# Joint Function

Joint function in the cervical spine is quite complex because there are distinct units in this region of the spine, each with unique anatomical and therefore biomechanical and functional characteristics. Understanding a joint's anatomy and biomechanics is quite helpful in understanding the joint's function.

## Atlantooccipital Joint

The atlantooccipital joint is the most proximal joint in the cervical spine. In this section, we describe the joint axes of motion, arthrokinematics of the joint, range of motion, closed and loose packed positions, end feel, and capsular patterns of this most proximal cervical spine joint.

### *Axes of Motion*

Flexion and extension occur in the sagittal plane around a mediolateral axis. Axial rotation takes place in the transverse plane around a vertical axis, and side bending takes place in the frontal plane around an anteroposterior axis.

### *Arthrokinematics*

The deep atlantal sockets of the atlas (concave articulating joint surfaces) (see figure 6.4) facilitate flexion–extension (or nodding) movements but impede other motions (Bogduk & Mercer 2000). The nodding motion during flexion of the head is a result of rolling and gliding of the occipital condyles in their sockets (figure 6.13*a*). As the head nods forward, the occipital condyles roll forward, rolling up the anterior wall of the atlantal socket. This results in a compression loading of the mass of the head in the socket. The flexor musculature, the tension in the joint capsule, or both, causes the occipital condyles to concomitantly translate downward and backward (Bogduk & Mercer 2000). Therefore, forward nodding of the head (or anterior rotation of the occipital condyles) is coupled with downward and posterior gliding of the condyles. The occipital condyles essentially stay settled in the floor of the atlantal sockets, ensuring maximum stability of the head on the neck. During extension of the head on the atlas, the converse occurs (figure 6.13*b*).

The concept of coupled motion, or coupling, has been defined as "a phenomenon of consistent association of one motion (translation or rotation) about an axis with another motion about a second axis" (Blauvelt & Nelson 1994). In essence, one motion cannot be produced without the other. In many schools of thought, examination and treatment of the spine are thought to be based on this very concept. Biomechanical descriptions of spinal movement also follow this concept.

Recently, the concept of coupling has come under some scrutiny. Although the understanding of biomechanical movement of the spine is commonly accepted, inconsistencies in recent literature reviews (Cook 2003; Legaspi & Edmond 2007) have led to the suggestion of using caution when applying the concepts of coupled motion to the evaluation and treatment of patients with pain in the low back or lumbar spine (Legaspi & Edmond 2007). This text describes the coupling patterns as initially described by the literature and suggests the reader independently investigate this concept.

**KEY POINT**

**The concept of coupled motion, or coupling, describes the fact that one motion of the spine cannot be produced without the other. Coupling involves consistent association of one motion (translation or rotation) about an axis with another motion about a second axis. Although the understanding of biomechanical movement of the spine is commonly accepted, sufficient literature has suggested that clinicians utilize caution in universal adoption of this concept.**

The normal coupling pattern of the AO joint appears to vary. Although it is generally accepted that rotation and side bending at this joint occur to opposite sides when they are combined, current literature does not support these defined coupled patterns (Mercer 2004). Occipital rotation and, to some degree,

