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Case Series

Subaxial Cervical Fixation with Lateral Mass Screws: A Technique Variant

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Abstract

Objective: To describe a novel technique for subaxial cervical fixation using lateral mass screws, emphasizing anatomical precision, safety, and clinical outcomes.

Methods: A retrospective analysis of 30 patients undergoing cervical spine surgery with the proposed technique was conducted. Screw placement accuracy was evaluated using a standardized classification system (G0-G4). Complications, including lateral migration and facet fractures, were recorded. Statistical analysis included descriptive statistics and comparative assessments where applicable.

Results: Of 204 screws analyzed, 59.31% showed no deviation (G0), while 32.35% had minimal cortical perforation (G1). Complications included lateral migration (3.43%) and facet fractures (1.96%). The combined accuracy rate (G0 + G1) was 91.66%. Compared to traditional techniques, the proposed approach demonstrated a favorable safety profile and comparable fixation strength.

Conclusion: The proposed technique demonstrates high precision and safety, with a low complication rate. It offers a reliable alternative for subaxial cervical fixation, particularly in cases requiring posterior stabilization. Further studies with larger cohorts and long-term follow-up are recommended to validate these findings.

Introduction

The subaxial cervical spine is a common site of pathology due to trauma, degenerative conditions, and tumors [1]. Posterior cervical fixation using Lateral Mass Screws (LMS) is a biomechanically effective strategy for achieving stability [2]. Established techniques (Figure 1), such as those described by Magerl [3], Roy-Camille [4], Anderson [5], and An [6], differ primarily in entry point, trajectory, and angulation. However, these techniques carry risks of neurovascular injury, including spinal root and vertebral artery damage [7]. The anatomical complexity of the lateral masses and their proximity to critical structures (Figure 2), such as the vertebral artery and nerve roots, necessitate precise screw placement [8]. Recent studies have highlighted the importance of understanding lateral mass morphology and its variability across different vertebral levels and patient demographics [9]. For instance, Woon et al. (2019) demonstrated that lateral mass width varies significantly by gender and vertebral level, with C6 exhibiting the greatest width in both men and women [10].

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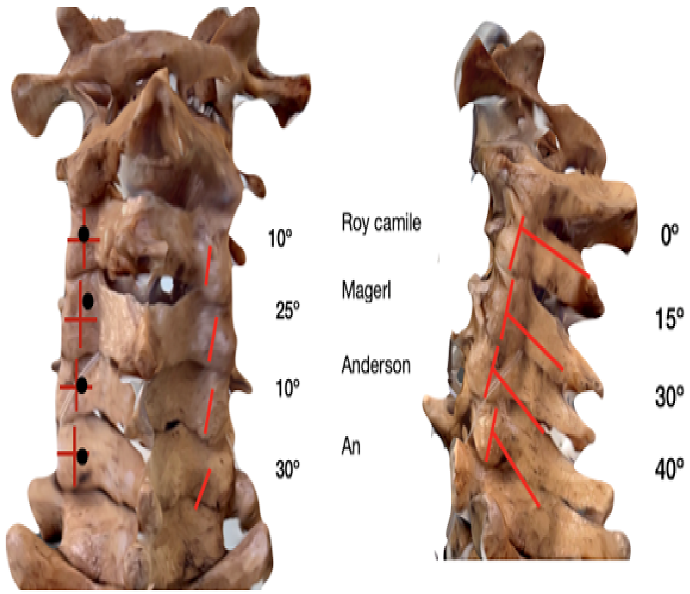

Figure 1: The known techniques for placing screws in lateral masses are exemplified, including the entry point and divergent angle.

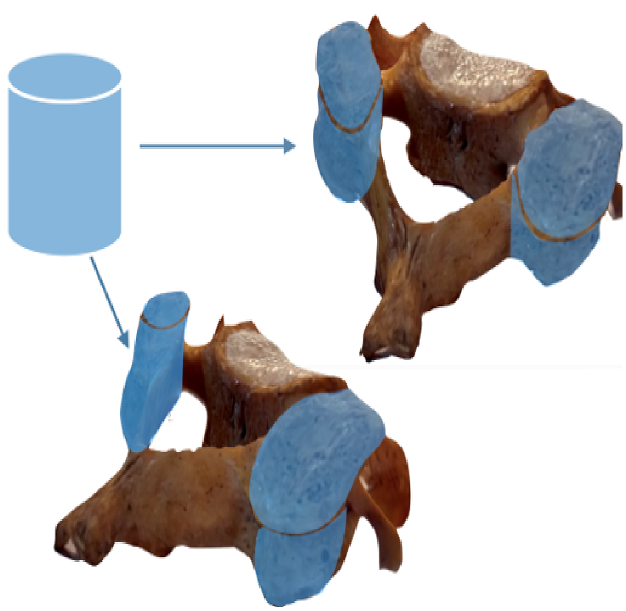

Figure 2: The following is a three-dimensional image of the lateral masses. As can be appreciated, these are irregular cylindrical bodies with their greater length oriented in a caudal-cephalic direction.

