clinical red flags and negative radiographs requires further evaluation with cross-sectional imaging. MRI is considered useful for evaluating pediatric back pain when further imaging is required [12,19,25,26]. MRI of the spine is useful when there is clinical suspicion for soft tissue pathology including spinal cord, intraspinal contents, and paraspinal soft tissues [16,17]. Whereas CT spine can be useful in determining mineralization and bony architecture, MRI has increased sensitivity in detecting marrow edema indicating microtrabecular injuries or in the setting of inflammatory spondyloarthropathy [17,19,24]. Several studies have demonstrated a significant increase in specific diagnosis when MRI of the spine was obtained following a thorough physical examination and radiographs. For example, a retrospective study analyzing a large cohort of 261 pediatric patients demonstrated definitive diagnosis in an additional 34% of patients [2]. Contrast can be helpful in evaluating pediatric back pain when there is clinical suspicion for infection, inflammation, or tumor [17,25]. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 3: Child. Back pain. With at least one clinical red flag. Negative radiographs. Next imaging study.
Q. US spine area of interest

US generally has great usefulness in pediatric diagnoses given its increased soft tissue resolution. However, in pediatric back pain requiring advanced imaging evaluation, US has little usefulness and MRI remains the standard of care. A potential application of US in pediatric back pain could be the evaluation for enthesitis in patients with spondyloarthropathy, particularly when there is a lack of radiographic findings. However, this application is limited by operator dependence and interoperate variability [24].

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.

The most common etiologies for pediatric back pain are benign including muscle strain, spondylolysis/spondylolisthesis, and disk herniation. However, it is imperative to exclude more serious diagnoses such as infection, neoplasm, and inflammatory diseases. A thorough clinical history and physical examination along with laboratory testing are important in suspecting these entities. Spine infections are particularly common in children between 2 and 12 years of age, with a 3:1 ratio of boys being more affected than girls. Though several components of the spine and paraspinal soft tissues can be infected, vertebral body osteomyelitis and discitis are the most common locations for the origin of infection [3,12,14]. Clinical presentation varies but symptoms can include persistent nighttime pain, low grade fever, decreased range of motion, irritability, localized tenderness, and limping. In addition, laboratory values usually demonstrate leukocytosis, elevated erythrocyte sedimentation rate, and C-reactive protein levels [3,12,14].

Inflammatory pathologies can affect both the spinal column as well as the spinal cord. The most common inflammatory etiology involving the spinal column is juvenile idiopathic arthritis, which usually occurs in late childhood and occurs most commonly in the cervical spine. Inflammatory etiologies involving the spinal cord could be autoimmune such as acute disseminated encephalomyelitis, neuromyelitis optica spectrum disorders, multiple sclerosis, and transverse myelitis [14].

Spine neoplasms are a rare entity in children, and the most common symptom is persistent nighttime back pain, refractory to conservative management and rest, present in 25% to 30% of children with spinal neoplasm. More specific symptoms including motor or gait disturbance and neurologic symptoms usually present later. Locally aggressive tumors may present with rapid increase in intensity of pain in a short interval of time. Spine neoplasm can be of different origins including the spinal column, extramedullary, and intramedullary tumors. Benign tumors of the spinal column include osteochondroma, osteoblastoma, osteoid osteoma, giant cell tumor, and aneurysmal bone cyst, whereas malignant tumors include leukemia, lymphoma, and rarely metastasis. Intramedullary tumors are the most common intraspinal tumors, accounting for 35% to 40% of tumors and the most common intramedullary tumor is astrocytoma (45%-60%) followed by ependymomas (30%-35%) [3,12,14,27,28]. Imaging is imperative when suspecting these etiologies, because delay in imaging can result in catastrophic consequences.

In the discussion below, "area of interest” can refer to the following: cervical, lumbar, and thoracic spine. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT area of interest

There is no relevant literature to support the use of bone scan whole body with SPECT or SPECT/CT through the region of interest in the initial evaluation of pediatric back pain with known or suspected inflammation, infection, or neoplasm.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.

B. Bone scan whole body with SPECT or SPECT/CT complete spine

There is no relevant literature to support the use of bone scan whole body with SPECT or SPECT/CT through the whole spine in the initial evaluation of pediatric back pain with known or suspected inflammation, infection, or neoplasm.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
C. CT complete spine with IV contrast

CT complete spine with IV contrast may be useful as an initial imaging test in this clinical scenario depending on the extent of suspected or known abnormality. IV contrast can be helpful in the evaluation of the soft tissues such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

CT is a useful cross-sectional modality for evaluation of some osseous tumors. For example, the bony sclerosis of an osteoid osteoma can be identified on radiography, but CT is particularly useful in precise localization of the lucent nidus and definitively diagnose this entity [3]. Dual-energy technique can be employed to render virtual unenhanced images [19]. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
D. CT complete spine without and with IV contrast

CT complete spine with and without IV contrast is usually not a useful as an initial imaging test in this clinical scenario. Although osseous pathologies do not require IV contrast, the bones can be adequately assessed in the presence of contrast-enhanced images. IV contrast can be helpful in the evaluation of the soft tissues such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

There is no relevant literature to support the use of CT complete spine without and with IV contrast in the initial evaluation of pediatric back pain with known or suspected inflammation, infection, or neoplasm.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
E. CT complete spine without IV contrast

CT complete spine without IV contrast may be useful as an initial imaging test in this clinical scenario depending on the extent of suspected or known abnormality. IV contrast is not required when assessing for osseous pathology.

