# Time to Surgery for Subaxial Cervical Fractures: A Multicenter Study

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■ OBJECTIVE: **To identify delays for surgery to stabilize subaxial cervical fractures and the main reasons for them across Latin America.**

■ METHODS: **This is a retrospective multicenter cohort study of patients surgically treated for subaxial cervical fractures from 13 spine centers across Latin America from January 1, 2014 to January 1, 2023. Causes of delay to surgery beyond 24 hours were documented.**

■ RESULTS: **We included 529 patients from 13 institutions in Latin American countries; 408 (77.1%) males and 121 (22.9%) females with a mean age of 43.4 (standard deviation = ±16.2). Predominantly caused by traffic accident (n = 256; 48.4%), followed by fall from height (n = 233; 44%). Mostly, suffered type C fractures (n = 348; 65.8%) and/or neurological injury (n = 384; 72.6%). The time from admission to surgery was >72 hours in 70% of the patients included (n = 375; 70.9%). More than 45% waited longer than a week (n = 257; 48.6%) for spine surgery. Only 12.5% (n = 66) of the patients received surgery in the first 24 hours from admission. The primary reasons for the surgical delay were the necessity for other surgical procedures (n = 161; 34.8%), the unavailability of surgical implants (n = 60; 13.0%), patient clinical instability (n = 55; 11.9%), and delays in referral (n = 38; 8.2%).**

■ CONCLUSIONS: **We documented significant and concerning delays in providing spinal decompression and stabilization surgery to patients with cervical spine fractures. Only 17% of patients have surgery in the recommended time <24 hours, more than half of the patients must wait for more than 72 hours, and nearly half of patients wait for longer than a week.**

## INTRODUCTION

Subaxial cervical spine injuries are the most common type of adult cervical spine injury, with the C5 to C7 segments being the most frequently affected.[1] Subaxial cervical spine injuries can range from minor fractures to devastating fracture-dislocations with spinal cord injury (SCI).[2] Severe traumatic cervical injuries require prompt initial assessment, diagnosis, and treatment, especially when neurological damage is present.[3] Surgical decompression is a keystone in the management of patients with traumatic SCI, and the timing of surgery is a critical factor in attempting to minimize the sequelae of SCI.[4,5] It is recommended that patients with an acute SCI, regardless of level, undergo surgery within 24 hours after injury when medically feasible.[6]

**Key words**
- Cervical trauma
- Cervical fracture
- Early stabilization
- Late stabilization
- Spinal cord injury
- Spine surgery
- Timing of surgery

**Abbreviations and Acronyms**
**SCI**: Spinal cord injury

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The timing of surgery is even more controversial in subaxial unstable cervical injuries without neurological injury, especially in polytrauma patients.[7] For some patients, the imperative of surgical spinal stabilization may require a delay. Still, every reasonable effort should be made to treat patients with unstable spinal fractures as early as possible. Previous studies have shown that spinal surgery within 72 hours of trauma in critically injured patients is beneficial in terms of shorter intubation time, intensive care unit length of stay, and overall length of stay, with no difference in mortality rates.[1,7]

Although clinical practice guidelines based on evidence suggest recommendations, their application in the real world can be challenging, especially in low-income countries. This situation was previously well-documented by our study group in a multicenter cohort of unstable thoracolumbar fractures from Latin American institutions.[8]

Given the increasing evidence in updated clinical practice guidelines in favor of early surgery (within 24 hours) and further investigations attempting to identify an even earlier cut-off point (ultra-early surgery), it is important to assess our regional situation regarding the treatment of subaxial cervical spine injuries and facilitate the development of novel strategies to overcome barriers to early treatment.[6,9]

We aim to identify delays in surgery to stabilize subaxial cervical fractures and the main reasons for them across Latin America.

## MATERIALS AND METHODS

This is a retrospective multicenter cohort study of patients surgically treated for subaxial cervical fractures from 13 spine centers across Latin America between January 1, 2014 and January 1, 2023.

Our sample was obtained according to the following eligibility criteria. We included adult patients (aged >18 years) of any sex who had undergone surgery for subaxial cervical spine fractures (from C3 to C7-T1). We have considered a minimum follow-up period from surgery to hospital discharge. Fracture types A0 to A2, according to the AO Spine subaxial cervical spine injury classification system, were excluded.[10] Penetrating trauma and incomplete medical records with regard to critical data on the time from trauma to surgery were excluded.