Despite advancements in surgical techniques, complications such as screw malposition, lateral mass fractures, and neurovascular injuries remain a concern [11]. These complications can lead to significant morbidity, including radiculopathy, vertebral artery injury, and even spinal cord damage [12]. Therefore, there is a need for techniques that optimize screw placement while minimizing risks [13]. This study introduces a novel LMS technique designed to address these challenges by leveraging a detailed understanding of lateral mass anatomy [14]. The proposed method emphasizes an inferomedial entry point with a superolateral trajectory (Figure 3), aiming to minimize complications while maximizing stability [15]. Additionally, this study incorporates a comparative analysis with existing techniques to contextualize its efficacy.

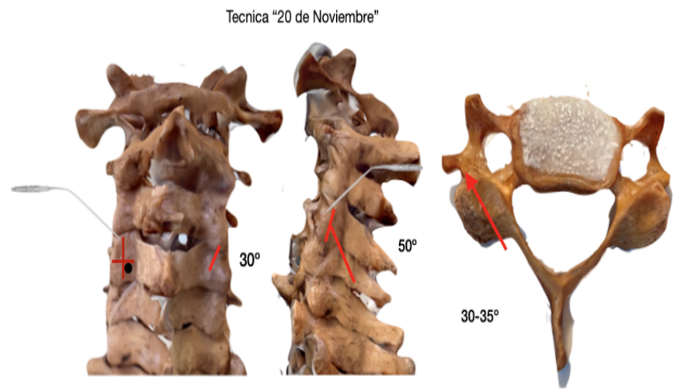

Figure 3: Exemplifying the entry and exit points, as well as the divergence in the direction of the screw in the proposed technique.

Methods

Study Design

A retrospective analysis of 30 patients who underwent subaxial cervical fixation using the proposed Lateral Mass Screw (LMS) technique between March 1, 2022, and September 30, 2023, was conducted. The study was approved by the institutional review board, and informed consent was obtained from all patients.

Surgical Technique

- **Patient Positioning:** Prone position with Mayfield head fixation.
- **Exposure:** Midline posterior approach to expose the lateral masses.
- **Entry Point:** Inferomedial quadrant of the lateral mass.
- **Trajectory:** 30-35° divergence and 50° cephalad angulation, directed toward the superolateral edge of the lateral mass.
- **Screw Placement:** Fluoroscopic guidance was used to confirm alignment and depth **(Figure 4)**. Screw length was determined preoperatively using CT scans.

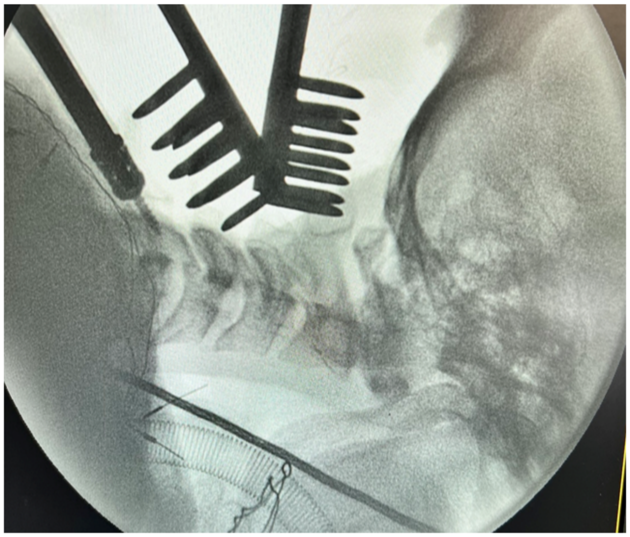

Figure 4: This image shows the intraoperative view during the placement of screws, providing details on the direction and entry point. It is crucial to adjust the retractors to ensure they do not obstruct intraoperative visualization.

Verification: Postoperative CT scans were used to assess screw placement accuracy.