CT is a useful cross-sectional modality for evaluation of some osseous tumors. For example, the bony sclerosis of an osteoid osteoma can be identified on radiography, but CT is particularly useful in precise localization of the lucent nidus and definitively diagnose this entity [3]. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
F. CT myelography complete spine

There is no relevant literature to support the use of CT myelography complete spine in the initial evaluation of pediatric back pain with known or suspected inflammation, infection, or neoplasm. Historically, this technique played an important role in the evaluation of intraspinal pathologies; however, the usefulness of myelography has decreased in recent decades.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
G. CT myelography spine area of interest

There is no relevant literature to support the use of CT myelography spine area of interest in the initial evaluation of pediatric back pain with known or suspected inflammation, infection, or neoplasm. Historically, this technique played an important role in the evaluation of intraspinal pathologies; however, the usefulness of myelography has decreased in recent decades.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
H. CT spine area of interest with IV contrast

CT spine area of interest with IV contrast may be useful as an initial imaging test in this clinical scenario depending on the extent of suspected or known abnormality. IV contrast can be helpful in the evaluation of the soft tissues such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

CT is a useful cross-sectional modality for evaluation of some osseous tumors. For example, the bony sclerosis of an osteoid osteoma can be identified on radiography, but CT is particularly useful in precise localization of the lucent nidus and definitively diagnose this entity [3]. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case.

If there is question of calcifications, limited CT images of the area of interest can be obtained for further evaluation. Dual-energy technique can be employed to render virtual unenhanced images [19].

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
I. CT spine area of interest without and with IV contrast

CT spine area of interest with and without IV contrast is usually not a useful as an initial imaging test in this clinical scenario. Although osseous pathologies do not require IV contrast, the bones can be adequately assessed in the presence of contrast-enhanced images. IV contrast can be helpful in the evaluation of the soft tissues such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

There is no relevant literature to support the use of CT complete spine without and with IV contrast in the initial evaluation of pediatric back pain with known or suspected inflammation, infection, or neoplasm.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
J. CT spine area of interest without IV contrast

CT spine area of interest without IV contrast may be useful as an initial imaging test in this clinical scenario depending on the extent of suspected or known abnormality. IV contrast is not required when assessing for osseous pathology.

CT is a useful cross-sectional modality for evaluation of some osseous tumors. For example, the bony sclerosis of an osteoid osteoma can be identified on radiography, but CT is particularly useful in precise localization of the lucent nidus and definitively diagnose this entity [3]. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case.

If there is question of calcifications, limited CT images of the area of interest can be obtained for further evaluation.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
K. MRI complete spine with IV contrast

MRI complete spine with IV contrast is not useful as a first-line imaging test in this clinical scenario because precontrast images are helpful to accurately assess enhancement after contrast administration. In the setting of discitis/osteomyelitis, prompt diagnosis is paramount, and radiography has low sensitivity in early stages of disease [20]. Therefore, MRI of the spine can be obtained as the initial imaging study in lieu of conventional radiography to exclude severe secondary complications such as epidural abscess and spinal cord compression [12,16,22,25]. Similarly, when intraspinal neoplasm or inflammatory process is suspected with clinical neurologic deficits, MRI can be obtained forgoing conventional radiography to promptly identify pathology given high sensitivity and specificity for detecting pathologies including syringomyelia, transverse myelitis, and primary neoplasms of the neural axis [12,25]. Frequently, sequela of discitis/osteomyelitis can extend into the paraspinal soft tissues, which is best assessed on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, if multifocal disease is suspected, a complete spine MRI is helpful.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
L. MRI complete spine without and with IV contrast

MRI is a useful modality of choice to evaluate pediatric back pain with clinical suspicion for infection, inflammation, or neoplasm. Importantly, in the setting of discitis/osteomyelitis, prompt diagnosis is paramount, and radiography has low sensitivity in early stages of disease [20]. Therefore, MRI of the spine can be obtained as the initial imaging study in lieu of conventional radiography to exclude severe secondary complications such as epidural abscess and spinal cord compression [12,16,22,25]. Similarly, when intraspinal neoplasm or inflammatory process is suspected with clinical neurologic deficits, MRI can be obtained forgoing conventional radiography to promptly identify pathology given high sensitivity and specificity for detecting pathologies including syringomyelia, transverse myelitis, and primary neoplasms of the neural axis [12,25]. Frequently, sequela of discitis/osteomyelitis can extend into the paraspinal soft tissues, which is best assessed on MRI. Gadolinium contrast administration can be useful in certain scenarios such as suspected neoplasm or discitis/osteomyelitis [20,22]. If contrast is administered, precontrast imaging is helpful to assess enhancement.

The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, if multifocal disease is suspected, a complete spine MRI is helpful.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
M. MRI complete spine without IV contrast

MRI is a useful modality of choice to evaluate pediatric back pain with clinical suspicion for infection, inflammation, or neoplasm. Importantly, in the setting of discitis/osteomyelitis, prompt diagnosis is paramount, and radiography has low sensitivity in early stages of disease [20]. Therefore, MRI of the spine can be obtained as the initial imaging study in lieu of conventional radiography to exclude severe secondary complications such as epidural abscess and spinal cord compression [12,16,22,25]. Similarly, when intraspinal neoplasm or inflammatory process is suspected with clinical neurologic deficits, MRI can be obtained forgoing conventional radiography to promptly identify pathology given high sensitivity and specificity for detecting pathologies including syringomyelia, transverse myelitis, and primary neoplasms of the neural axis [12,25]. Frequently, sequela of discitis/osteomyelitis can extend into the paraspinal soft tissues, which is best assessed on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, if multifocal disease is suspected, a complete spine MRI is helpful.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
N. Radiography complete spine

Anteroposterior and lateral radiographs is useful as the first-line initial imaging evaluation of pediatric back pain with clinical suspicion for infection, inflammation, or neoplasm [13,18,25]. Additional oblique radiography contributes little diagnostic information [9,12]. Although radiographs have low sensitivity for discitis/osteomyelitis, they can help direct further evaluation with advanced imaging modalities and potentially identify a different condition for cause of back pain such as trauma [25]. The decision to perform a targeted versus complete spine radiograph depends on the clinical question and will vary for each case. If there is clinical suspicion of multifocal infectious, inflammatory, or neoplastic process, radiography may be useful in predicting secondary complications such as pathologic fracture. However, in these cases, additional advanced imaging is prudent for complete evaluation of disease.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial imaging.
O. Radiography spine area of interest

Anteroposterior and lateral radiographs is useful in evaluating pediatric back pain with clinical suspicion for infection, inflammation, or neoplasm [13,18,25]. Additional oblique radiography contributes little diagnostic information [9,12]. Although radiographs have low sensitivity for discitis/osteomyelitis, they can help direct further evaluation with advanced imaging modalities and potentially identify a different condition for cause of back pain such as trauma [25]. The decision to perform a targeted versus complete spine radiograph depends on the clinical question and will vary for each case. If there is clinical suspicion of multifocal infectious, inflammatory, or neoplastic process, radiography may be useful in predicting secondary complications such as pathologic fracture. However, in these cases, additional advanced imaging is prudent for complete evaluation of disease.

