CHAPTER 3

Cervical Spine

Examination of the cervical spine involves determining whether the injury or pathology occurs in the cervical spine or in a portion of the upper limb. Cyriax[1] called this assessment the **scanning examination.** In the initial assessment of a patient who complains of pain in the neck and/or upper limb, this procedure is always carried out unless the examiner is absolutely sure of the location of the lesion. If the injury is in the neck, the scanning examination is definitely called for to rule out neurological involvement. After the lesion site has been determined, a more detailed assessment of the affected area is performed if it is outside the cervical spine.

Because many conditions affecting the cervical spine can be manifested in other parts of the body, the cervical spine is a complicated area to assess properly, and adequate time must be allowed to ensure that as many causes or problems are examined as possible.

Applied Anatomy

The cervical spine consists of several pairs of joints. It is an area in which stability has been sacrificed for mobility, making the cervical spine particularly vulnerable to injury because it sits between a heavy, mobile head and a stable thoracic spine and ribs. The cervical spine is divided into two areas—the **cervicoencephalic** for the upper cervical spine and the **cervicobrachial** for the lower cervical spine. The cervicoencephalic or cervicocranial region (C0 to C2) shows the relationship between the cervical spine and the occiput, and injuries in this region have the potential of involving the brain, brain stem, and spinal cord (Fig. 3.1).[2,3] Injuries in this area lead to symptoms of headache, fatigue, vertigo, poor concentration, hypertonia of the sympathetic nervous system, and irritability. In addition, there may be a cognitive dysfunction and a cranial nerve dysfunction.[2,3]

The **atlanto-occipital joints** (C0 to C1) are the two uppermost joints. The principal motion of these two joints is flexion-extension (15° to 20°), or nodding of the head. Side flexion is approximately 10°, whereas rotation is negligible. The **atlas** (C1) has no vertebral body as such. During development, the vertebral body of C1 evolves into the **odontoid process,** which is part of C2. The atlanto-occipital joints are ellipsoid and act in unison. Along with the atlanto-axial joints, these joints are the most complex articulations of the axial skeleton.

There are several ligaments that stabilize the atlanto-occipital joints. Anteriorly and posteriorly are the atlanto-occipital membranes. The anterior membrane is strengthened by the anterior longitudinal ligament. The posterior membrane replaces the ligamentum flavum between the atlas and occiput. The tectorial membrane, which is a broad band covering the dens and its ligaments, is found within the vertebral canal and is a continuation of the posterior longitudinal ligament. The alar ligaments are two strong rounded cords found on each side of the upper dens passing upward and laterally to attach on the medial sides of the occipital condyles. The alar ligaments limit flexion and rotation and play a major role in stabilizing C1 and C2, especially in rotation.[4]

The **atlanto-axial joints** (C1–C2) constitute the most mobile articulations of the spine. Flexion-extension is approximately 10°, and side flexion is approximately 5°. Rotation, which is approximately 50°, is the primary movement of these joints. With rotation, there is a decrease in height of the cervical spine at this level as the vertebrae approximate because of the shape of the facet joints. The odontoid process of C2 acts as a pivot point for the rotation. This middle, or median, joint is classified as a **pivot (trochoidal) joint.** The lateral atlanto-axial, or facet, joints are classified as **plane joints.** Generally, if a person can talk and chew, there is probably some motion occurring at C1–C2. At the atlanto-axial joints, the main supporting ligament is the **transverse ligament of the atlas**, which holds the dens of the axis against the anterior arch of the atlas. It is this ligament that weakens or ruptures in rheumatoid arthritis. As the ligament crosses the dens, there are two projections off the ligament, one going superiorly to the occiput and one inferiorly to the axis. The ligament and the projections form a cross, and the three parts taken together are called the **cruciform ligament of the atlas** (Fig. 3.2).

The vertebral artery—part of the vertebrobasilar system that passes through the transverse processes of the cervical vertebrae usually starting at C6 but entering as high as C4—supplies 20% of the blood supply to the brain (primarily the hindbrain) along with the internal carotid artery (80%) (Fig. 3.3).[5,6] In its path, the vertebral artery lies close to the facet joints and vertebral body where it

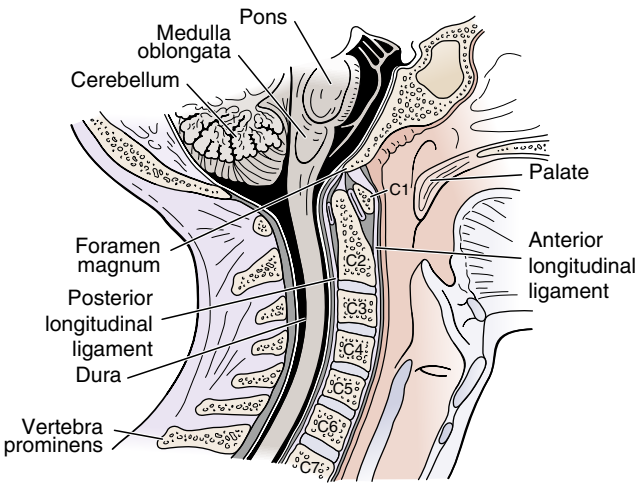

Fig. 3.1 This sagittal view of the cervical spine shows the relations among the brain stem, the medulla oblongata, the foramen magnum, the spinal canal, and the cervical spine. The lower portion of the medulla is outside and below the foramen; therefore, with subluxation of the atlas on the axis, compression of the brain stem can occur through pressure of the odontoid against the upper spinal cord and the lower medulla. Note that the anterior arch of the atlas is only millimeters from the pharynx. (Redrawn from Bland JH: *Disorders of the cervical spine*, Philadelphia, 1994, W.B. Saunders, p 47.)

may be compressed by osteophyte formation or injury to the facet joint. In addition, in older individuals, atherosclerotic changes and other vascular risk factors (e.g., hypertension, high fat or cholesterol levels, diabetes, smoking) may contribute to altered blood flow in the arteries.[7] The vertebral and internal carotid arteries are stressed primarily by rotation, extension, and traction movements, but other movements may also stretch the artery.[8–10] Rotation and extension of as little as 20° have been shown to significantly decrease vertebral artery blood flow.[11,12] The greatest stresses are placed on the vertebral arteries in four places: where it enters the transverse process of C6, within the bony canals of the vertebral transverse processes, between C1 and C2, and between C1 and the entry of the arteries into the skull.[13,14] These latter two areas have the greatest potential for problems (e.g., thrombosis, dissection, stroke) related to treatment and their concomitant stress on the vertebral arteries.[15] Dutton[13] reports that the most common mechanism for nonpenetrating injury to the vertebral artery is neck extension, with or without side flexion or rotation.[16,17] Given the type of injury possible, symptoms may be delayed.[18,19] Symptoms related to the vertebral artery include vertigo, balance deficits, arm paresthesia, nausea, tinnitus, "drop attacks" (i.e., falling without fainting), visual disturbances, or, in rare cases, stroke or death.[20]

The lower cervical spine (C3 to C7) is called the **cervicobrachial area**, since pain in this area is commonly referred into the upper extremity.[2,3] Pathology in this region leads to neck pain alone, arm pain alone, or both neck and arm pain. Thus, symptoms include neck and/or arm pain, headaches, restricted range of motion (ROM), paresthesia, altered myotomes and dermatomes, and radicular signs. Cognitive dysfunction and cranial nerve dysfunction are not commonly symptoms of injuries in this area although sympathetic dysfunction may be. Injury to both areas, if severe enough, may result in psychosocial issues.

