



## The Nuchal Lines as Anatomic Landmarks to Dissect the Muscles in the Far Lateral Approach

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■ **BACKGROUND:** A critical step in the far lateral approach (FLA) is exposure of the V3 segment of the vertebral artery, located deep in the suboccipital triangle (SOT). Safe exposure of the SOT is achieved by means of a plane-by-plane dissection, which carries the risk of devascularization. A suitable alternative is to lift a cutaneous muscle flap including the 3 first muscle planes and leave the deepest plane (SOT) attached to the skull base. To achieve this, it is necessary to have superficial anatomic landmarks to help identify the cleavage site. We describe the use of the nuchal lines as a safe, effective, and reproducible method to dissect the muscles to expose the SOT and vertebral artery.

■ **METHODS:** Eight adult cadaveric heads, fixed with formaldehyde and injected, were studied. On both sides, FLA was simulated by using the nuchal lines as anatomic landmarks to expose the SOT. This technique was later applied on 10 patients requiring FLA.

■ **RESULTS:** Anatomic dissections confirmed identification, by means of the nuchal lines, of a cleavage site, which made it possible to separate the deepest muscle plane from the rest of the flap. This technique was successfully applied in 10 patients undergoing FLA.

■ **CONCLUSIONS:** The nuchal lines allow dissection of muscles in 2 groups, one superficial and the other deep (SOT), which remains attached to the skull base. The V3 segment of the vertebral artery is easily exposed.

### INTRODUCTION

The far lateral approach (FLA) was designed to treat neoplastic, vascular, and inflammatory lesions located in the foramen magnum.<sup>1-3</sup> A crucial aspect of the FLA is adequate exposure of the vertebral artery (VA).<sup>4</sup> The V3 segment of the VA runs behind the articular facet of C1, between the transverse foramen of the atlas laterally and the dural entrance medially.<sup>5,6</sup> The V3 segment of the VA lies deep in the suboccipital triangle (SOT).<sup>7</sup> This triangle is formed by the rectus capitis posterior major muscle and the inferior oblique and superior oblique muscles, which belong to the deepest plane of the neck muscles.<sup>8</sup>

The neck muscles are organized into 4 planes.<sup>8</sup> Therefore, safe exposure of the SOT involves dissecting these muscles plane by plane.<sup>9</sup> However, a serious risk of applying this technique is devascularization of the skin and subcutaneous tissue, possibly resulting in skin necrosis. An alternative is to lift the skin flap and subcutaneous tissue with the first 3 muscle planes and leave the deepest plane attached to the skull base, achieving exposure of the SOT and VA.<sup>8,10</sup> To achieve this, it is necessary to have superficial anatomic landmarks to guide surgeons where to make the separation. The objective of the present study is to describe the use of the nuchal lines as a safe, efficient, and reproducible method to dissect the muscles and expose the SOT and VA.

### MATERIALS AND METHODS

Eight adult cadaveric heads, fixed with formaldehyde and injected with colored silicone, were studied. In both sides, an FLA was simulated with the patient in semisitting position, using the nuchal lines as anatomic landmarks to dissect the muscles and expose the SOT. Between 2005 and 2017, the

#### Key words

- Far lateral
- Foramen magnum
- Landmarks
- Nuchal lines
- Suboccipital triangle
- Vertebral artery

#### Abbreviations and Acronyms

- FLA:** Far lateral approach  
**INL:** Inferior nuchal line  
**SNL:** Superior nuchal line  
**SOT:** Suboccipital triangle  
**VA:** Vertebral artery