The recruitment process involved either an open call or e-mail to contact all active members of the Latin American branch of AO Spine. Before any data collection, 2 informative meetings were held with all the interested centers to clarify the study objectives, scope, and inclusion and exclusion criteria. This study was conducted in accordance with ethical standards and approved by the Ethics Committee 2017–7 for multiple centers. All patients were anonymized with an identification number, and the investigators were blinded to their identity.

We obtained data from medical records according to the following variables.

The primary outcome was the time from trauma to surgery, measured in hours. Surgical delay was defined as any time between the time of traumatic injury and surgery exceeding 24 hours. Therefore, patients who underwent surgery within the first 24 hours after trauma were not considered to have experienced surgical delay. This duration was calculated as the time interval between the patient's documented date and time of trauma in the clinical report and the date and time of the initiation of surgery. Current guidelines for SCI recommend a cut-off point of 24 hours after trauma for surgery.[6] The timing of surgery in neurologically intact patients is still a topic of debate, and the risk-benefit ratio of early surgery versus delayed surgery should be individualized. However, we have selected a cut-off point of 24 hours from trauma for 2 main reasons: first, to prioritize patients with neurological injuries in our investigation; second, to explore the feasibility of early surgery.

Causes of delay to surgery beyond 24 hours were documented. Additionally, we registered the following patient data: age, gender, injury mechanism, type of hospital (public or private), time to referral from another hospital, comorbidities, associated injuries, neurological status according to American Spinal Injury Association impairment scale, surgical approach, fixed spinal segments, use of steroids, use of cervical traction, complications, and mortality.[11]

## STATISTICAL ANALYSIS

Counts and frequencies were used to describe categorical variables, which were analyzed using either the chi-square method or Fisher's exact test. Numerical variables were summarized using means or medians, depending on their normal or non-normal distribution, with their respective measures of dispersion reported as standard deviation or range values. Numerical variables were compared using either the Student's *t*-test or the Mann-Whitney U test, depending on the data distribution. Statistical significance was defined as $P < 0.05$. The statistical analyses were performed using SPSS Statistics 25 software (IBM, Armonk, NY).

## RESULTS

We included 529 patients from 13 institutions among 6 Latin American countries. Distribution by country and hospital type is shown in Table 1. The sample included 408 (77.1%) males and 121 (22.9%) females, with a mean age of 43.4 (standard deviation = ±16.2; range = 18–100). The main cause of trauma was traffic accidents (n = 256; 48.4%), followed by falls from height (n = 233; 44%) (Table 2). Patients without comorbidities (n = 337; 63.7%) were largely registered; distribution of specific comorbidities was described in Table 2.

**Table 1.** Hospitals and Patients by Country

| Country | Patients | Institutions | Private Institutions | Public Institutions |
|---|---|---|---|---|
| Mexico | 321 | 4 | 0 | 4 |
| Brazil | 97 | 4 | 1 | 3 |
| Chile | 40 | 2 | 2 | 0 |
| Peru | 28 | 1 | 0 | 1 |
| Argentina | 24 | 1 | 1 | 0 |
| Ecuador | 19 | 1 | 0 | 1 |
| Total | 529 | 13 | 4 | 9 |

**Table 2.** Sample Characteristics

| Variable | Results |
|---|---|
| Age; mean (SD; range) | 43.4 (16.2; 18—100) |
| Gender; n (%) | |
| Male | 408 (77.1) |
| Female | 121 (22.9) |
| Injury mechanism; n (%) | |
| Traffic accident | 256 (48.4) |
| Fall from height | 233 (44.0) |
| Direct trauma | 20 (3.8) |
| Dive injury | 13 (2.5) |
| Other | 7 (1.3) |
| AO type; n (%) | |
| A | 79 (14.9) |
| B | 102 (19.3) |
| C | 348 (65.8) |
| Facet injury; n (%) | |
| None | 207 (39.1) |
| F1 | 29 (5.5) |
| F2 | 32 (6.0) |
| F3 | 25 (4.7) |
| F4 | 236 (44.6) |
| Comorbidities (one or more); n (%) | 192 (36.3) |
| Specific comorbidities; n (%) | |
| Hypertension | 66 (12.5) |
| Diabetes | 44 (8.3) |
| Smoking | 44 (8.3) |
| Obesity | 28 (5.3) |
| Drugs or alcohol abuse | 9 (1.7) |
| Heart disease | 5 (0.9) |
| Lung disease | 5 (0.9) |
| Ankylosing spondylitis | 5 (0.9) |
| Renal disease | 1 (0.2) |
| Other | 45 (8.5) |
| AIS on arrival | |
| A | 184 (34.8) |
| B | 53 (10.0) |
| C | 74 (14.0) |
| D | 73 (13.8) |
| E | 145 (27.4) |

SD, standard devition; AIS, ASIA impairment acale.