There are 14 **facet (apophyseal) joints** in the cervical spine (C1 to C7). The upper four facet joints in the two upper thoracic vertebrae (T1 to T2) are often included in the examination of the cervical spine. The superior facets of the cervical spine face upward, backward, and medially; the inferior facets face downward, forward, and laterally (Fig. 3.4). This plane facilitates flexion and extension, but it prevents simple rotation or side flexion without both occurring to some degree together. This is called a **coupled movement** with rotation and side flexion both occurring with either movement.[21] Ishii et al.[22,23] reported that between C0 and C2, as well as C7 and T1, the two movements occur in opposite directions while between C2 and C7, they occur in the same direction. These joints move primarily by gliding and are classified as **synovial (diarthrodial) joints**. The capsules are lax to allow sufficient movement. At the same time, they provide support and a check-rein type of restriction at end range. The greatest flexion-extension of the facet joints occurs between C5 and C6; however, there is almost as much movement at C4 to C5 and C6 to C7. Because of this mobility, degeneration is more likely to be seen at these levels. The neutral or resting position of the cervical spine is slightly extended. The close packed position of the facet joints is complete extension.

Cervical Spine

Resting position:	Midway between flexion and extension
Close packed position:	Full extension
Capsular pattern:	Side flexion and rotation equally limited extension

The **recurrent meningeal,** or **sinuvertebral, nerve** innervates the anterior dura sac, the posterior annulus fibrosus, and the posterior longitudinal ligament. The facet joints are innervated by the medial branch of the dorsal primary rami.[24] For C3 to C7, the main ligaments are the anterior longitudinal ligament, the posterior longitudinal ligament, the ligamentum flavum, and the supraspinal and interspinal ligaments (Fig. 3.5). There are also ligaments between the transverse processes (intertransverse ligaments), but in the cervical spine, they are rudimentary.

Some anatomists[25–28] refer to the costal or uncovertebral processes as **uncinate joints** or **joints of Luschka** (Fig. 3.6). These structures were described by von Luschka in 1858. The uncus gives a "saddle"

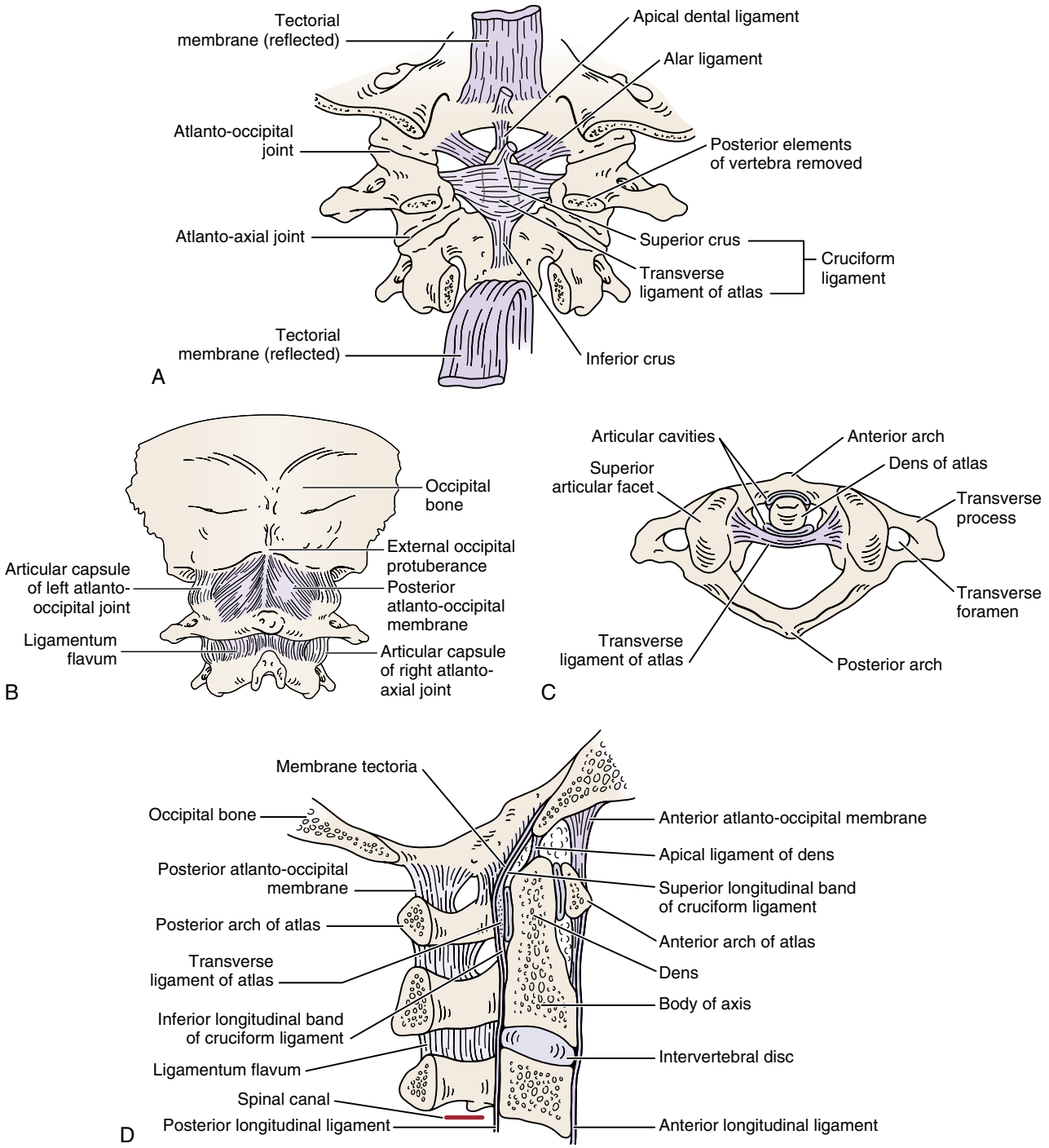

Fig. 3.2 Ligaments of the upper cervical spine. (A) Posterior deep view. (B) Posterior superficial view. (C) Superior view. (D) Lateral view.

form to the upper aspect of the cervical vertebra, which is more pronounced posterolaterally; it has the effect of limiting side flexion. Extending from the uncus is a "joint" that appears to form because of a weakness in the annulus fibrosus. The portion of the vertebra above, which "articulates" or conforms to the uncus, is called the *échancrure*, or notch. Notches are found from C3 to T1, but according to most authors,[25–28] they are not seen until age 6 to 9 years and are not fully developed until 18 years of age. There is some controversy as to whether they should be classified as real joints because some authors believe they are the result of degeneration of the intervertebral disc.

