Journal of Neurology & Stroke

Review Article

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# Subaxial cervical fixation utilizing screws for lateral masses, a variation of the technique


## Abstract

The lateral mass screw fixation (LMSF) technique represents a biomechanically effective approach for addressing various subaxial cervical spine pathologies, including tumoral, degenerative, and traumatic conditions, among others. The most recognized and frequently employed techniques are those developed by Magerl, Anderson, An, and Roy Camille, distinguished primarily by their entry points, divergent directions, and the caudocephalic inclination with which the screws are oriented.

**Objective:** To delineate the alternative technique for the insertion of screws in subaxial cervical lateral masses, grounded in a comprehensive understanding of the anatomical configuration of the lateral masses.


Volume 14 Issue 5 - 2024


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**Received:** September 20, 2024 | **Published:** October 04, 2024

## Introduction

The indications for anterior and posterior cervical fixation have been extensively addressed in the literature, particularly regarding the conditions that warrant a posterior cervical approach and the potential complications involved. The insertion of screws into the subaxial cervical lateral masses is regarded as one of the most frequently employed methods, yielding optimal outcomes for achieving cervical spine stability.[1–4]

FTML is a prevalent surgical procedure utilizing the posterior cervical approach. Numerous modifications to the technique have been documented, with the primary distinctions among them being the entry point, angulation, and alterations in the exit point. We will begin with the three-dimensional image of the lateral masses as a starting point.[5] We regard these as irregular cylindrical structures, with the maximum length aligned in a cephalocaudal orientation (Figure 1). The width of the lateral masses exhibits a variable diameter. According to the study published by Woon et al.[6] the diameter ranges from 8.0 to 16.1 mm, significantly varying (Pen tode 03 from the model in 6 for men (12.8 mm) to women (10.5 mm). The width of the lateral mass demonstrated a limited correlation with the height of the volunteer (r = 0.446), weight (r = 0.472), and neck length (r = 0.232).

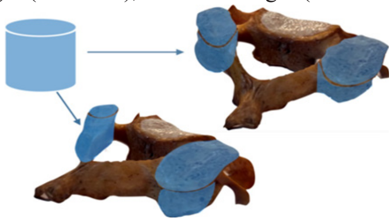

**Figure 1** It is essential to examine the anatomical relationships, as the nerve roots emerge just anterior to them (through the vertebral foramina), and the vertebral arteries, which run anterior to the nerve roots, remain near their point of emergence.

Currently, the following parameters are acknowledged as essential considerations: Anatomical Vertebro-Facet Distance (AVFD), defined as the shortest linear distance between the vertebral artery and the medial edge of the facet joint; Surgical Vertebro-Facet Distance (SVFD), which represents the shortest distance between a line tangent to the medial margin of the vertebral artery and another line tangent to the medial edge of the facet joint; and the Vertebro-Facet Angle (VFA), which is the angle formed between the AVFD and the SVFD (Figure 2).[7] Although the vertebral artery is situated near the lateral masses, the structure most frequently associated with injuries reported in various screw placement techniques within the lateral masses is the spinal root corresponding to the level being addressed.[8,9]

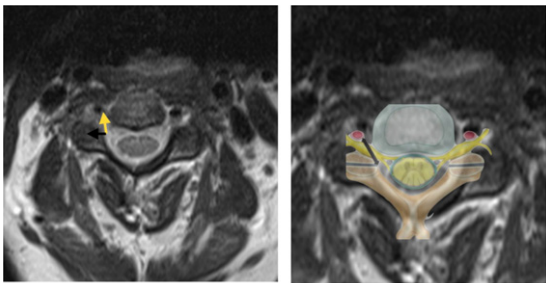

**Figure 2** In a study published by Sheth,[8] Brian[9] et al. it was reported that the mean AVFD exhibited differences between the levels of C5-6 (2.83±1.57 mm) and C6-7 (1.64±1.80 mm), with a significance of $p < 0.001$. The most substantial difference was observed between C5-6 (12.83±1.57 mm) and C6-7 (16.41± .86 mm). The artery was positioned closer to the lateral recess at the elevated levels.