The most frequent injury pattern was type C fractures (n = 348; 65.8%), which affected more than 50% of cases in the C5—C6 (n = 149; 28.2%) and C6—C7 (n = 145; 27.4) segments (Figure 1). Facet injury was documented in 322 (60.8%) patients, and F4 facet fractures were mostly described (n = 236; 44.6). The percentage of patients who suffered multiple-level spinal fractures was 27.4% (n = 145). The median number of fractured levels was 1 (range = 1—4). A total of 72.6% of the patients (n = 384) presented with neurological damage upon admission. Of these, 37.8% (n = 200) exhibited incomplete neurological injury, while 34.8% (n = 184) had complete neurological injury. The American Spinal Injury Association impairment scale grade is documented in Table 2.

Only one third of the sample was referred prior to the first 24 hours after trauma (n = 178, 33.6%). Most patients (n = 403; 76.2%) suffered an isolated cervical spine trauma. Among those with nonvertebral associated injuries, head trauma was the most common (n = 67; 12.7%), followed by nonvertebral fractures (n = 48; 9.1%), thorax trauma (n = 47; 8.9%), and abdominal trauma (n = 17; 3.2%). A further surgical procedure was required in 61 patients (11.5%), with 32 (52.5%) undergoing surgery before the cervical spine surgery. Craniectomy was the most frequent nonvertebral surgical intervention (n = 27; 44.3%). The initial assessment and damage control characteristics are documented in Table 3.

The time from admission to surgery was >72 hours in 70% of the sample (n = 375; 70.9%) (Table 4). More than 45% waited

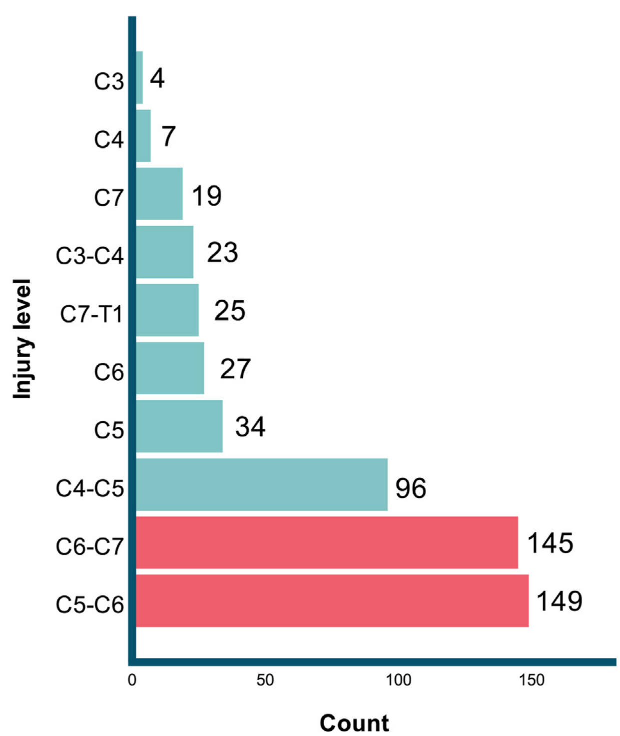


**Figure 1.** Bar chart: injury-level distribution.

**Table 3.** Primary Assessment and Damage Control

| Variables | n (%) |
|---|---|
| Multiple trauma (two or more associated injuries) | 126 (23.8) |
| Specific associated traumatic injury | |
| Thorax | 47 (8.9) |
| Head | 67 (12.7) |
| Abdominal | 17 (3.2) |
| Pelvis | 9 (1.7) |
| Multiple fractures | 48 (9.1) |
| Maxillofacial | 1 (0.2) |
| Other | 4 (0.8) |
| Nonvertebral surgery | 61 (11.5) |
| Timing of nonvertebral surgery | |
| Previous cervical spine surgery | 32 (52.5) |
| After cervical spine surgery | 29 (47.5) |
| Type of surgery | 16 (26.2) |
| Damage control | 3 (4.9) |
| Craniectomy | 27 (44.3) |
| Fracture internal fixation | 8 (13.1) |
| Minor procedure | 3 (4.9) |
| Thoracolumbar spinal surgery | 4 (6.6) |
| Other | |
| Referral delay | |
| <1 day | 178 (33.6) |
| 1–2 days | 87 (16.4) |
| 2–3 days | 94 (17.8) |
| 3–7 days | 60 (11.3) |
| 7–30 days | 87 (16.4) |
| More than 30 days | 23 (4.3) |