The **intervertebral discs** make up approximately 25% of the height of the cervical spine. No disc is found between the atlas and the occiput (C0–C1) or between the atlas and the axis (C1–C2). It is the discs rather than the vertebrae that give the cervical spine its lordotic shape

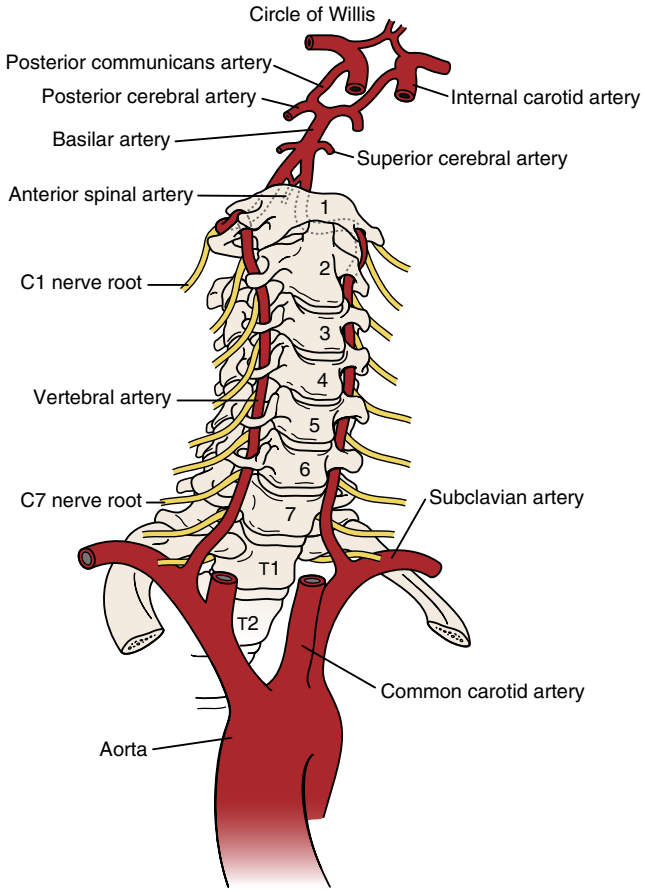

Fig. 3.3 Anterolateral drawing of the course of the vertebral artery from C6 to C1 through the bony rings of the foramina transversaria. Note the double U-turn the artery makes from C2 to C1 and the posterior course around the lateral mass of the atlas. (Modified from Bland JH, Nakano KK: Neck pain. In Kelley WN, et al., eds: *Textbook of rheumatology*, ed 1, Philadelphia, 1981, W.B. Saunders.)

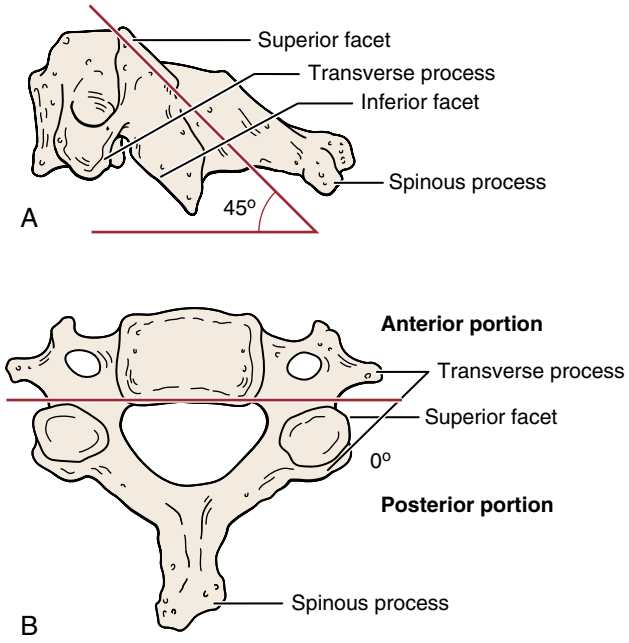

Fig. 3.4 Cervical spine-plane of facet joints. (A) Lateral view. (B) Superior view.

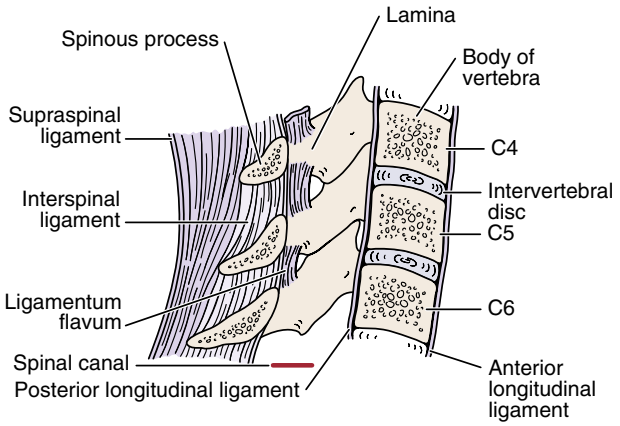

Fig. 3.5 Median section of C4 to C6 vertebrae to illustrate the intervertebral disc and the ligaments of the cervical spine.

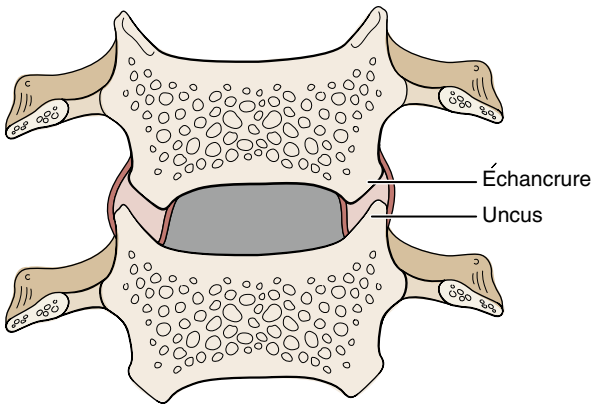

Fig. 3.6 Joints of Luschka.

