CINERADIOGRAPHIC STUDIES OF THE COLLAR-IMMOBILIZED CERVICAL SPINE*

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The various movements of the normal cervical spine studied by static films, supplemented by cineradiography, have been described previously.\(^2,3\) Controlled motions and positions of the body, and the participation of various cervical segments in flexion and extension related to the method of initiating these motions have also been described.\(^2\)

With the head held in a semiextended position while flexing the neck, flexion occurs first in the lower cervical segment but when the head is flexed, flexion occurs first in the upper cervical segment. When the neck is extended while the head is in flexed position, the lower cervical segments show initial extension, whereas extension occurs first in the upper spine if the initial motion is extension of the head (Fig. 1).

![Fig. 1](image_url)

Fig. 1. Female, aged 27 years, 6 weeks after cervical sprain. Without collar. (A) Range of motion in extension. (B) Cervical spine and head in neutral position. (C) Range of flexion potential elicited by first flexing the head and then the neck. Sharp reversal of lordosis in mid-cervical region.

In flexion, the intervertebral discs are compressed anteriorly and expand posteriorly. The reverse occurs in extension. Anterior gliding of the vertebral bodies on one another—the translatory motion—occurs during flexion, while posterior gliding occurs during extension. The zygapophyseal joints show a similar gliding motion. At the end of full extension, widening of the superior portions of the joints occurs. This represents the expansion-com-

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pression potential of the zygapophysial joints. Rotary motion of the cervical area comprises two actions: rotation of the head and rotation of the neck (or lower cervical spine). In rotation of the head, most action occurs in the upper cervical segments. The expected concomitant motion of the discs and zygapophysial joints can be observed by voluntarily limiting rotation of the head while rotating the neck, the latter motion consisting of side-to-side bending and flexion and extension.

MATERIAL

In this study, 11 patients wore cervical collars of plastic, leather, or felt-stockinette. Two additional patients wore chin-occiput braces; 1 of these had had fusion of the lower 3 cervical segments for anterior subluxation of the 7th cervical on the 1st thoracic vertebra. All patients, except the one with fusion, were studied with and without the collar by standard views of flexion and extension. One patient, involved in a rear-end collision and treated by traction and plastic collar, was studied both without the collar and with three different heights of the anterior portion of the collar.

OBSERVATION

Motion of the cervical segments was related to the effect of various supporting devices. The collars only slightly limited rotation of the high cervical spine. The chin-occiput braces restricted, but did not prevent, rotation. Application of the collar produced a varying restriction of flexion and extension between the 2nd and 3rd, and the 3rd and 4th cervical vertebrae, depending on the initiating motion. In general, flexion of the middle and lower cervical segments was less restricted with the neck supported by collar than by a chin-occiput brace. Slight limitation of motion of this area occurred in individuals wearing felt-stockinette collars when the action of flexion was instituted by flexing the head, or the collars were of sufficient height anteriorly to hold the head in a semiextended position. This restriction of total flexion was produced by the chin striking the collar (Fig. 2).

The collar reduced extreme extension but the amount of restriction depended on the initiating motion. Thus, the initiating motion of flexion of the head with concomitant extension of the neck allowed almost complete motion in the lower cervical segments, but the collar limited the extension primarily in the upper segments. If, however, the head was extended first, a general restriction of motion of the cervical spine was apparent with the upper cervical segments showing the least restriction.

To evaluate the effect of the height of the collar, one collar, fixed posteriorly at 2 inches, was adjusted to anterior heights of 3 1/2, 4 and 5 inches. As the collar was heightened, increased, but not uniform, limitation of motion resulted, i.e., the increasing height of the collar forced the head and high cervical area into semiextension. Thus, with flexion and extension, the restriction of motion appeared to be greater in the high cervical area but the mid and lower cervical segments showed good function (Fig. 3). With the