Variant 4: Child. Back pain. Known or suspected inflammation, infection, or neoplasm. Initial

imaging.

P. US spine area of interest

There is no relevant literature to support the use of US spine in the evaluation of pediatric back pain as initial imaging when suspecting inflammation, infection, or malignancy.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.

Clinical red flags in the setting of pediatric back pain include morning stiffness, gait abnormalities, night pain, neurologic deficit, radiating pain, fever, unintentional weight loss, pain lasting >4 weeks, tachycardia, lymphadenopathy, or abnormal spinal curvature [3]. The most common etiologies for pediatric back pain are benign including muscle strain, spondylolysis/spondylolisthesis, and disk herniation. However, it is imperative to exclude more serious diagnoses such as infection, neoplasm, and inflammatory diseases. A thorough clinical history and physical examination along with laboratory testing are important in suspecting these entities. Spine infections are particularly common in children between 2 and 12 years of age, with a 3:1 ratio of boys being more affected than girls. Though several components of the spine and paraspinal soft tissues can be infected, vertebral body osteomyelitis and discitis are the most common locations for the origin of infection [3,12,14]. Clinical presentation varies but symptoms can include persistent nighttime pain, low grade fever, decreased range of motion, irritability, localized tenderness, and limping. In addition, laboratory values usually demonstrate leukocytosis, elevated erythrocyte sedimentation rate, and C-reactive protein levels [3,12,14].

Inflammatory pathologies can affect both the spinal column as well as the spinal cord. The most common inflammatory etiology involving the spinal column is juvenile idiopathic arthritis, which usually occurs in late childhood and occurs most commonly in the cervical spine.

Spine neoplasms are a rare entity in children and the most common symptom is persistent nighttime back pain, refractory to conservative management and rest, present in 25% to 30% of children with spinal neoplasm. More specific symptoms including motor or gait disturbance and neurologic symptoms usually present later. Locally aggressive tumors may present with rapid increase in intensity of pain in a short interval of time. Spine neoplasm can be of different origins including the spinal column, extramedullary, and intramedullary tumors. Benign tumors of the spinal column include osteochondroma, osteoblastoma, osteoid osteoma, giant cell tumor, and aneurysmal bone cyst, whereas malignant tumors include leukemia, lymphoma, and rarely metastasis. Intramedullary tumors are the most common intraspinal tumors accounting for 35% to 40% of tumors and the most common intramedullary tumor is astrocytoma (45%-60%) followed by ependymomas (30%-35%) [3,12,14,27,28]. Imaging is imperative when suspecting these etiologies because delay in imaging can result in catastrophic consequences.

In the discussion below, "area of interest” can refer to the following: cervical, lumbar, and thoracic spine. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.

A. Bone scan whole body with SPECT or SPECT/CT area of interest

Bone scan whole body with SPECT or SPECT/CT through the region of interest may be a useful next step modality of choice following clinical evaluation and radiographs [18]. Although radiotracer uptake on bone scan is not specific, complete spine SPECT/CT is highly sensitive with some studies suggesting 90% sensitivity [20,25].

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
B. Bone scan whole body with SPECT or SPECT/CT complete spine

Bone scan whole body with SPECT or SPECT/CT through the region of interest and not the whole spine is a useful next step modality of choice following clinical evaluation and radiographs [18]. Although radiotracer uptake on bone scan is not specific, SPECT/CT is highly sensitive with some studies suggesting 90% sensitivity [20,25].

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
C. CT complete spine with IV contrast

CT complete spine with IV contrast may be useful as a next step imaging test in this clinical scenario depending on the extent of suspected or known abnormality. IV contrast can be helpful in the evaluation of the soft tissues such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

Radiography or MRI remain useful modalities when suspecting inflammation, infection, or neoplasm. However, if any of these processes are known in a patient, CT spine can be used for further evaluation [18]. CT is a useful cross-sectional modality for evaluation of some osseous tumors. For example, the bony sclerosis of an osteoid osteoma can be identified on radiography, but CT is particularly useful in precise localization of the lucent nidus and definitively diagnose this entity [3]. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case.

Dual-energy technique can be employed to render virtual unenhanced images [19].

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
D. CT complete spine without and with IV contrast

CT complete spine with and without IV contrast is usually not a useful as a next step imaging test in this clinical scenario. Although osseous pathologies do not require IV contrast, the bones can be adequately assessed in the presence of contrast-enhanced images. IV contrast can be helpful in the evaluation of the soft tissues such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

Radiography or MRI remain useful modalities when suspecting inflammation, infection, or neoplasm. CT is a useful cross-sectional modality for evaluation of some osseous tumors. For example, the bony sclerosis of an osteoid osteoma can be identified on radiography, but CT is particularly useful in precise localization of the lucent nidus and definitively diagnose this entity [3].

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
E. CT complete spine without IV contrast

CT complete spine without IV contrast may be useful as a next step imaging test in this clinical scenario depending on the extent of suspected or known abnormality. IV contrast is not required when assessing for osseous pathology.