(Fig. 3.7). The **nucleus pulposus** functions as a buffer to axial compression in distributing compressive forces, whereas the **annulus fibrosus** acts to withstand tension within the disc. The intervertebral disc has some innervation on the periphery of the annulus fibrosus.[29,30]

There are seven vertebrae in the cervical spine with the body of each vertebra (except C1) supporting the weight of those above it. The facet joints may bear some of the weight of the vertebrae above, but this weight is minimal if the normal lordotic posture is maintained. However, even this slight amount of weight bearing can lead to spondylitic changes in these joints. The outer ring of the vertebral body is made of cortical bone, and the inner part is made of cancellous bone covered with the cartilaginous end plate. The vertebral arch protects the spinal cord, while the spinous processes, most of which are bifid in the cervical spine, provide for attachment of muscles. The transverse processes have basically the same function. In the cervical spine, the transverse processes are made up of two parts: the anterior portion that provides the foramen for the vertebral body, and the posterior portion containing the two articular facets (see Fig. 3.4B). In the cervical spine, the

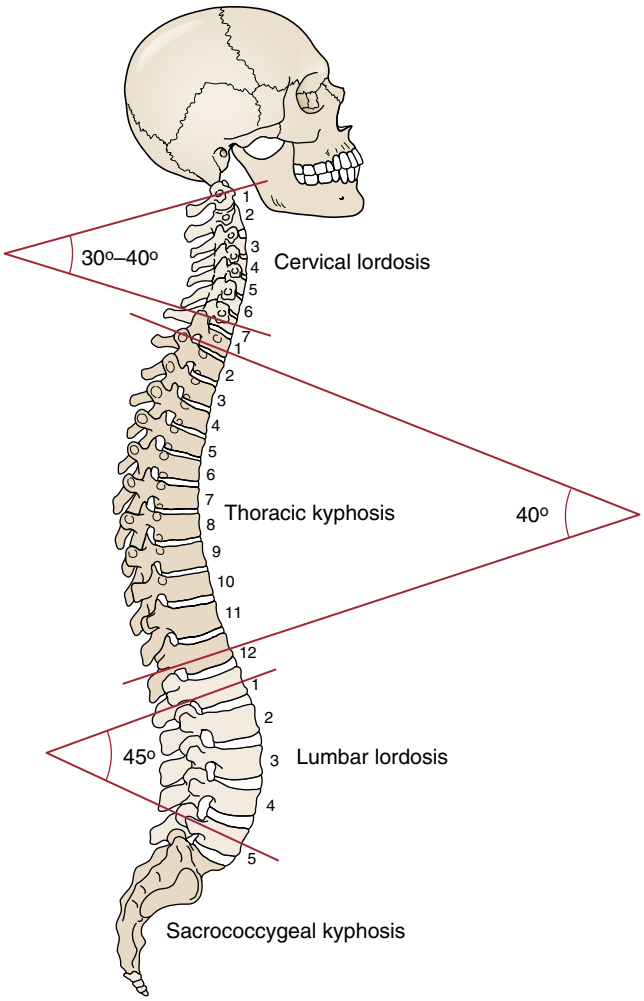

Fig. 3.7 The normal sagittal plane curvatures across the regions of the vertebral column. The curvatures represent the normal resting postures of the region. (Modified from Neumann DA: Kinesiology of the musculoskeletal system—foundations for physical rehabilitation, St Louis, 2002, Mosby, p 276.)

spinous processes are at the level of the facet joints of the same vertebra. Generally, the spinous process is considered to be absent or at least rudimentary on C1. This is why the first palpable vertebra descending from the external occiput protuberance is the spinous process of C2.

Although there are seven cervical vertebrae, there are eight **cervical nerve roots.** This difference occurs because there is a nerve root exiting between the occiput and C1 that is designated the C1 nerve root. In the cervical spine, each nerve root is named for the vertebra below it. As an example, C5 nerve root exists between the C4 and C5 vertebrae (Fig. 3.8). In the rest of the spine, each nerve root is named for the vertebra above; the L4 nerve root, for example, exists between the L4 and L5 vertebrae. The switch in naming of the nerve roots from the one below to the one above is made between the C7 and T1 vertebrae. The nerve root between these two vertebrae is called C8, accounting for the fact that there are eight cervical nerve roots and only seven cervical vertebrae.

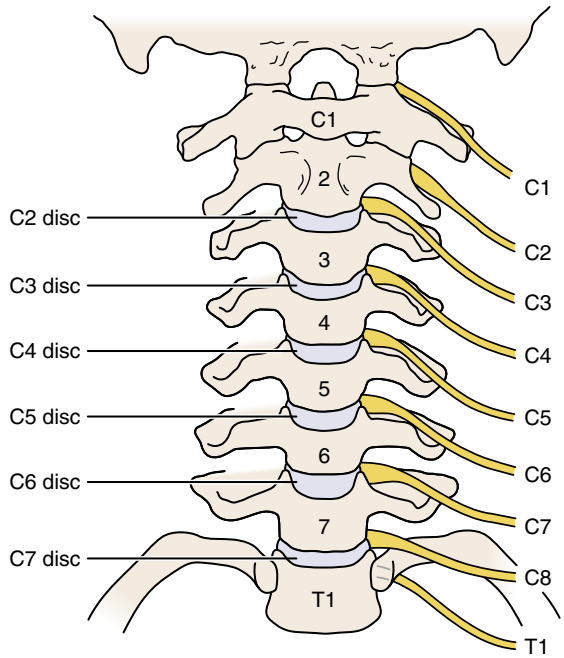

Fig. 3.8 Anterior view of cervical spine showing nerve roots. Note how each cervical nerve root is numbered for the vertebra below it.

Patient History

In addition to the questions listed under Patient History in Chapter 1, the examiner should obtain the following information from the patient:

1. *What is the patient's age?* Spondylosis (also called *spondylosis deformans*) is often seen in persons 25 years of age or older, and it is present in 60% of those older than 45 years and 85% of those older than 65 years of age.[31,32] It is a generalized disease of aging initiated by intervertebral disc degeneration. Symptoms of osteoarthritis do not usually appear until a person is 60 years of age or older (Table 3.1).
2. *What are the signs and symptoms, and which are most severe?* Table 3.2 outlines many of the signs and symptoms that may arise from cervical spine pathology.[33] Where are the symptoms most severe—in the neck, the shoulder, above or below the elbow, in the hands, and/or fingers?[34] Location of the symptoms may help determine what level of the cervical spine is involved (e.g., tingling in the middle finger may indicate a problem at C6 to C7). Are the symptoms constant, intermittent, or variable?[34] The Bone and Joint Decade 2000–10 Task Force on Neck Pain and its Associated Disorders recommended that neck pain sufferers be divided into four groups (Table 3.3).[35]

   Watkins[36] provided a severity scale for neurological injury in football that can be used as a guideline for injury severity involving the cervical spine, especially if one is contemplating allowing the patient to return to activity (Fig. 3.9). A combined score (A + B) of