The established techniques for screw placement in lateral masses were developed to prevent vascular or nerve injuries, as well as to mitigate the risk of fractures in the lateral masses themselves.[10] Straightforwardly, we can delineate the visible aspect of the lateral mass in the posterior cervical approach, beginning from its medial edge, which aligns with the cervical laminae. The upper and lower boundaries correspond to the edges that articulate with the lateral masses of the adjacent levels, while the lateral edge represents the most external aspect in the lateral direction. Once this delineation is established, we should envision two lines that bisect the lateral mass into two halves, both vertically and horizontally, converging at the center. This division results in the lateral mass being segmented into four quadrants. The existing techniques for screw placement in lateral masses share this foundational step.[11]

Among the primary techniques employed, we identify:

Figure 3

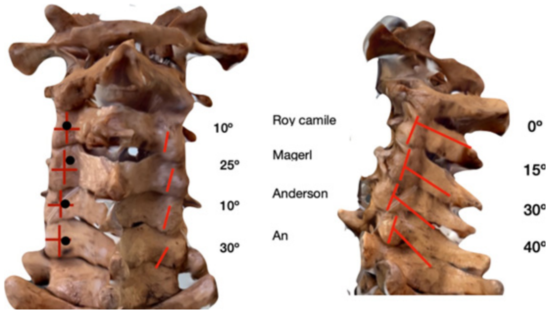


**Figure 3** Other points shared by both well-known techniques and lesser-known or studied ones include the necessity of planning entry and exit points, which should align with the caudocephalic angulation as well as divergence. The techniques of Roy Camile, Magerl, Anderson, and An differ in their entry points, caudocephalic direction, and divergence.

Numerous studies have been conducted to ascertain the most suitable technique. Considering the safety of the trajectory (the potential risk of damaging nervous or vascular structures), as well as the screw's path about the bone structure, it is essential to identify the most effective techniques based on the aforementioned characteristic.[12–14]

Upon identifying the structure and anatomical configuration of the lateral masses of the subaxial vertebrae, as well as discussing the variations in screw placement techniques, we propose an entry point in the inferior medial quadrant with the screw oriented towards the superolateral direction. This orientation should exhibit a divergent angulation of 30-35° and a caudocephalic angulation of 50°, directed toward the superior, lateral, and ventral edge of the respective lateral mass. The structural integrity of the lateral masses is confirmed through tomography, while the length of the screws to be utilized is meticulously planned according to the specific level and mass. It is advisable to fully expose the lateral masses and position the most distal edge of the aspirator at the anticipated location where a longer screw would emerge, thereby enhancing its functionality (Figure 4).

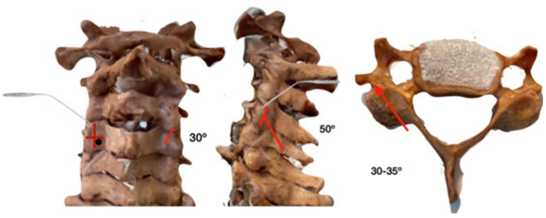


**Figure 4** To ensure the safety and preservation of the critical nervous and vascular structures in this area, we maintained the use of the fluoroscope in a lateral position during screw insertion to verify cancellation and depth in real time.

In a manner analogous to the classification employed to assess the appropriate placement of pedicle screws, this classification can also be utilized. Commented by J. Clin 2022 to assess the deviation of the screws in 5 degrees 20.

i. GO: No deviation error.

ii. G1: Featuring a minor perforation that slightly encroaches upon the cortex of the vertebral foramen.

iii. G2: A hole measured in millimeters that is less than half the diameter of the screw.

iv. G3: It is a perforation measured in millimeters that exceeds half the diameter of the screw.

v. G4: It is a perforation through which the complete diameter of the screw has penetrated the vertebral foramen, making contact with the vertebral artery (Figure 5 & 6).[15]