Radiography or MRI remain useful modalities when suspecting inflammation, infection, or neoplasm. However, if any of these processes are known in a patient, CT spine can be used for further evaluation [18]. CT is a very useful cross-sectional modality for evaluation of some osseous tumors. For example, the bony sclerosis of an osteoid osteoma can be identified on radiography, but CT is particularly useful in precise localization of the lucent nidus and definitively diagnose this entity [3]. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
F. CT myelography complete spine

There is no relevant literature to support the use of CT myelography complete spine as the next imaging step in the imaging evaluation of pediatric back pain in the setting of a clinical red flag with negative radiographs. Historically, this technique played an important role in the evaluation of intraspinal pathologies; however, the usefulness of myelography has decreased in recent decades. CT myelography can occasionally be obtained to address specific scenarios [23].

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
G. CT myelography spine area of interest

There is no relevant literature to support the use of CT myelography spine area of interest as the next imaging step in the imaging evaluation of pediatric back pain in the setting of a clinical red flag with negative radiographs. Historically, this technique played an important role in the evaluation of intraspinal pathologies; however, the usefulness of myelography has decreased in recent decades. CT myelography can occasionally be obtained to address specific scenarios [23].

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
H. CT spine area of interest with IV contrast

CT spine area of interest with IV contrast may be useful as a next step imaging test in this clinical scenario depending on the extent of suspected or known abnormality. IV contrast can be helpful in the evaluation of the soft tissues such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

Radiography or MRI remain useful modalities when suspecting inflammation, infection, or neoplasm. However, if any of these processes are known in a patient, CT spine can be used for further evaluation [18]. CT is the most useful cross-sectional modality for evaluation of some osseous tumors. For example, the bony sclerosis of an osteoid osteoma can be identified on radiography, but CT is particularly useful in precise localization of the lucent nidus and definitively diagnose this entity [3]. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case.

If there is question of calcifications, limited CT images of the area of interest can be obtained for further evaluation. Dual-energy technique can be employed to render virtual unenhanced images [19].

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection,

inflammation, or malignancy on radiography. Next imaging study.
I. CT spine area of interest without and with IV contrast

CT spine area of interest with and without IV contrast is usually not a useful next step imaging test in this clinical scenario. Although osseous pathologies do not require IV contrast, the bones can be adequately assessed in the presence of contrast-enhanced images. IV contrast can be helpful in the evaluation of the soft tissues such as with epidural abscess, soft tissue abscess, or paraspinal soft tissue extent of osseous tumor [20].

Radiography or MRI remain useful modalities when suspecting inflammation, infection, or neoplasm. However, if any of these processes are known in a patient, CT spine can be used for further evaluation [18]. CT is the most useful cross-sectional modality for evaluation of some osseous tumors. For example, the bony sclerosis of an osteoid osteoma can be identified on radiography, but CT is particularly useful in precise localization of the lucent nidus and definitively diagnose this entity [3]. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case.

If there is question of calcifications, limited CT images of the area of interest can be obtained for further evaluation.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
J. CT spine area of interest without IV contrast

CT spine area of interest without IV contrast may be useful as a next step imaging test in this clinical scenario depending on the extent of suspected or known abnormality. IV contrast is not required when assessing for osseous pathology.

Radiography or MRI remain useful modalities when suspecting inflammation, infection, or neoplasm. However, if any of these processes are known in a patient, CT spine can be used for further evaluation [18]. CT is the most useful cross-sectional modality for evaluation of some osseous tumors. For example, the bony sclerosis of an osteoid osteoma can be identified on radiography, but CT is particularly useful in precise localization of the lucent nidus and definitively diagnose this entity [3]. The decision to perform a targeted versus complete spine CT depends on the clinical question and will vary for each case.

If there is question of calcifications, limited CT images of the area of interest can be obtained for further evaluation.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
K. FDG-PET/CT whole body

PET/CT with fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG) is useful in evaluating the metabolic activity of tumors involving the spine, which can help in differentiating malignant from benign neoplasms. Obtaining images from the skull vertex to the toes allows identification of metabolically active tumors distant from the primary neoplasm indicating metastasis [29].

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
L. MRI complete spine with IV contrast

MRI complete spine with IV contrast is not useful as a first-line imaging test in this clinical scenario because precontrast images are helpful to accurately assess enhancement after contrast administration. MRI is a useful modality of choice to evaluate pediatric back pain with clinical suspicion for infection, inflammation, or neoplasm. Importantly, in the setting of discitis/osteomyelitis prompt diagnosis is paramount and radiography has low sensitivity in early stages of disease [20].

The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, if multifocal disease is suspected, a complete spine MRI is helpful.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
M. MRI complete spine without and with IV contrast

MRI is a useful modality of choice to evaluate pediatric back pain with clinical suspicion for infection, inflammation, or neoplasm. Importantly, in the setting of discitis/osteomyelitis, prompt diagnosis is paramount, and radiography has low sensitivity in early stages of disease [20]. Therefore, MRI of the spine can be obtained as the next step imaging study to exclude severe secondary complications such as epidural abscess and spinal cord compression [12,16,22,25]. Similarly, when intraspinal neoplasm or inflammatory process is suspected with clinical neurologic deficits, MRI can be obtained to promptly identify pathology given high sensitivity and specificity for detecting pathologies including syringomyelia, transverse myelitis, and primary neoplasms of the neural axis [12,25]. Frequently, sequela of discitis/osteomyelitis can extend into the paraspinal soft tissues, which is best assessed on MRI. Gadolinium contrast administration can be useful in certain scenarios such as suspected neoplasm or discitis/osteomyelitis [20,22]. If contrast is administered, precontrast imaging is helpful to assess enhancement.