TABLE 3.1

Differential Diagnosis of Cervical Spondylosis, Spinal Stenosis, and Disc Herniation

	Cervical Spondylosis	Cervical Spinal Stenosis	Cervical Disc Herniation[a]
Pain	Unilateral	May be unilateral or bilateral	May be unilateral (most common) or bilateral
Distribution of pain	Into affected dermatomes	Usually several dermatomes affected	Into affected dermatomes
Pain on extension	Increases	Increases	May increase (most common)
Pain on flexion	Decreases	Decreases	May increase or decrease[b] (most common)
Pain relieved by rest	No	Yes	No
Age group affected	60% of those older than 45 years 85% of those older than 65 years	11–70 years Most common: 30–60 years	17–60 years
Instability	Possible	No	No
Levels commonly affected	C5–C6, C6–C7	Varies	C5–C6
Onset	Slow	Slow (may be combined with spondylosis or disc herniation)	Sudden
Diagnostic imaging	Diagnostic	Diagnostic	Diagnostic (be sure clinical signs support)

[a]Posterolateral protrusion.
[b]Depends on the direction of the herniation.

TABLE 3.2

Signs and Symptoms Arising From Cervical Spine Pathology

Signs	Symptoms
• Anesthesia (lack of sensation) • Asymmetry • Ataxia • Atrophy • Drop attack • Dysesthesia (abnormal sensation) • Falling • Fasciculation • Hyperesthesia (increased sensitivity) • Nystagmus • Pathologic gait • Reflex changes • Spastic gait • Sweating or lack of sweating • Tender bones • Tender muscles • Tender scalp • Transient loss of hearing, consciousness, sight • Upper extremity weakness	• Arm and leg pain and ache • Auditory disturbance • Cough • Depressed mood • Diarrhea • Diplopia • Dizziness • Fatigue • Gait disturbance • Headache • Insomnia • Muscle twitch • Nausea • Pain • Paresthesia • Poor balance • Restless arms and legs • Sneeze • Speech disturbance • Stiff neck • Threatened faint • Tinnitus • Torticollis • Vertigo • Visual disturbance

Modified from Bland JH: *Disorders of the Cervical Spine*, Philadelphia, 1994, W.B. Saunders Co, p 161.

TABLE 3.3

Grading of Patients Suffering From Neck Pain

Grade	Clinical Presentation
1	No signs of major pathology Little or no interference with ADL
2	No signs of major pathology Interference with ADL
3	Pain with neurological signs of nerve compression (radiculopathy)
4	Signs of major pathology (e.g., instability, infection)

ADL, Activities of daily living.
Adapted from Guzman J, Haldeman S, Carroll LJ, et al: Clinical practice implications of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders: from concepts and findings to recommendations, *J Manipulative Physiol Ther* 32(2 Suppl):235, 2009.

4 is considered a mild episode, 4 to 7 is a moderate episode, and 8 to 10 is a severe episode. This scale can be combined with radiologic information on canal size (score C) to give a general determination of the possibility of symptoms returning if the patient returns to activity. In this case, a score of 6 (A + B + C) indicates minimum risk, 6 to 10 is moderate risk, and 10 to 15 is severe risk. Watkins[36] also points out that extenuating factors (such as age of patient, level of activity, and risk versus benefit) also play a role and, although not included in the score, must be considered. Table 3.4

Watkins' Severity Scale for Neurological Deficit

Grade	Neurological Deficit
1	Unilateral arm numbness or dysesthesia; loss of strength
2	Bilateral upper extremity loss of motor and sensory function
3	Ipsilateral arm, leg, and trunk loss of motor and sensory function
4	Transient quadriparesis (temporary sensory loss in all 4 limbs)
5	Transient quadriplegia (temporary motor loss in all 4 limbs)
Score: (A)	

Grade	Time Symptoms Present
1	Less than 5 min
2	Less than 1 h
3	Less than 24 h
4	Less than 1 week
5	Greater than 1 week
Score: (B)	

Severity Score: A + B = _____
(≤4: mild episode; 4–7: moderate episode; 8–10. severe episode)

Grade	Central Canal Diameter
1	>12 mm
2	Between 10 and 12
3	10 mm
4	8–10 mm
5	<8 mm
Score: (C)	

Return to Activity Score: A + B + C = _____
(≤6: minimum risk; 6–10: moderate risk; 10–15: severe risk)

Fig. 3.9 Watkins Severity Scale for Neurologic Deficit. (Data from Watkins RG: Neck injuries in football. In Watkins RG, editor: *The spine in sports*, St. Louis, 1996, Mosby-Year Book, p 327.)

outlines some of the factors that increase the chances of recovery from neck pain. **Chronic post-whiplash syndrome** can lead to anxiety, pain catastrophizing (negative or heightened orientation toward pain), and other adverse psychosocial factors over time, and it can play a major role in the symptoms felt by the patient.[37] Table 3.5 outlines yellow flags related to fear-avoidance beliefs and possible long-term disability.

3. *What was the mechanism of injury?* Was trauma, stretching, or overuse involved? Was the patient moving when the injury occurred? Table 3.6 outlines warning signs and symptoms (red flags) of serious cervical spine disorders.[38] These questions help determine the type and severity of injury. For example, trauma may cause a whiplash-type (acceleration) injury or **whiplash-associated disorder (WAD)** (Table 3.7),[39] stretching may lead to "burners," overuse or sustained postures may result in thoracic outlet symptoms, and a report of an insidious onset in someone older than 55 years of age may indicate cervical spondylosis. Was the patient hit from the side, front, or behind? Did the patient see the accident coming?[40] "Burners" or "stingers" typically occur from a blow to part of the brachial plexus or from stretching or compression of the brachial plexus (Table 3.8; Fig. 3.10). **Backpack palsy (BPP)**[41] is sometimes reported from carrying a heavy backpack especially without waist support and the symptoms, commonly bilateral, are related to the brachial plexus (i.e., paresis, numbness, paresthesia, and painless motor weakness in the shoulder girdle and elbow flexor muscles). The answers to these questions help the examiner determine how the injury occurred, the tissues injured, and the severity of the injuries.
4. *Has the patient had neck pain before?* Table 3.9 outlines factors that decrease chances of a new