longer than a week (n = 257; 48.6%) for cervical spine surgery. Only 12.5% (n = 66) of the sample performed cervical surgery 24 hours after admission. Ultra-early (<12 hours) surgery was performed in only 26 cases (4.9%). According to neurological status on arrival, there were no statistically significant differences ($P = 0.066$; Kruskall-Wallis test) in the median of time from admission to surgery in hours among patients with complete (median = 139 hours; range = 1.2–4731.3), incomplete (median = 167.4 hours; range = 4.8–3834.5), or without neurological injury (median = 160 hours; range = 3–2754).

The primary documented reasons for surgical delay in patients operated on for cervical spine injury after 24 hours from admission were the necessity for other surgical procedures (n = 161; 34.8%), the unavailability of surgical implants (n = 60; 13.0%), patient clinical instability (n = 55; 11.9%), and delays in referral (n = 38; 8.2%) (**Table 5**).

**Table 4.** Nature of Cervical Spine Trauma Treatment (Surgical Approach, Timing, Instrumented Segments, Surgical Delay, and Use of Steroids)

| Variables | Results |
|---|---|
| Surgical approach; n (%) | |
| Posterior | 82 (15.5) |
| Anterior | 342 (64.7) |
| Combined | 105 (19.8) |
| Timing of combined approach; n (%) | |
| 2 times | 41 (39.0) |
| 1 time | 64 (61.0) |
| First approach; n (%) | |
| Anterior | 66 (62.9) |
| Posterior | 39 (37.1) |
| Posterior instrumented segments; n (%)* | |
| 1 | 44 (23.5) |
| 2 | 59 (31.5) |
| 3 | 40 (21.3) |
| 4 | 14 (7.4) |
| Anterior instrumented segments; n (%)† | |
| 1 | 291 (65.1) |
| 2 | 143 (31.9) |
| 3 | 20 (4.5) |
| Time from admission to surgery; n (%) | |
| <12 hours | 26 (4.9) |
| 12–24 hours | 40 (7.6) |
| 24–48 hours | 40 (7.6) |
| 48–72 hours | 47 (8.9) |
| 3–7 days | 118 (22.3) |
| 7–30 days | 192 (36.3) |
| >30 days | 65 (12.3) |
| Steroids use; n (%) | 54 (10.2) |

Definitions: Instrumented segment = 2 vertebras; Steroids use: use of steroids to prevent or reduce the effects of secondary injury in any doses or protocol.
*percentages were calculated among those who performed posterior or combined approach.
†percentages were calculated among those who performed anterior or combined approach.

The duration of the delay was analyzed by country and hospital type. Statistically significant differences in timing were observed between countries. The highest median of delay in hours was documented for Peru (median = 261 hours), followed by Mexico (median = 197 hours) and Argentina (median = 152 hours). The lowest delay was registered in patients from Chile (median = 46.6). The analysis revealed a statistically significant difference in

**Table 5.** Distribution of Reasons for Surgical Delay >24 Hours (n = 463)

| Reason for Surgical Delay | n (%) |
|---|---|
| Other surgical procedures | 161 (34.8) |
| Availability of surgical implants | 60 (13.0) |
| Clinical instability | 55 (11.9) |
| Delay in referral | 38 (8.2) |
| Availability of a specialized surgical team | 25 (5.4) |
| Surgeon's choice | 20 (4.3) |
| Availability of operating room | 14 (3.0) |
| Others | 22 (4.8) |

median delay between private and public centers. The median delay for private centers was 99.5 hours, while that for public centers was 184 hours ($P < 0.001$) (Table 6).

The reasons for the delay were evaluated in each country and documented in Table 7. The different reasons mentioned above varied statistically significantly between countries. The only common cause for delay without significant difference was patient clinical instability ($P = 0.068$).