The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, if multifocal disease is suspected, a complete spine MRI is helpful.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
N. MRI complete spine without IV contrast

MRI complete spine without IV contrast may be a useful modality of choice to evaluate pediatric back pain with clinical suspicion for infection, inflammation, or neoplasm. Importantly, in the setting of discitis/osteomyelitis, prompt diagnosis is paramount, and radiography has low sensitivity in early stages of disease [20]. Therefore, MRI of the spine can be obtained as the next step imaging study to exclude severe secondary complications such as epidural abscess and spinal cord compression [12,16,22,25]. Similarly, when intraspinal neoplasm or inflammatory process is suspected with clinical neurologic deficits, MRI can be obtained to promptly identify pathology given high sensitivity and specificity for detecting pathologies including syringomyelia, transverse myelitis, and primary neoplasms of the neural axis [12,25]. Frequently, sequela of discitis/osteomyelitis can extend into the paraspinal soft tissues, which is best assessed on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, if multifocal disease is suspected, a complete spine MRI is helpful. Gadolinium contrast administration can be useful in suspected neoplasm or discitis/osteomyelitis [20,22] and is usually more helpful than MRI without IV contrast.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
O. MRI spine area of interest with IV contrast

MRI spine area of interest with IV contrast is not useful as a first-line imaging test in this clinical scenario because precontrast images are helpful to accurately assess enhancement after contrast administration. MRI is a useful modality of choice to evaluate pediatric back pain with clinical suspicion for infection, inflammation, or neoplasm. Importantly, in the setting of discitis/osteomyelitis, prompt diagnosis is paramount, and radiography has low sensitivity in early stages of disease [20].

Frequently, sequela of discitis/osteomyelitis can extend into the paraspinal soft tissues, which is best assessed on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
P. MRI spine area of interest without and with IV contrast

MRI is a useful modality of choice to evaluate pediatric back pain with clinical suspicion for infection, inflammation, or neoplasm. Importantly, in the setting of discitis/osteomyelitis, prompt diagnosis is paramount, and radiography has low sensitivity in early stages of disease [20]. Therefore, MRI of the spine can be obtained as the next step imaging study to exclude severe secondary complications such as epidural abscess and spinal cord compression [12,16,22,25]. Similarly, when intraspinal neoplasm or inflammatory process is suspected with clinical neurologic deficits, MRI can be obtained to promptly identify pathology given high sensitivity and specificity for detecting pathologies including syringomyelia, transverse myelitis, and primary neoplasms of the neural axis [12,25].

Frequently, sequela of discitis/osteomyelitis can extend into the paraspinal soft tissues, which is best assessed on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
Q. MRI spine area of interest without IV contrast

MRI spine area of interest without IV contrast may be a useful modality of choice to evaluate pediatric back pain with clinical suspicion for infection, inflammation, or neoplasm. Importantly, in the setting of discitis/osteomyelitis, prompt diagnosis is paramount, and radiography has low sensitivity in early stages of disease [20]. Therefore, MRI of the spine can be obtained as the next step imaging study to exclude severe secondary complications such as epidural abscess and spinal cord compression [12,16,22,25]. Similarly, when intraspinal neoplasm or inflammatory process is suspected with clinical neurologic deficits, MRI can be obtained to promptly identify pathology given high sensitivity and specificity for detecting pathologies including syringomyelia, transverse myelitis, and primary neoplasms of the neural axis [12,25]. Frequently, sequela of discitis/osteomyelitis can extend into the paraspinal soft tissues, which is best assessed on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case.

Gadolinium contrast administration can be useful in suspected neoplasm or discitis/osteomyelitis

[20,22] and is usually more helpful than MRI without IV contrast.

Variant 5: Child. Back pain. With at least one clinical red flag. Suspected infection, inflammation, or malignancy on radiography. Next imaging study.
R. US spine area of interest

There is no relevant literature to support the use of US spine in the evaluation of pediatric back pain as a next step imaging modality when suspecting inflammation, infection, or malignancy.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.

Pediatric back pain is a commonly encountered complaint and has become more prevalent in recent decades. The prevalence rates vary widely with more recent epidemiological studies showing prevalence between 30% and 50% [1-4]. Although pediatric back pain can be due to a wide number of etiologies, overuse and repetitive activity due to increased intensity of youth sports has become more recognized [2,3,12]. Competitive athletic activity has been associated with increased risk of spine injury with lumbar spine injuries including degenerative disk disease and spondylolysis being most common. Specific sporting activities such as weightlifting, wrestling, soccer, track and field, baseball, tennis, and gymnastics have an increased predisposition for lumbar spine injuries. Each of these activities place different biomechanical stresses resulting in varying patterns of lumbar spine injuries. For example, young soccer athletes are more prone to multilevel spondylolysis due to compressive stress injuries from running, whereas young baseball players had injuries from high rotational and torsional forces. Although clinical history of back pain and treatment might be similar in these cases, imaging can be particularly useful when there are associated neurologic deficits. Imaging can identify the location of injury and more importantly whether there is associated spondylolisthesis and spinal canal or neural foraminal narrowing [13,30-32].

In the discussion below, "area of interest” can refer to the following: cervical, lumbar, and thoracic spine. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT area of interest

Radiography is useful as the first-line imaging for imaging evaluation of pediatric back pain. However, radiography has low sensitivity to detect spondylolysis in the absence of spondylolisthesis. Area of interest SPECT is very sensitive for identifying spondylolysis and may be a useful next step, particularly when radiography is negative with high clinical suspicion. SPECT relies on radiotracer uptake in areas of increased bone turnover in the setting of stress reaction, stress fracture, or spondylolysis. SPECT can be performed in conjunction with CT to improve localization; however, the additional localizer CT is not always necessary if findings will not change clinical management [3,14,30,33,34].

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
B. Bone scan whole body with SPECT or SPECT/CT complete spine

Radiography is useful as the first-line imaging for imaging evaluation of pediatric back pain. However, radiography has low sensitivity to detect spondylolysis in the absence of spondylolisthesis. Area of interest SPECT is very sensitive for identifying spondylolysis and may be a useful next step, particularly when radiography is negative with high clinical suspicion. Complete spine SPECT is unnecessary because stress injuries are typically localized to one segment of the spine. SPECT relies on radiotracer uptake in areas of increased bone turnover in the setting of stress reaction, stress fracture, or spondylolysis. SPECT can be performed in conjunction with CT to improve localization; however, the additional localizer CT is not always necessary if findings will not change clinical management [3,14,30,33,34].