TABLE **3.4**

Factors That Increase Chances of Recovery From an Episode of Neck Pain

Scenario and Grade of Neck Pain	Likely Increase	Might Increase	No Effect	Not Enough Evidence to Make Determination
General population	Younger age, no previous neck pain, good physical and psychological health, good coping, good social support	Being employed	—	Gender, general exercise or fitness prior to pain episode, cervical disc changes
At work	Exercise and sports, no prior pain or prior sick leave	Changing jobs (for certain job types), white collar job, greater influence over work	Age, ergonomics/physical job demands, work-related psychosocial factors (but many such factors not studied)	Gender, compensation, litigation, obesity, smoking, cervical disc changes
After a traffic collision	No prior pain or sick leave, fewer initial symptoms, less symptom severity, Grade I WAD, good psychological health (e.g., not coping passively, no fear of movement, no post-injury anxiety), no early "overtreatment"	No prior pain problems, good prior health, non-tort insurance, no lawyer involvement, lower collision speed	Collision-specific factors (such as head position when struck, position in vehicle, direction of collision)	Age, gender, culture, prior physical fitness, cervical disc changes

WAD, Whiplash-associated disorder.
From Guzman J, Haldeman S, Carroll LJ, et al: Clinical practice implications of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and its Associated Disorders: from concepts and findings to recommendations, *J Manipulative Physiol Ther* 32(2 Suppl):234, 2009.

episode of neck pain.[35] In chronic cases of pain or headache, a **pain diary** may be useful to help determine pain patterns or factors that trigger the pain or headaches.

5. *What is the patient's usual activity or pastime?* Do any particular activities or postures bother the patient? What type of work does the patient do? Are there any positions that the patient holds for long periods (e.g., when sewing, typing, or working at a desk)? Does the patient wear glasses? If so, are they bifocals or trifocals? Upper cervical symptoms may result from excessive nodding as the patient tries to focus through the correct part of the glasses. Cervicothoracic (lower cervical/upper thoracic spine) joint problems are often painful when activities that require push-and-pull motion (such as lawn mowing, sawing, and cleaning windows) are performed. What movements bother the patient? For example, extension can aggravate symptoms in patients with radicular signs and symptoms.[42]
6. *Did the head strike anything, or did the patient lose consciousness?* If the injury was caused by a motor vehicle accident, it is important to know whether the patient was wearing a seat belt, the type of seat belt (lap or shoulder), and whether the patient saw the accident coming. These questions give some idea of the severity and mechanisms of injury. If the patient was unconscious or unsteady, the character of each episode of altered consciousness should be noted (see Chapter 2).
7. *Did the symptoms come on right away?* Bone pain usually occurs immediately, but muscle or ligamentous pain can either come on immediately (e.g., a tear) or occur several hours or days later (e.g., stretching caused by a motor vehicle accident). Seventy percent of whiplash patients reported immediate symptom occurrence while the rest reported delayed symptoms.[33,43–47] How long have the symptoms been present? Myofascial pain syndromes demonstrate generalized aching and at least three trigger points, which have lasted for at least 3 months with no history of trauma.[48]
8. *What are the sites and boundaries of the pain?* Have the patient point to the location or locations of the pain. Symptoms do not go down the arm for a C4 nerve root injury or for nerve roots above that level. For example, C2 and C3 nerve roots go to the lateral neck while C4 and C5 nerve roots go to the lateral neck and shoulders. **Cervical radiculopathy,** or injury to the nerve roots in the cervical spine, presents primarily with unilateral motor and sensory symptoms into the upper limb, with muscle weakness (myotome), sensory alteration (dermatome), reflex hypoactivity, and sometimes focal activity being the primary signs.[49–52] Acute

TABLE 3.5

Clinical Yellow Flags Indicating Heightened Fear-Avoidance Beliefs and Risk of Patient Developing Long-Term Disability

Attitudes and Beliefs	Behaviors
• Belief that pain is harmful or disabling, resulting in guarding and fear of movement • Belief that all pain must be abolished before returning to activity • Expectation of increased pain with activity or work, lack of ability to predict capabilities • Catastrophizing, expecting the worst • Belief that pain is uncontrollable • Passive attitude to rehabilitation	• Use of extended rest • Reduced activity level with significant withdrawal from daily activities • Avoidance of normal activity and progressive substitution of lifestyle away from productive activity • Reports of extremely high pain intensity • Excessive reliance on aids (braces, crutches, and so on) • Sleep quality reduced following the onset of back pain • High intake of alcohol or other substances with an increase since the onset of back pain • Smoking

From Childs JD, Fritz JM, Piva SR, et al: Proposal of a classification system for patients with neck pain, *J Orthop Sports Phys Ther* 34:686–700, 2004. Data from Kendall, et al: *Guide to assessing psychosocial yellow flags in acute low back pain: risk factors for long-term disability and work loss*, Wellington, New Zealand, 2002, Accident Rehabilitation and Compensation Insurance Corporation of New Zealand and the National Health Committee.

radiculopathies are commonly associated with disc herniations, whereas chronic types are more related to spondylosis.[50] Disc herniations in the cervical spine commonly cause severe neck pain that may radiate into the shoulder, scapula, and/or arm; limit ROM; and cause an increase in pain on coughing, sneezing, jarring, or straining.[47] Using discography, it has been demonstrated that disc injury in the cervical spine can refer pain to the thoracic spine, especially along the medial scapular border.[53] C3–C4 disc referral of pain is to the cervicothoracic junction and ipsilateral upper trapezius, C4–C5 is to the superomedial border of the scapula, C5–C6 to mid-scapular area, and C6–C7 to lower scapular area and along the medial scapular border. **Cervical myelopathy,** or injury to the spinal cord itself, is more likely to present with spastic weakness, paresthesia, and possible incoordination in one or both lower limbs, as well as proprioceptive and/or sphincter dysfunction (Tables 3.10 and 3.11).[54] With cervical myelopathy, hand symptoms may be evident early. This **myelopathic hand** results in weakness then loss of adduction and extension of the ulnar two or three fingers (**finger escape sign** or **Wartenberg sign**—difficulty with little finger adduction) and the patient has an inability to grip and release (**grip and release test**) these fingers rapidly.[55] To do the test, the patient is asked to

TABLE 3.6

Warning Signs and Symptoms of Serious Cervical Spine Disorders (Red Flags), Some of Which Will Necessitate Immediate Imaging Studies