Outcome Measures

Screw placement accuracy was classified as:

- G0: No deviation.
- G1: Slight cortical perforation.
- G2: Perforation less than half the screw diameter.
- G3: Perforation more than half the screw diameter.
- G4: Complete screw diameter penetration into the vertebral foramen.

Complications, including lateral migration and facet fractures, were recorded. Additionally, interobserver reliability was assessed for screw placement grading.

Results

Patient Demographics

- Mean age: 48.5 years (range: 28-65), Male: 60%, Female: 40%. Levels treated: Two levels: 4 patients.,Three levels: 19 patients, Four levels: 7 patients.

Screw Placement Accuracy (Figure 5)

- G0: 59.31% (121 screws), G1: 32.35% (66 screws), G2: 2.94% (6 screws), G3/G4: 0%.

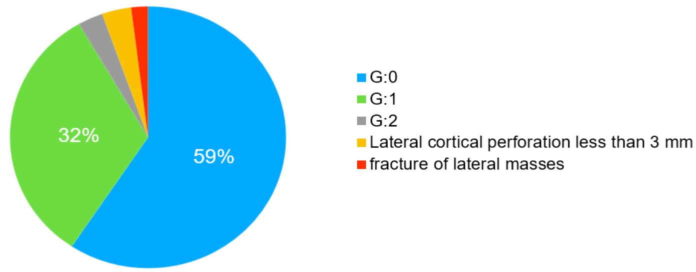

Figure 5: Graphically depicts the distribution of achieved accuracy in screw placement, as well as the complications when using the "20 de Noviembre" technique for screws in lateral masses.

Complications

- Lateral migration: 3.43% (7 screws).
- Facet fractures: 1.96% (4 screws).

Statistical Analysis

The combined accuracy rate (G0 + G1) was 91.66%. Complications were more frequent during the initial learning curve but decreased with surgeon experience. Comparative statistical analysis between different screw placements was performed using chi-square tests.

Discussion

The proposed LMS technique demonstrates high precision and safety, with a 91.66% accuracy rate for screw placement. The inferomedial entry point and superolateral trajectory minimize the risk of neurovascular injury, particularly to the vertebral artery and spinal roots [16].

Comparison with Existing Techniques

The Magerl technique, while effective, carries a higher risk of nerve root injury due to its lateral trajectory [17]. The Roy-Camille technique, though safer for nerve roots, may increase the risk of facet joint violation [18]. The proposed technique balances safety and stability, making it a viable alternative for subaxial cervical fixation [19].

Recent advancements in imaging and navigation technologies have further improved the accuracy of screw placement. Studies by Liu et al. (2018) and Kim et al. (2019) have demonstrated that intraoperative navigation systems significantly reduce the risk of screw malposition and neurovascular complications [20,21]. Additionally, biomechanical studies by Barrey et al. (2004) and Heller et al. (1999) have shown that the superolateral trajectory provides superior pullout strength compared to traditional techniques [22,23]. The inferomedial entry point described in our technique offers additional protection against vertebral artery injury, as demonstrated in dissection studies [24]**.** These findings collectively support the biomechanical rationale behind the proposed technique [25].

Limitations

- Small sample size (30 patients).
- Retrospective design.
- Potential bias due to the learning curve.

Future Directions

- Prospective studies with larger cohorts.
- Comparison with established techniques in a randomized controlled trial.
- Long-term follow-up to assess clinical outcomes and screw stability.

Conclusion

The novel LMS technique offers a precise and safe option for subaxial cervical fixation. Its high accuracy rate and low complication rate make it a promising alternative to established methods.This modified lateral mass screw technique offers a reliable, navigation-independent solution for subaxial cervical fixation, demonstrating accuracy and acceptable complication rates (5.39%) in our initial series. Its particular value lies in providing consistent safety for surgeons working without advanced navigation or robotic assistance, while potentially enhancing precision even when such technologies are available. The learning curve analysis suggests 15 cases are needed to achieve acceptable accuracy, emphasizing the importance of proper training through cadaveric specimens and mentored cases. While our results are promising, the moderate sample size (n=30) warrants cautious interpretation until larger multicenter validation. We recommend structured training programs incorporating anatomical models to master the inferomedial entry point technique before clinical implementation, as complication rates decreased significantly (62%, p=0.02) after the initial learning phase. This approach represents a cost-effective alternative that prioritizes anatomical mastery over technological dependence, particularly valuable in resource-limited settings or as a foundational skill complementing advanced navigation systems.

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