## DISCUSSION

The study presents a critical examination of the timing and challenges associated with surgical intervention for subaxial cervical spine injuries across Latin America. These injuries represent a significant burden, ranging from minor fractures to severe fracture-dislocations, sometimes accompanied by SCI. Prompt assessment and surgical intervention are imperative, especially in cases involving neurological damage, with recommendations advocating surgery within 24 hours postinjury when feasible.[6]

**Table 6.** Duration of Surgical Delay by Country and Hospital Type

| Country | N | Median of Delay in Hours | Range | P* |
|---|---|---|---|---|
| Argentina | 24 | 152.2 | 5.5—859.0 | <0.001 |
| Chile | 40 | 46.6 | 4.9—2208.8 | |
| Mexico | 321 | 197.0 | 3.0—4731.3 | |
| Brazil | 97 | 105.0 | 1.2—2640.0 | |
| Ecuador | 19 | 55.7 | 9.0—132.4 | |
| Peru | 28 | 261.0 | 28.9—2674.5 | |
| **Hospital Type** | **n** | **Median of Delay in Hours** | **Range** | **P†** |
| Public | 419 | 184 | 1.2—4731.3 | <0.001 |
| Private | 110 | 99.5 | 3.0—2640.0 | |

*Nonparametric Kruskal-Wallis test.
†Nonparametric Mann-Whitney U test.

The landmark Surgical Timing in Acute Spinal Cord Injury trial, published in 2012, was pivotal in ushering in a new era in spine surgery, emphasizing early intervention for SCI.[12] These findings promoted a new concept, "Time is Spine," which emphasizes the crucial time element in managing these patients.[12] However, the optimal timing of surgery remains contentious. In resource-constrained settings, the ideal conditions are difficult to achieve, as elucidated by prior studies within Latin American cohorts.[8]

This comprehensive analysis of 529 patients from 13 institutions across 6 Latin American countries provides valuable insights into the region's epidemiology, clinical presentation, and management challenges associated with cervical spine injuries. The predominance of males in the sample, comprising 77.1%, reflects a demographic trend commonly observed in trauma cases. Traffic accidents and falls from height in patients without comorbidities (63.7%) emerged as the primary causes of trauma, emphasizing the importance of preventive measures and targeted interventions to mitigate these risks.

Type C fractures were identified as the most frequent injury pattern, particularly affecting the C5—C6 and C6—C7 segments. Additionally, facet injuries and multiple-level spinal fractures were prevalent, contributing to the complexity of injury management and rehabilitation. Neurological symptoms were frequent upon admission, observed in 72.6% of patients, among whom incomplete neurological injuries were slightly more common than complete injuries. Nevertheless, there were no differences in timing for surgery between SCI groups. Incomplete neurological deficit is the subgroup of patients in whom early surgery might be anticipated to yield greater benefit;[8] last clinical guidelines for SCI from Fehlings et al. state that while several studies incorporate patients with various levels and severities of SCI, estimates have typically been pooled and that conclusions for early surgery cannot be made in specific patient subgroups.[6]

Steroid use was reported in 10% of patients, which is not consistent with a recently published international survey of Current Practice of Acute Spinal Cord Injury Management of 593 AO Spine members.[12] Notably, 61.2% of these respondents were from low- and middle-income countries. Respondents from low- and middle-income countries were more likely to administer steroids than those from high-income countries (61.2% vs. 41.7%; $P < 0.001$). The authors noted that the leading reason not to administer steroids was a lack of belief that steroid administration would improve neurologic recovery. This was followed by the avoidance of potential drug-associated complications.

Despite the imperative for timely surgical intervention, our study revealed substantial delays to performcervical spine surgery, with more than 70% of patients waiting over 72 hours and nearly half waiting longer than a week. Only a small fraction underwent surgery within 24 hours of admission, and 5% received ultra-early surgery (<12 hours). This finding is consistent with previous data reported in the United States, where hospital reviews show that less than 50% of patients with an SCI in North America receive the recommended early treatment after traumatic SCI,[13-16] highlighting systemic challenges in expediting surgical management.