Potential Cause	Clinical Characteristics
Fracture	Clinically relevant trauma in adolescent or adult Minor trauma in elderly patient Ankylosing spondylitis Follow Canadian C-Spine Rules
Neoplasm (cancer)	Pain worse at night Unexplained weight loss History of neoplasm Age of more than 50 or less than 20 years Previous history of cancer Constant pain, no relief with bed rest
Infection	Fever, chills, night sweats Unexplained weight loss History of recent systemic infection Recent invasive procedure Immunosuppression Intravenous drug use
Neurologic injury	Progressive neurologic deficit Upper- and lower-extremity symptoms Bowel or bladder dysfunction
Cervical myelopathy	Muscle wasting of hand intrinsic muscles Sensory disturbance in the hands Unsteady gait Hoffman's reflex present Hyperreflexia Bowel and bladder disturbances Multisegmental weakness and/or sensory changes Clonus (a series of involuntary, rhythmic muscle contractions) Inverted supinator sign
Upper cervical ligamentous instability	Occipital headache and numbness Severe limitation during neck active ROM in all directions Signs of cervical myelopathy Post trauma Rheumatoid arthritis Down syndrome
Vertebral artery insufficiency	Drop attacks Dizziness or light-headedness related to neck movement Dysphasia (difficulty swallowing) Dysarthria (difficulty speaking) Diplopia (double vision) Positive cranial nerve signs Ataxia (lack of muscle coordination) Nausea
Inflammatory or systemic disease	Temperature more than 37°C (98.6°F) Blood pressure more than 160/95 mm Hg Resting pulse more than 100 bpm Resting respiration more than 25 bpm Fatigue

ROM, Range of motion.
Modified from Rao RD, Currier BL, Albert TJ, et al: Degenerative cervical spondylosis: clinical syndromes, pathogenesis, and management, *J Bone Joint Surg Am* 89(6):1360–1378, 2007; Childs JD, Fritz JM, Piva SR, et al: Proposal of a classification system for patients with neck pain, *J Orthop Sports Phys Ther* 34:688, 2004.

TABLE 3.7

The Quebec Severity Classification of Whiplash-Associated Disorders

Grade	Clinical Presentation
0	No neck symptoms, no physical sign(s)
1	No physical sign(s); neck pain; stiffness or tenderness only; neck complaints predominate; normal ROM; normal reflexes, dermatomes, and myotomes
2	Neck symptoms (pain, stiffness) and musculoskeletal sign(s), such as decreased ROM and point tenderness; soft-tissue complaints (pain, stiffness) into shoulders and back; normal reflexes, dermatomes, and myotomes
3	Neck symptoms (pain, stiffness, restricted ROM) and neurological sign(s), such as decreased or absence of deep tendon reflexes, weakness (positive myotomes), and sensory (positive dermatome) deficits; x-ray shows no fracture; CT/MRI may show nerve involvement; possible disc lesion
4	Neck symptoms (pain, stiffness, restricted ROM) with fracture or dislocation and objective neurological signs, possible spinal cord signs

CT, Computed tomography; *MRI,* magnetic resonance imaging; *ROM,* range of motion.
Modified from Spitzer WO, Skovron ML, Salmi LR, et al: Scientific monograph of the Quebec Task Force on Whiplash-Associated Disorders: redefining "whiplash" and its management, *Spine* 20(8 Suppl):8S–58S, 1995.

grip and release for 10 seconds. Normally, 20 or more repetitions are possible.

9. *Is there any radiation of pain?* It is helpful to correlate this answer with dermatome and sensory peripheral nerve findings when performing sensation testing and palpation later in the examination. Is the pain deep, superficial, shooting, burning, or aching? For example, when an athlete experiences a "burner," the sensation is a lightning-like, burning pain into the shoulder and arm, followed by a period of heaviness or loss of function in the arm. Fig. 3.11 shows the radiation of pain with facet (apophyseal) joint pathology.[56,57]
10. *Is the pain affected by laughing, coughing, sneezing, or straining?* If so, an increase in intrathoracic or intra-abdominal pressure may be contributing to the problem.
11. *Does the patient have any headaches? If so, where? How frequently do they occur?* Cervicogenic headaches occur as a symptom of musculoskeletal dysfunction in the cervical spine, especially C1, C2, and C3.[58–61] Table 3.12 outlines the clinical criteria for a cervicogenic headache.[58] If the patient complains of a headache, the examiner should record the headache history, its temporal pattern, symptoms behavior, and medication intake to ensure the headache is benign and can be classified.[62] For example, do they occur every day, two times per day, two days per week, or one day per month?[63] How intense are they? How long do they last? Are they affected by medication and, if so, by how much medication, and

TABLE 3.8

Differential Diagnosis of Cervical Nerve Root and Brachial Plexus Lesion

	Cervical Nerve Root Lesion	Brachial Plexus Lesion
Cause	Disc herniation Stenosis Osteophytes Swelling with trauma Spondylosis	Stretching of cervical spine Compression of cervical spine Depression of shoulder
Contributing factors	Congenital defects	Thoracic outlet syndrome
Pain	Sharp, burning in affected dermatomes	Sharp, burning in all or most of arm dermatomes, pain in trapezius
Paresthesia	Numbness, pins and needles in affected dermatomes	Numbness, pins and needles in all or most arm dermatomes (more ambiguous distribution)
Tenderness	Over affected area of posterior cervical spine	Over affected area of brachial plexus or lateral to cervical spine
Range of motion	Decreased	Decreased but usually returns rather quickly
Weakness	Transient paralysis usually Myotome may be affected	Transient muscle weakness Myotomes affected
Deep tendon reflexes	Affected nerve root may be depressed	May be depressed
Provocative test	Side flexion, rotation, and extension with compression increase symptoms Cervical traction decreases symptoms Upper limb tension tests positive	Side flexion with compression (same side) or stretch (opposite side) may increase symptoms Upper limb tension tests may be positive

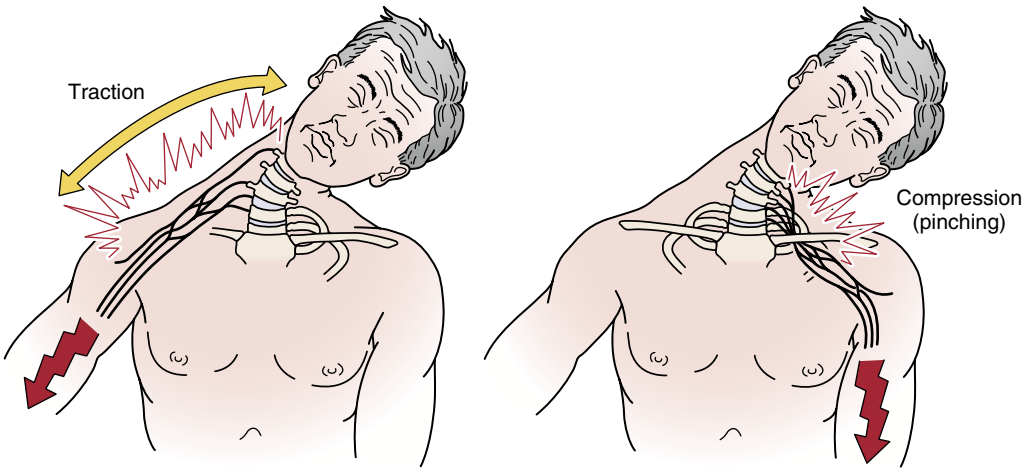

Fig. 3.10 Mechanism of injury for brachial plexus (burner or stinger) pathology.