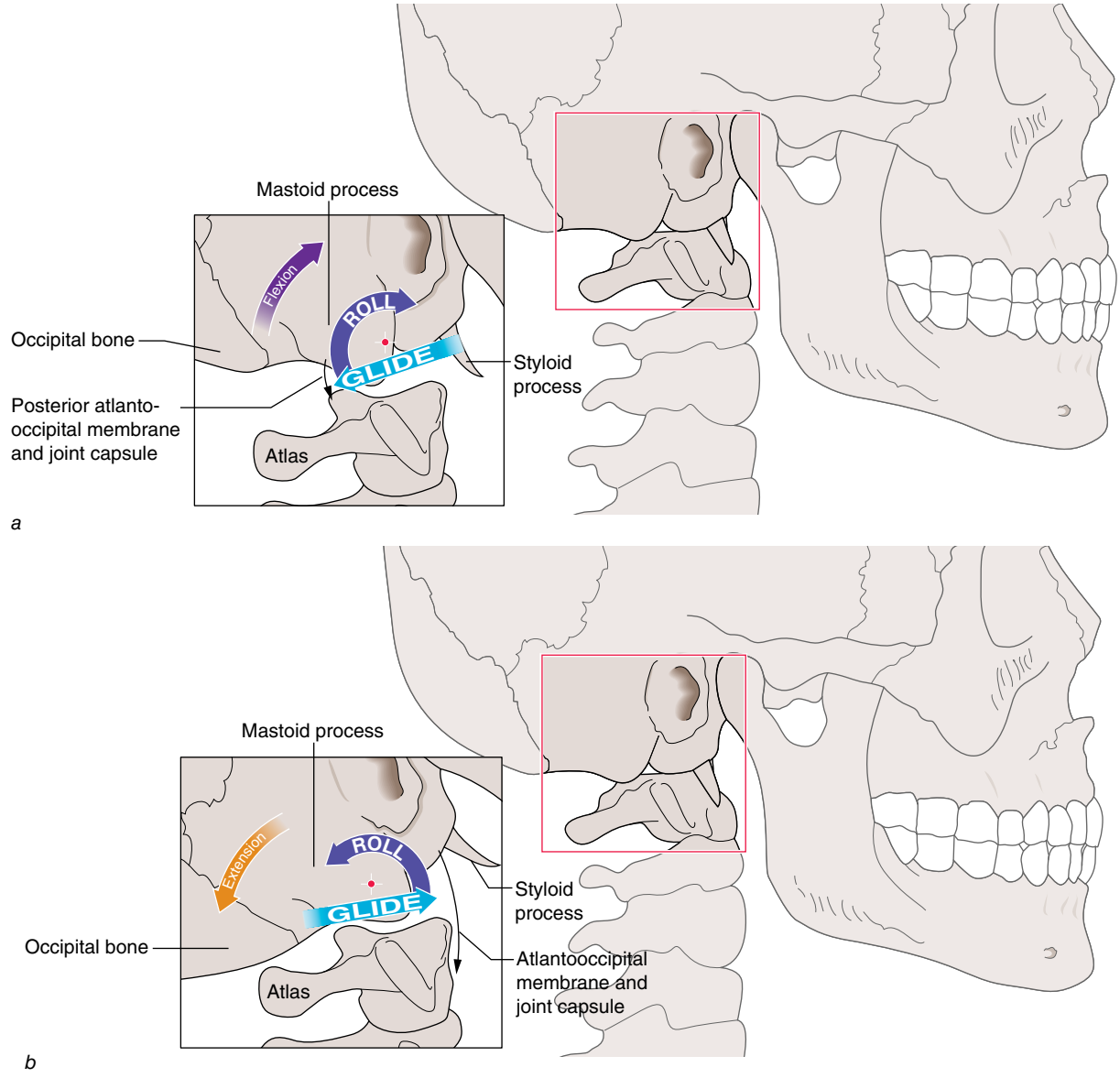


**FIGURE 6.13** Kinematics of craniocervical *(a)* flexion and *(b)* extension at the atlantooccipital joint.

anteroposterior translation of the occiput on C1 are limited by the alar ligaments (O'Brien & Lenke 1997).

There is controversy regarding lateral flexion and rotation of the AO joint. Although, as just pointed out, some believe that coupling is inconclusive (Van Roy et al. 1997), Steindler (1955) describes lateral tilt as being associated with a contralateral rotation at this joint. Jirout (1973) contends that lateral flexion of the AO joint occurs together with rotation of the atlantoaxial (AA) joint. Still others (Penning 1978; Panjabi et al. 1993; Panjabi & Crisco et al. 2001) propose that it depends on which motion occurs first, side bending or rotation. Each of the authors, through three-dimensional in vitro analyses, determined axial rotation was coupled to the ipsilateral side of side bending when side bending was initiated first, while axial rotation was coupled to the contralateral side of side bending when rotation was the initial movement (Penning 1978; Panjabi et al. 1993; Panjabi & Crisco et al. 2001).