The influence of ultra-early surgery on patient-related outcome measures has not been determined.[6] The determination of consistent timing thresholds is in evolution, and the concept by

**Table 7.** Surgical Delay Causes by Country

| Causes | Argentina | Chile | Mexico | Brazil | Ecuador | Peru | P* |
|---|---|---|---|---|---|---|---|
| Other surgical procedures | 0 (0) | 0 (0) | 172 (53.6) | 1 (1.0) | 0 (0) | 3 (10.7) | <0.001 |
| Without delay | 7 (29.2) | 16 (40) | 54 (16.8) | 30 (30.9) | 0 (0) | 1 (3.6) | <0.001 |
| Surgical implants | 3 (12.5) | 0 (0) | 36 (11.2) | 6 (6.2) | 10 (52.6) | 8 (28.6) | <0.001 |
| Clinical instability | 4 (16.7) | 5 (12.5) | 26 (8.1) | 18 (18.6) | 1 (5.3) | 4 (14.3) | 0.068 |
| Delay in referral | 4 (16.7) | 6 (15) | 28 (8.7) | 1 (1.0) | 0 (0) | 0 (0) | 0.005 |
| Specialized surgical team | 1 (4.2) | 0 (0) | 0 (0) | 13 (13.4) | 6 (31.6) | 6 (21.4) | <0.001 |
| Surgeon's choice | 2 (8.3) | 6 (15) | 0 (0) | 10 (10.3) | 0 (0) | 2 (7.1) | <0.001 |
| Availability of operating room | 0 (0) | 1 (2.5) | 0 (0) | 12 (12.4) | 1 (5.3) | 0 (0) | <0.001 |
| Others | 3 (12.5) | 6 (15) | 5 (1.6) | 6 (6.2) | 1 (5.3) | 4 (14.3) | <0.001 |

*Chi-squared test.

itself constitutes a hard-to-reach clinical setting in an under-resourced country with extended referral timing from less complex hospitals.

In our study, the primary reasons for surgical delays included the necessity for other surgical procedures, followed by unavailability of surgical implants, patient clinical instability, and delays in referral. Craniectomy was the most commonly associated surgery, reflecting the high energy involved in the accidents resulting in subaxial cervical fractures. Other causes of delay could be attributed to systemic inadequacies in resource allocation, infrastructure, and coordination of care. This was previously mentioned in the study by Thompson and associates from Canada, which enumerated various barriers to early surgery, including transfer delays to spine centers, delays before surgical plan completion, and waiting time for the operating room. Compared to our previous study on thoracolumbar fractures,[8] where most delays were due to economic aspects, only 21.4% were due to these reasons (unavailability of surgical implants, specialized surgical team, and operating rooms).

Significant disparities in surgical delay were observed between countries and hospital types, with Peru, Mexico, and Argentina exhibiting longer median delays compared to Chile. Latin American healthcare systems are diverse, with various approaches to accessing healthcare services. Healthcare can be categorized based on funding into 1) the public system (generally underfunded and financed mostly through general taxes, serving the nonworking poor population), 2) social security institutions (generally well-funded by salaried individuals), and 3) the private sector (well-funded and used by those with the most financial access). For simplicity, we have divided hospitals into public and private systems, as access to technologies and the potential for early surgery are generally similar in the social security and private sectors.[8] Private centers demonstrated shorter delays compared to public centers, underscoring potential differences in resource availability, administrative processes, and healthcare infrastructure. These findings highlight the need for targeted interventions to address systemic barriers to timely surgical intervention, enhance resource allocation, and optimize patient outcomes across diverse healthcare settings in Latin America. By addressing these challenges, healthcare systems can strive toward delivering timely and equitable care for cervical spine trauma patients, ultimately reducing the burden of disability and improving long-term functional outcomes.

The present study is subject to several limitations. First, it's important to note that most Level I trauma centers in Latin America are part of the public healthcare system, which may introduce bias into the results due to their typically lower funding, potentially leading to longer surgical delays. Furthermore, the heterogeneity of Latin American countries limits the generalizability of the results. Despite this, the study provides valuable insights into cervical spine fractures with and without neurological impairment. Additionally, the unequal distribution of patients among the countries, with a large representation from Mexico and a lower representation from other countries, may influence the interpretation of results according to the country of origin. Finally, the study could not objectively verify the reported reasons for surgical delays, posing a potential limitation. Despite these limitations, the study offers an understanding of the issue and potential reasons for surgical delays for cervical spine stabilization surgery in Latin America.

## CONCLUSION

In Latin America, there are significant and concerning delays in providing spinal stabilization surgery to patients with cervical spine fractures. 17% of patients have surgery in the recommended time <24 hours, more than half of the patients must wait for more than 72 hours, and nearly half of patients wait for longer than a week. The primary reason for these delays seems to be the severity of trauma requiring other surgeries, followed by the lack of economic resources to support early interventions. Our study highlights the complex clinical presentations and management challenges associated with cervical spine injuries and the need for new strategies to overcome barriers and ensure timely stabilization surgery across Latin America.