TABLE **3.9**

Factors That Decrease Chances of Getting a New Episode of Neck Pain

Scenario and Grade of Neck Pain	Likely Decrease	Might Decrease	No Effect	Not Enough Evidence to Make Determination
General population	No previous neck pain, no other musculoskeletal problems, good psychological health	Younger age, male gender, non-smoking, changing rules in sports (like in ice hockey)	Obesity	Weight of school bags, cervical disc changes (on imaging)
At work	Younger age (peak risk in fourth and fifth decades), male gender, no previous pain in the neck, back or upper limbs, little psychological job strain, good coworker support, active work (nonsedentary), less repetitive or precision work	Not being an immigrant or a visible minority, higher strength or endurance of the neck, not working with the neck bent for prolonged periods, non-smoking, no previous headaches, good physical health, "non-type A" personality, not working in awkward positions, light physical work, adequate keyboard position, no awkward head, elbow and shoulder posture, no screen glare	Physical or sports activity during leisure, sleep quality, time spent on domestic activities, time spent on hobbies	Marital status, education, occupational class duration of employment, obesity, self-assessed health status, mental stress, job satisfaction, working with hands above the shoulder level, height of computer screen, cervical disc changes
After a traffic collision	—	Male gender, no previous neck pain, riding in back seat, side collision, no compensation for pain and suffering, specially engineered car seats and headrests	Tow bars in the car, age, type of child seat restraint	Awareness of collision, head position at time of collision, severity of collision impact, cervical disc changes (on imaging)

From Guzman J, Haldeman S, Carroll LJ, et al: Clinical practice implications of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders: from concepts and finding to recommendations, *J Manipulative Physiol Ther* 32(2 Suppl):233, 2009.

what kind? Are there any precipitating factors (e.g., food, stress, posture)? See Tables 2.15–2.17, which indicate the influence of time of day, body position, headache location, and type of pain on diagnosis of the type of headache that the patient may have. Table 2.18 outlines the salient features of some of the more common headaches. Craniovertebral joint dysfunction commonly is accompanied by headaches. For example, C1 headaches occur at the base and top of the head, whereas C2 headaches are referred to the temporal area. **Cervical arterial dissection**, although rare, may result in neck pain and

TABLE **3.10**

Signs and Symptoms in Cervical Myelopathy

Motor Changes	Sensory Changes
Initial Symptoms (Predominantly Lower Limbs) • Spastic paraparesis • Stiffness and heaviness, scuffing of the toe, difficulty climbing stairs • Weakness, spasms, cramps, easy fatigability • Decreased power, especially of flexors (dorsiflexors of ankles and toes; flexors of hips) • Hyperreflexia of knee and ankle jerks, with clonus • Positive Babinski sign, extensor hypertonia • Decreased or absent superficial abdominal and cremasteric reflexes • Drop foot, crural monoplegia ***Later Symptoms (In Order of Occurrence)*** • Various combinations of upper and lower limb involvement • Mixed picture of upper and lower motoneuron dysfunction • Atrophy, weakness, hypotonia, hyperreflexia to hyporeflexia, and absent deep tendon reflexes	• Headache and head pain • Neck, eye, ear, throat, or sinus pain • Sensory symptoms in the pharynx and larynx • Paroxysmal hoarseness and aphonia • Rotary vertigo • Tinnitus synchronous with pulse or continuous whistling noises • Deafness • Oculovisual changes (e.g., blurring, photophobia, scintillating scotomata, diplopia, homonymous hemianopsia, and nystagmus) • Autonomic disturbance (e.g., sweating, flushing, rhinorrhea, salivation, lacrimation, nausea, and vomiting) • Weakness in one or both legs, drop attacks with or without loss of consciousness • Numbness on one or both sides of the body • Dysphagia or dysarthria • Myoclonic jerks • Hiccups • Respiratory changes (e.g., Cheyne-Stokes respiration, Biot respiration, or ataxic respiration)

Modified from Bland JH: *Disorders of the cervical spine*, Philadelphia, 1994, W.B. Saunders, pp 215–216.

a migraine-like headache.[20] Dissection of a cervical artery (i.e., vertebral or internal carotid artery [Fig. 3.12]) usually results in "unusual" acute moderate to severe neck pain that is different from anything previously experienced. This may be followed by a **transient ischemic attack (TIA)** or stroke.[20] Vertebral artery dissection signs and symptoms include balance disturbances, ataxia (i.e., slurred speech, stumbling, falling [like being drunk]), syncope (i.e., fainting), drop attacks, dysphagia (i.e., difficulty swallowing), dysarthria (i.e., difficulty speaking), and visual defects (i.e., blurred vision) (Table 3.13).[20,64] Many of these patients have transient neurological signs and symptoms days or weeks prior to dissection.[20] Internal carotid artery dissection presents with unilateral frontal or retro-orbital pain as well as constriction of the pupil (i.e., miosis) or facial palsy.[20]

If the headache is a major complaint especially following trauma, then the examiner should take a blood pressure measurement, assess the mental state of the patient as is done with a concussion (see Chapter 2 SCAT5), and assess the cranial nerves (see Table 2.1).[65]

12. *Does a position change alter the headache or pain?* If so, which positions increase or decrease the pain? The patient may state that the pain and referred symptoms are decreased or relieved by placing the hand or arm of the affected side on top of the head. This is called **Bakody sign,** and it is usually indicative of problems in the C4 or C5 area.[66,67]
13. *Is paresthesia (a "pins and needles" feeling) present?* This sensation occurs if pressure is applied to the nerve root. It may become evident if pressure is relieved from a nerve trunk. Numbness and/or paresthesia in the hands or legs and deteriorating hand function all may relate to cervical myelopathy (see Table 3.10).
14. *Does the patient experience any tingling in the extremities?* Are the symptoms bilateral? Bilateral symptoms usually indicate either systemic disorders (e.g., diabetes, alcohol abuse) that are causing neuropathies or central space–occupying lesions.
15. *Are there any risk factors present?* For example, hypertension can be a risk factor for carotid and vertebral artery disease.[68] Instability due to problems with the craniovertebral ligaments could compromise neurological and vascular tissues in the upper cervical spine.[68] Other risk factors related to vertebrobasilar insufficiency include cardiovascular disease, TIA, blood clotting disorders, anticoagulant therapy, oral contraceptives, smoking, long-term use of steroids, and past history of trauma to the neck.
16. *Are there any lower-limb symptoms?* This finding may indicate a severe problem affecting the spinal cord (myelopathy; see Table 3.10). These symptoms may include numbness, paresthesia, stumbling, difficulty walking, and lack of balance or agility. All of these symptoms could indicate cervical myelopathy. Likewise, signs of sphincter (bowel or bladder) or sexual dysfunction may be related to cervical myelopathy.