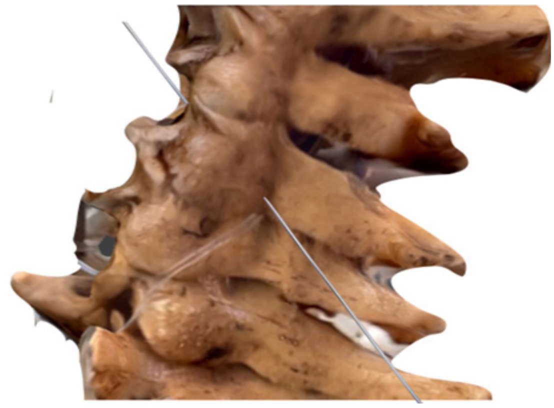

**Figure 5** Illustrates the proper orientation of the screw and its exit point if its length surpasses the cortex of the lateral mass.

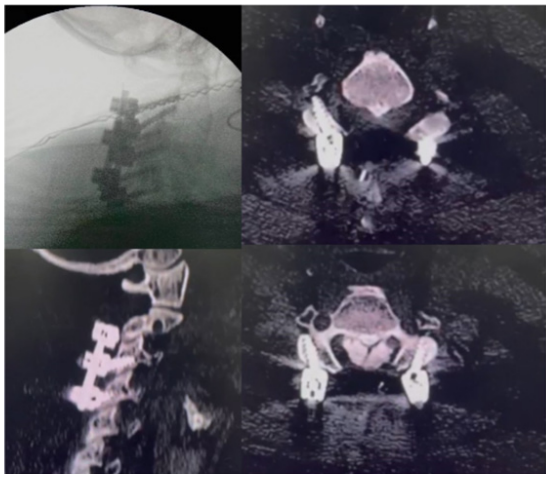

**Figure 6** Illustrates the application of a lateral transoperative fluoroscope for the insertion of screws into the lateral masses. The post-surgical outcome is further depicted through computed tomography in the sagittal section (b) and the counter-axial section, showcasing the screw in an appropriate position (c) while also highlighting the safety margin that the orientation of the screws may provide in the event of a lateral deviation.

## Discussion

Currently, FTML is extensively utilized, indicated for a diverse range of pathologies, and is deemed safe due to modifications implemented to safeguard vascular and nervous structures. Nevertheless, opportunities for enhancement remain as lateral mass fractures resulting from various techniques continue to occur. One technique does not inherently negate another. For instance, based on our experience, the traditional Roy Camille technique can serve as a rescue strategy in instances where the initially proposed technique has yielded suboptimal results. Furthermore, this technique can be integrated with others, such as in 360° approaches to the cervical spine in conjunction with an anterior cervical approach, as well as in occipitocervical fixations.[16–18]

## Conclusion

While this technique is grounded in theory and has yielded promising results in practice, it currently lacks a sufficient number of cases to provide statistically significant data that can be compared with the conventional techniques discussed in this study. It is essential to note that, in addition to employing appropriate techniques, factors such as the design of the implants and the materials from which they are constructed must be taken into account. The closer the density of the implants is to that of bone, irrespective of the alloys utilized in their development, the more favorable the outcomes will be. The size of the implants should ideally correspond to the dimensions of the lateral masses. A method known as the Finite Element Method (FEM), which neurosurgeons may not be widely familiar with, was developed around 1950 and employs the analytical resolution of differential equations. It is crucial to ensure that forces and moments are in equilibrium and to comprehend the relationships between deformations, displacements, and stresses based on fundamental principles. Other researchers have made significant contributions that have enabled the advancement of the materials we utilize. Additionally, technologies such as augmented reality enhance our understanding of anatomy in the most effective manner possible. In the images utilized in this study, we employed our images developed within the spinal surgery department of CMN 20 de Noviembre.

Applying the principles outlined above to our daily practice, collaborating as a team with professionals responsible for developing software, prosthetics, supplies, and other resources will enhance our familiarity with these concepts promptly and, ultimately, positively impact the advancement of new techniques or technologies that can benefit the patient.

## Acknowledgments

None.

## Conflicts of interest

The authors decare that there are no conflicts of interest.

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