## CRediT AUTHORSHIP CONTRIBUTION STATEMENT

**Guisela Quinteros:** Conceptualization, Investigation, Writing — original draft, Writing — review & editing. **Guillermo Ricciardi:** Formal analysis, Methodology. **Ignacio Cirillo:** Writing — review & editing. **Edgar Marquez García:** Data curation. **Juan P. Cabrera:** Supervision. **Charles A. Carazzo:** Supervision, Writing — review & editing. **Ratko Yurac:** Writing — review & editing. **Alfredo Guiroy:** Conceptualization.

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## REFERENCES

1. Alve J, Huttunen J, Leinonen V, Jyrkkänen HK, Danner N. Outcome and complications of operatively treated subaxial cervical spine injuries: a population-based retrospective cohort study. *World Neurosurg X*. 2024;22:100283.

2. Sharif S, Ali MYJ, Sih IMY, Parthiban J, Alves ÓL. Subaxial cervical spine injuries: WFNS spine Committee recommendations. *Neurospine*. 2020;17:737-758.

3. Zaveri G, Das G. Management of Sub-axial cervical spine injuries. *Indian J Orthop*. 2017;51:633-652.

4. Quddusi A, Pedro KM, Alvi MA, Hejrati N, Fehlings MG. Early surgical intervention for acute spinal cord injury: time is spine. *Acta Neurochir*. 2023;165:2665-2674.

5. Fehlings MG, Hachem LD, Tetreault LA, et al. Timing of decompressive surgery in patients with acute spinal cord injury: systematic review update. *Global Spine J*. 2024;14(3_Suppl):38S-57S.

6. Fehlings MG, Tetreault LA, Hachem L, et al. An update of a clinical practice guideline for the management of patients with acute spinal cord injury: recommendations on the role and timing of decompressive surgery. *Global Spine J*. 2024;14(3 Suppl):174S-186S.

7. Sousa A, Rodrigues C, Barros L, Serrano P, Rodrigues-Pinto R. Early versus late spine surgery in severely injured patients-which is the appropriate timing for surgery? *Global Spine J*. 2022;12:1781-1785.

8. Guiroy A, Carazzo CA, Zamorano JJ, et al. Time to surgery for unstable thoracolumbar fractures in Latin America-a multicentric study. *World Neurosurg*. 2021;148:e488-e494.

9. Wilson JR, Witiw CD, Badhiwala J, Kwon BK, Fehlings MG, Harrop JS. Early surgery for traumatic spinal cord injury: where are we now? *Global Spine J*. 2020;10(1 Suppl):84S-91S.

10. Karamian BA, Schroeder GD, Lambrechts MJ, et al. An international validation of the AO spine subaxial injury classification system. *Eur Spine J*. 2023;32:46-54.

11. Kirshblum SC, Biering-Sorensen F, Betz R, et al. International standards for neurological classification of spinal cord injury: cases with classification challenges [published correction appears in J spinal cord med. 2014 Jul;37(4):481]. *J Spinal Cord Med*. 2014;37:120-127.

12. Pedro KM, Fehlings MG. Time is spine: What's over the horizon. *J Clin Orthop Trauma*. 2022;35:102043.

13. Hejrati N, Moghaddamjou A, Pedro K, et al. Current practice of acute spinal cord injury management: a Global survey of members from the AO spine. *Global Spine J*. 2024;14:546-560.

14. Tator CH, Fehlings MG, Thorpe K, Taylor W. Current use and timing of spinal surgery for management of acute spinal surgery for management of acute spinal cord injury in North America: results of a retrospective multicenter study. *J Neurosurg*. 1999;91(1 Suppl):12-18.

15. Wilson JR, Voth J, Singh A, et al. Defining the pathway to definitive care and surgical decompression after traumatic spinal cord injury: results of a Canadian population-based cohort study. *J Neurotrauma*. 2016;33:963-971.

16. Furlan JC, Tung K, Fehlings MG. Process benchmarking appraisal of surgical decompression of spinal cord following traumatic cervical spinal cord injury: opportunities to reduce delays in surgical management. *J Neurotrauma*. 2013;30:487-491.

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