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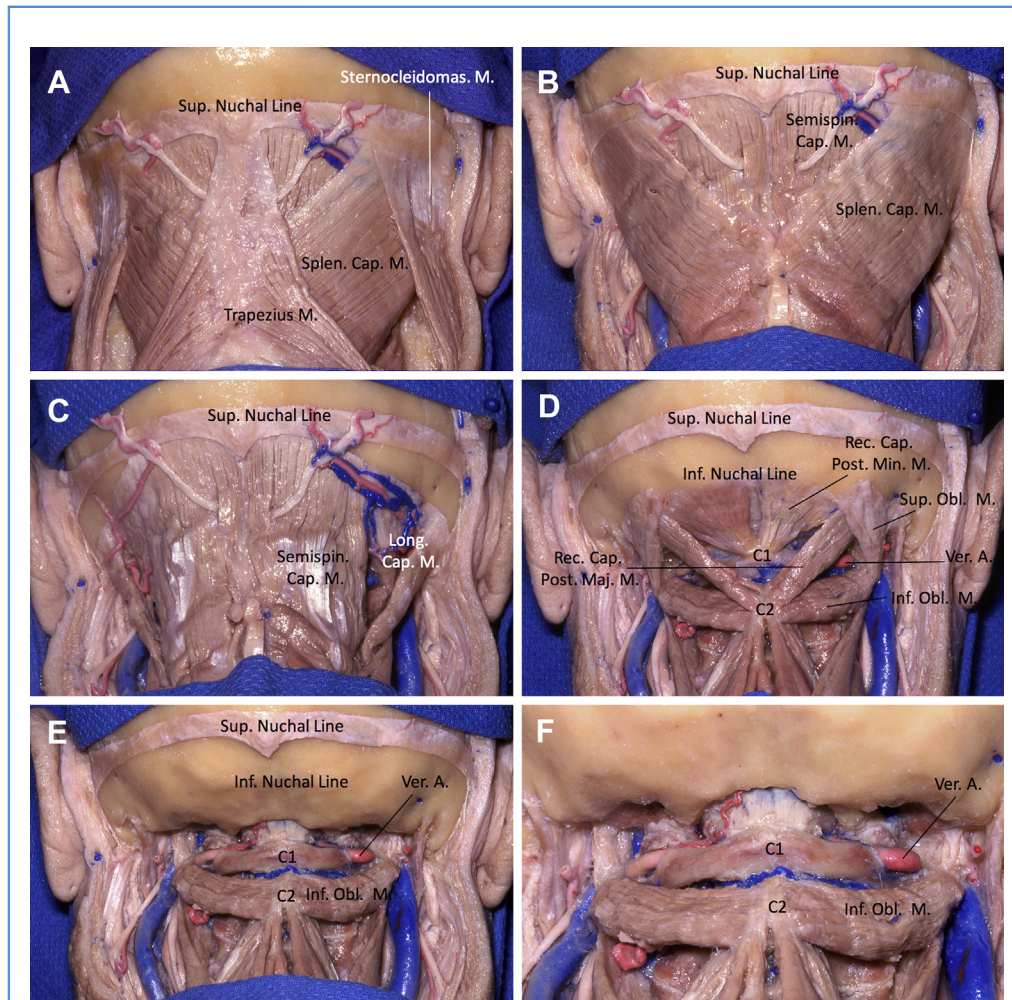
senior author (A.C.) used this technique to expose the SOT and VA in 10 patients diagnosed with foramen magnum meningiomas who required an FLA for resection.

**RESULTS**

**Anatomic Considerations**

**Nuchal Muscles.** There are 4 muscular planes in the nuchal region, which from surface to depth are 1) sternocleidomastoid and trapezius muscles; 2) splenius capitis muscle; 3) semispinalis capitis and longissimus capitis muscles; and 4) rectus capitis

posterior minor, rectus capitis posterior major, inferior oblique, and superior oblique muscles. The muscles forming the first 3 muscle planes have their upper main insertion at the level of the superior nuchal line (SNL), whereas the muscles in the deepest plane (rectus and obliques) have their main superior insertion at the level of the inferior nuchal line (INL). The rectus capitis posterior minor muscle inserts superiorly on the most medial part of the INL and below on the C1 spinous process. The rectus capitis posterior major muscle inserts superiorly on the medial part of the INL and inferiorly on the C2 spinous process. The superior oblique muscle inserts superiorly on the lateral part of the INL and inferiorly on the C1 transverse process. Finally, the inferior



**Figure 1.** Cadaveric stepwise dissection of the suboccipital region muscles. (A) The muscles of the first layer are trapezius and sternocleidomastoid; both have their main occipital insertion on the superior nuchal line. (B) The muscle of the second layer is the splenius capitis; its main occipital insertion is the superior nuchal line. (C) The muscles of the third layer are semispinalis capitis and longissimus capitis; both have their main occipital insertion on the superior nuchal line. (D) The muscles of the fourth layer are rectus capitis posterior minor, rectus capitis posterior major, superior oblique, and inferior oblique. The V3

segment of the vertebral artery, in the depth of the suboccipital triangle, was exposed. (E and F) The rectus and oblique muscles have been removed to expose the entire V3 segment of the vertebral artery, the posterior arch of C1, the occipitoatlantal junction, and the foramen magnum. Sternocleidomas., sternocleidomastoid; M., muscle; Sup., superior; Splen, splenius; Cap., capitis; Semispin., semispinalis; Long., longissimus; Rec., rectus; Post., posterior; Min., minor; Inf., inferior; Obl., oblique; Ver., vertebral; Maj., major; A., artery.

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