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
C. CT complete spine with IV contrast

There is no relevant literature to support the use of CT complete spine with IV contrast in the initial evaluation of chronic pediatric mechanical back pain associated with overuse or repetitive activity.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
D. CT complete spine without and with IV contrast

There is no relevant literature to support the use of CT complete spine without and with IV contrast in the initial evaluation of chronic pediatric mechanical back pain associated with overuse or repetitive activity.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
E. CT complete spine without IV contrast

CT complete spine without IV contrast is not useful as an initial imaging test in this clinical scenario because stress injuries resulting from overuse or repetitive activity tends to be localized and does not involve the whole spine.

Radiography is useful as the first-line imaging for imaging evaluation of pediatric back pain. However, radiography has low sensitivity to detect spondylolysis in the absence of spondylolisthesis. CT spine has increased sensitivity for detecting nondisplaced fractures and spondylolysis when compared to conventional radiography [18,23]. However, CT is less sensitive in detecting stress injuries involving the pars interarticularis without lysis, which is frequently seen in pediatric patients. In these cases, CT has been found to be complementary to SPECT and MRI for higher specificity and sensitivity [2,23]. Furthermore, CT can be used in follow-up imaging of spondylolysis if clinically warranted [23]. Stress injuries are usually localized and do not involve the whole spine.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
F. CT myelography complete spine

There is no relevant literature to support the use of CT myelography complete spine in the initial evaluation of chronic pediatric mechanical back pain associated with overuse or repetitive activity.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
G. CT myelography spine area of interest

There is no relevant literature to support the use of CT myelography complete spine in the initial evaluation of chronic pediatric mechanical back pain associated with overuse or repetitive activity.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.

H. CT spine area of interest with IV contrast

There is no relevant literature to support the use of CT spine area of interest with IV contrast in the initial evaluation of chronic pediatric mechanical back pain associated with overuse or repetitive activity.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.

I. CT spine area of interest without and with IV contrast

There is no relevant literature to support the use of CT spine area of interest without and with IV contrast in the initial evaluation of chronic pediatric mechanical back pain associated with overuse or repetitive activity.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.

J. CT spine area of interest without IV contrast

CT spine area of interest without IV contrast may be useful as a next step imaging test in this clinical scenario. IV contrast is not required when assessing for osseous pathology.

Radiography is useful as the first-line imaging for imaging evaluation of pediatric back pain. However, radiography has low sensitivity to detect spondylolysis in the absence of spondylolisthesis. CT spine has increased sensitivity for detecting nondisplaced fractures and spondylolysis when compared to conventional radiography [18,23]. However, CT is less sensitive in detecting stress injuries involving the pars interarticularis without lysis, which is frequently seen in pediatric patients. In these cases, CT has been found to be complementary to SPECT and MRI for higher specificity and sensitivity [2,23]. Furthermore, CT can be used in follow-up imaging of spondylolysis if clinically warranted [23]. Stress injuries are usually localized to the area of the spine affected by overuse or repetitive activity and not involve the whole spine.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.

K. MRI complete spine with IV contrast

There is no relevant literature to support the use of MRI complete spine with IV contrast in the initial evaluation of chronic pediatric mechanical back pain associated with overuse or repetitive activity.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.

L. MRI complete spine without and with IV contrast

There is no relevant literature to support the use of MRI complete spine without and with IV contrast in the initial evaluation of chronic pediatric mechanical back pain associated with overuse or repetitive activity.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.

M. MRI complete spine without IV contrast

Radiography is useful as the first-line imaging for imaging evaluation of pediatric back pain. MRI is usually performed as a suitable next step if radiographs are negative or if there are concerning clinical findings such as neurologic deficits. Because symptoms in this clinical scenario are typically localized, imaging of the whole spine is typically not required. MRI provides better soft tissue resolution compared to conventional radiography, which helps identify disk degeneration, herniation, and vertebral marrow edema. In more severe cases of overuse injuries, MRI is also helpful in identifying soft tissue edema or hematoma [3,14,16].

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
N. MRI spine area of interest with IV contrast

There is no relevant literature to support the use of MRI spine area of interest with IV contrast in the initial evaluation of chronic pediatric mechanical back pain associated with overuse or repetitive activity.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
O. MRI spine area of interest without and with IV contrast

There is no relevant literature to support the use of MRI spine area of interest without and with IV contrast in the initial evaluation of chronic pediatric mechanical back pain associated with overuse or repetitive activity.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
P. MRI spine area of interest without IV contrast

Radiography is useful as the first-line imaging for imaging evaluation of pediatric back pain. MRI is usually performed as a suitable next step if radiographs are negative or if there are concerning clinical findings such as neurologic deficits. MRI provides better soft tissue resolution compared to conventional radiography, which helps identify disk degeneration, herniation, and vertebral marrow edema. In more severe cases of overuse injuries, MRI is also helpful in identifying soft tissue edema or hematoma [3,14,16].

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
Q. Radiography complete spine

Anteroposterior and lateral radiographs remain the standard of care for initial imaging evaluation of pediatric back pain [2,12,16]. Although oblique radiography is usually not recommended in most cases of back pain, it can be useful in better visualizing pars interarticularis defects [9,12]. Prospective studies have shown a 9% to 22% yield in accurate diagnosis when radiography was performed along with a detailed history and physical examination [1,17]. The decision to perform a targeted versus complete spine radiograph depends on the clinical question and will vary for each case. In most instances, if the initial radiographs identify a cause for back pain, specific treatment can be initiated without the need for additional imaging. Back pain related to overuse or repetitive activity in pediatric patients is mostly seen in young athletes and weightlifters with low back pain being the most common complaint [32]. In these cases, spondylolysis and disk pathology are the most common etiologies [2,12,17,35]. Repetitive use and mechanical back pain in children usually presents with localized symptoms and imaging the complete spine has limited role and imaging of the area of interest is more prudent.

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.

R. Radiography spine area of interest

Anteroposterior and lateral radiographs remain the standard of care for initial imaging evaluation of pediatric back pain [2,12,16]. Although oblique radiography is usually not recommended in most cases of back pain, it can be useful in better visualizing pars interarticularis defects [9,12]. Prospective studies have shown a 9% to 22% yield in accurate diagnosis when radiography was performed along with a detailed history and physical examination [1,17]. The decision to perform a targeted versus complete spine radiograph depends on the clinical question and will vary for each case. In most instances, if the initial radiographs identify a cause for back pain, specific treatment can be initiated without the need for additional imaging. Back pain related to overuse or repetitive activity in pediatric patients is mostly seen in young athletes and weightlifters with low back pain being the most common complaint [32]. In these cases, spondylolysis and disk pathology are the most common etiologies [2,12,17,35].

Variant 6: Child. Chronic mechanical back pain associated with overuse or repetitive activity. Initial imaging.
S. US spine area of interest

There is no relevant literature to support the use of US spine in the evaluation of pediatric back pain as initial imaging when suspecting overuse or repetitive activity injuries.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.

Pediatric back pain is most commonly due to benign etiologies, but when there are ancillary clinical findings of skin abnormalities, further investigation is required to exclude neurocutaneous syndromes or spinal dysraphism. A thorough skin examination is important in diagnosing underlying common genetic disorders such as neurofibromatosis, including café-au-lait spots and axillary freckling [27]. Other skin abnormalities such as sacral dimple, palpable mass, hemangioma, hairy patch, and asymmetrical gluteal cleft can be additional clues of an underlying spinal dysraphism [27,36]. In addition to these superficial skin abnormalities, gait abnormality, abnormal spine curvature, urinary incontinence, torticollis, or neurologic deficits such as weakness in the extremities could all provide clues to diagnosing intraspinal or spinal column pathologies. Spinal imaging is important to identify these structural pathologies and should not be delayed in children presenting with neurologic deficits [16].

In the discussion below, "area of interest" can refer to the following: cervical, lumbar, and thoracic spine. These body regions might be evaluated separately or in combination as guided by physical examination findings, patient history, and other available information.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT area of interest

There is no relevant literature to support the use of bone scan whole body with SPECT or SPECT/CT through the area of interest in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
B. Bone scan whole body with SPECT or SPECT/CT complete spine

There is no relevant literature to support the use of bone scan whole body with SPECT or SPECT/CT through the whole spine in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
C. CT complete spine with IV contrast

There is no relevant literature to support the use of CT spine in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
D. CT complete spine without and with IV contrast

There is no relevant literature to support the use of CT spine in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
E. CT complete spine without IV contrast

There is no relevant literature to support the use of CT spine in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
F. CT myelography complete spine

There is no relevant literature to support the use of CT myelography in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
G. CT myelography spine area of interest

There is no relevant literature to support the use of CT myelography in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
H. CT spine area of interest with IV contrast

There is no relevant literature to support the use of CT spine in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
I. CT spine area of interest without and with IV contrast

There is no relevant literature to support the use of CT spine in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
J. CT spine area of interest without IV contrast

There is no relevant literature to support the use of CT spine in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
K. MRI complete spine with IV contrast

MRI complete spine with IV contrast is not useful as a first-line imaging test in this clinical scenario because precontrast images are helpful to accurately assess enhancement after contrast administration. When physical examination and clinical symptoms raise suggestion for underlying spinal dysraphism, MRI is a useful modality given its high sensitivity and specificity for detecting pathologies including syringomyelia and spinal dysraphism [12,16]. For example, if a dermal sinus tract is identified on physical examination, MRI of the spine can be obtained as initial imaging to evaluate for intraspinal lesions and to assess for spinal dysraphism [16,27]. Imaging findings of a potentially associated tethered cord syndrome including low lying conus medullaris or fatty filum terminale can also be identified on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, MRI of the lumbar spine is required in these cases to evaluate the conus, filum terminale, and for potential open or closed spinal dysraphism [16].

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
L. MRI complete spine without and with IV contrast

When physical examination and clinical symptoms raise suggestion for underlying spinal dysraphism, MRI is a useful modality given its high sensitivity and specificity for detecting pathologies including syringomyelia and spinal dysraphism [12,16]. For example, if a dermal sinus tract is identified on physical examination, MRI of the spine can be obtained as initial imaging to evaluate for intraspinal lesions and to assess for spinal dysraphism [16,27]. Imaging findings of a potentially associated tethered cord syndrome including low lying conus medullaris or fatty filum terminale can also be identified on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, MRI of the lumbar spine is required in these cases to evaluate the conus, filum terminale, and for potential open or closed spinal dysraphism [16]. Although gadolinium contrast is not typically required to evaluate for these structural abnormalities and associated lipomatous masses, contrast administration can be useful in certain scenarios such as suspected neoplasm or an infected dermal sinus tract [27]. If contrast is administered, precontrast imaging is helpful to assess enhancement.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
M. MRI complete spine without IV contrast

When physical examination and clinical symptoms raise suggestion for underlying spinal dysraphism, MRI is a useful modality given its high sensitivity and specificity for detecting pathologies including syringomyelia and spinal dysraphism [12,16]. For example, if a dermal sinus tract is identified on physical examination, MRI of the spine can be obtained as initial imaging to evaluate for intraspinal lesions and to assess for spinal dysraphism [16,27]. Imaging findings of a potentially associated tethered cord syndrome including low lying conus medullaris or fatty filum terminale can also be identified on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, MRI of the lumbar spine is required in these cases to evaluate the conus, filum terminale, and for potential open or closed spinal dysraphism [16].

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or

draining sinus. Initial imaging.
N. MRI spine area of interest with IV contrast

MRI spine area of interest with IV contrast is not useful as a first-line imaging test in this clinical scenario because precontrast images are helpful to accurately assess enhancement after contrast administration. When physical examination and clinical symptoms raise suggestion for underlying spinal dysraphism, MRI is a useful modality given its high sensitivity and specificity for detecting pathologies including syringomyelia and spinal dysraphism [12,16]. For example, if a dermal sinus tract is identified on physical examination, MRI of the spine can be obtained as initial imaging to evaluate for intraspinal lesions and to assess for spinal dysraphism [16,27]. Imaging findings of a potentially associated tethered cord syndrome including low lying conus medullaris or fatty filum terminale can also be identified on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, MRI of the lumbar spine is required in these cases to evaluate the conus, filum terminale, and for potential open or closed spinal dysraphism [16].

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
O. MRI spine area of interest without and with IV contrast

When physical examination and clinical symptoms raise suggestion for underlying spinal dysraphism, MRI is a useful modality given its high sensitivity and specificity for detecting pathologies including syringomyelia and spinal dysraphism [12,16]. For example, if a dermal sinus tract is identified on physical examination, MRI of the spine can be obtained as initial imaging to evaluate for intraspinal lesions and to assess for spinal dysraphism [16,27]. Imaging findings of a potentially associated tethered cord syndrome including low lying conus medullaris or fatty filum terminale can also be identified on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, MRI of the lumbar spine is required in these cases to evaluate the conus, filum terminale, and for potential open or closed spinal dysraphism [16]. Although gadolinium contrast is not typically required to evaluate for these structural abnormalities and associated lipomatous masses, contrast administration can be useful in certain scenarios such as suspected neoplasm or an infected dermal sinus tract [27]. If contrast is administered, precontrast imaging is helpful to assess enhancement.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
P. MRI spine area of interest without IV contrast

When physical examination and clinical symptoms raise suggestion for underlying spinal dysraphism, MRI is a useful modality of choice given its high sensitivity and specificity for detecting pathologies including syringomyelia and spinal dysraphism [12,16]. For example, if a dermal sinus tract is identified on physical examination, MRI of the spine can be obtained as initial imaging to evaluate for intraspinal lesions and to assess for spinal dysraphism [16,27]. Imaging findings of a potentially associated tethered cord syndrome including low lying conus medullaris or fatty filum terminale can also be identified on MRI. The decision to perform a targeted versus complete spine MRI depends on the clinical question and will vary for each case. However, MRI of the lumbar spine is required in these cases to evaluate the conus, filum terminale, and for potential open or closed spinal dysraphism [16].

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.

Q. Radiography complete spine

There is no relevant literature to support the use of radiography in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
R. Radiography spine area of interest

There is no relevant literature to support the use of radiography in initial imaging evaluation of pediatric back pain with associated skin abnormalities.

Variant 7: Child. Back pain with palpable lump or skin discoloration or hairy patch or draining sinus. Initial imaging.
S. US spine area of interest

In neonates and infants <4 months of age, although back pain may not be a noticeable symptom, skin abnormalities such as discoloration, sacral dimple, palpable lump, and asymmetric gluteal cleft are usually noticed by parents. In addition, there may be associated neurologic deficits such as lower extremity weakness, abnormal extremity movements, or neurogenic bladder. In these cases, rather than conventional radiography, US of the spine is a useful modality to evaluate for signs of spinal dysraphism [27,36].

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:** In the initial assessment of back pain in a child with no clinical red flags, imaging is usually not appropriate, and conservative management is recommended.
- **Variant 2**: In the initial assessment of back pain in a child and at least one clinical red flag is present, radiography of the area of interest is an appropriate initial imaging test.
- **Variant 3**: In the initial assessment of back pain in a child and at least one clinical red flag is present and radiographs are negative, an MRI of the spine area of interest without IV contrast or MRI of the spine area of interest without and with IV contrast is an appropriate next imaging study
- **Variant 4**: For initial assessment of back pain in a child with known or suspected inflammation, infection, or neoplasm, complete spine MRI without and with IV contrast is appropriate.
- **Variant 5**: If radiography of a child with clinical red flags shows features suspicious for infection, inflammation, or malignancy, complete spine or spine area of interest MRI without and with IV contrast are appropriate next imaging studies.
- **Variant 6:** Chronic mechanical back pain associated with overuse or repetitive activity is usually appropriately imaged initially by area of interest radiography.
- **Variant 7:** Initial imaging of back pain associated with a lump, skin discoloration, hairy patch, or draining sinus can be imaged by either a US of the area of interest particularly in neonates and young infants or alternatively by MRI spine of the area of interest without IV contrast or MRI spine of the area of interest without and with IV contrast; the latter can be useful in suspected neoplasm or infected dermal sinus tract.

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, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates 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.

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.

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 (e.g., 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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[a]Lucile Packard Children's Hospital at Stanford, Stanford, California. [b]Research Author, Stanford University, Stanford, California. [c]Panel Chair, University of Missouri, Columbia, Missouri. [d]Texas Children's Hospital, Houston, Texas; American Association of Neurological Surgeons/Congress of Neurological Surgeons. [e]Radiology Associates of North Texas, Fort Worth, Texas. [f]St. Joseph's Hospital and Medical Center, Glendale, Arizona; American Academy of Neurology. [g]Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio; American Pediatric Surgical Association. [h]University of California San Francisco Benioff Children's Hospital, San Francisco, California. [i]University of North Carolina at Chapel Hill, Chapel Hill, North Carolina. [j]Lucile Packard Children's Hospital at Stanford, Stanford, California; Commission on Nuclear Medicine and Molecular Imaging. [k]Phoenix Children's, Phoenix, Arizona. [l]Indiana University Health, Indianapolis, Indiana. [m]Medical University of South Carolina, Charleston, South Carolina; North American Spine Society. [n]Children's Hospital of Los Angeles, University of Southern California Keck University School of Medicine, Los Angeles, California; Committee on Emergency Radiology-GSER. [o]University of Arizona College of Medicine, Tucson, Arizona. [p]University of Washington and Seattle Children's Hospital, Seattle, Washington; American College of Emergency Physicians. [q]Seattle Children's Hospital, Seattle, Washington. [r]University of California, Davis Health, Sacramento, California; American Academy of Pediatrics. [s]Specialty Chair, Vanderbilt Children's Hospital, Nashville, Tennessee.