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Outcome of Subaxial Spinal Cord injury (Early vs Late Decompression Surgery)

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ABSTRACT

Introduction: Cervical spine injuries can cause severe neurological deficits, and the timing of decompression surgery is critical for influencing recovery. Early decompression, performed within hours to days, improves outcomes by preventing irreversible spinal cord damage, while delayed decompression may lead to worsened recovery due to prolonged spinal cord compression.

Case Description: Two cases were discussed: Case 1 involved a 22-year-old male with severe spinal cord compression, who showed rapid improvement following immediate decompression surgery. Case 2 involved a 20-year-old male with a C3 vertebra dislocation, who underwent delayed decompression surgery three months after injury, resulting in substantial recovery after rehabilitation.

Discussion: Early decompression surgery, as seen in Case 1, leads to faster recovery by minimizing spinal cord ischemia and preventing further neuronal damage, resulting in significant functional improvement. In contrast, delayed decompression, demonstrated in Case 2, results in slower recovery due to prolonged spinal cord compression, but meaningful improvement is still possible with intensive rehabilitation. The timing of decompression surgery plays a crucial role in recovery outcomes, although patient-specific factors, including injury severity and rehabilitation, also influence the extent of recovery.

Conclusion: Early decompression surgery for subaxial spinal cord injuries generally results in better outcomes, with faster recovery, while late decompression can still provide significant recovery, albeit with a slower trajectory and increased risk of residual deficits.

Keyword: Cervical Spine Injury; Early Decompression; Late Decompression; Neurological Recovery.

1. Introduction

Cervical spine injuries are critical clinical conditions that often lead to severe neurological deficits, including motor and sensory impairment, as well as loss of autonomic functions. One of the key factors influencing the prognosis of such injuries is the timing of surgical intervention. Early decompression surgery, typically within hours to a few days post-injury, has been suggested to improve outcomes by preventing irreversible spinal cord damage. Studies show that timely decompression can reduce the extent of cord compression, preserve neurological function, and

minimize the risk of long-term disability. Conversely, delayed decompression, often due to diagnostic or logistical reasons, can potentially worsen neurological recovery, as spinal cord injury may progress without early intervention.[1, 2]

This study compares two cases of cervical spine trauma with distinct surgical intervention timings—one undergoing early decompression and the other delayed decompression. Early decompression is theorized to improve spinal cord perfusion and prevent secondary ischemic injury, while late decompression is often associated with increased risk of permanent neurological impairment due to prolonged cord compression. Previous research highlights the importance of surgical timing, with some studies showing superior outcomes in early intervention, particularly in terms of motor function recovery. However, late decompression may still offer benefits, particularly when secondary complications like swelling or vascular issues initially hinder surgery.[3, 4]

Despite the established advantages of early decompression, the question remains whether late decompression surgeries can still result in meaningful neurological recovery. Some studies have suggested that while late decompression may not yield the same level of immediate functional recovery as early surgery, patients can still benefit from rehabilitation and post-surgical recovery with delayed intervention. This is particularly relevant in cases where early surgery was not feasible due to the severity of the trauma or delays in diagnosis. Thus, it is essential to evaluate the long-term functional outcomes and recovery trajectories between these two approaches, to better inform clinical decision-making regarding timing.[5]

This paper aims to analyze and compare the outcomes of early versus late decompression surgeries in cervical spine trauma, with a focus on neurological recovery, motor function improvement, and overall quality of life. By reviewing these two distinct cases, we aim to contribute to the ongoing debate about the optimal timing for surgical intervention in subaxial spinal cord injuries, providing insights that may help refine treatment protocols and improve patient outcomes. Given the complexities of spinal cord injuries and the variation in individual responses to treatment, understanding the impact of surgical timing on recovery is crucial.[3, 5]

2. Case Series

Case 1 (Early Decompression Surgery)

A 22-year-old male The patient came with a complaint of weakness of all four limbs which was found since 1 day before the admission due to the patient jumping into the swimming pool with the back head hitting the bottom of the pool with a height of 1 meter. Weakness of all four limbs was felt simultaneously. Loss of consciousness was found after the incident with a duration of <5 minutes. Urination and defecation disorders were found since 1 day before the admission. Motoric score was 11111/22222 ; 11111/11111. MRI revealed cervical injury ASIA A at level C4-C5.

The patient underwent immediate Anterior Cervical Corpectomy Fusion (ACCF). Postoperatively, patient showed remarkable recovery, regaining upper extremity function and sensation in his lower extremities within hours. By postoperative day 3, motor strength in the lower extremities still poor, and the patient was ambulatory with physical therapy. This case highlights the potential for significant recovery following spinal cord injury in acute subaxial spinal cord injuries.

Figure 1. Case no. 1. Sagittal MRI shows a cervical injury. The spinal cord is notably displaced ventrally and severely flattened.

Case 2 (Late Decompression Surgery)

A 20-year-old male presented with a C3 vertebra dislocation resulting from a car accident. He initially underwent conservative management, including one month of cervical collar use and close monitoring at a neurosurgery clinic. Despite undergoing a two-month rehabilitation program, no significant neurological improvements were observed, and his motor strength remained poor. Neurological examination revealed a sensory level at C4 with deep anal sensation and voluntary anal contraction, categorizing him as American Spinal Injury Association (ASIA) Level C, with a motor score of 32. Imaging showed no significant change compared to initial post-injury findings, leading to a decision for decompression surgery.

Three months after the injury, the patient underwent C3 and C4 vertebra stabilization and decompression surgery. Postoperatively, he was enrolled in a second rehabilitation program lasting two months. Remarkable improvement was noted at the end of the rehabilitation period, with his sensory level advancing to C7 and his ASIA level improving to D. His motor score increased significantly to 87, and he achieved the ability to ambulate independently over long distances. This case underscores the potential for significant recovery following late decompression surgery in subaxial spinal cord injuries, even after a delayed intervention.

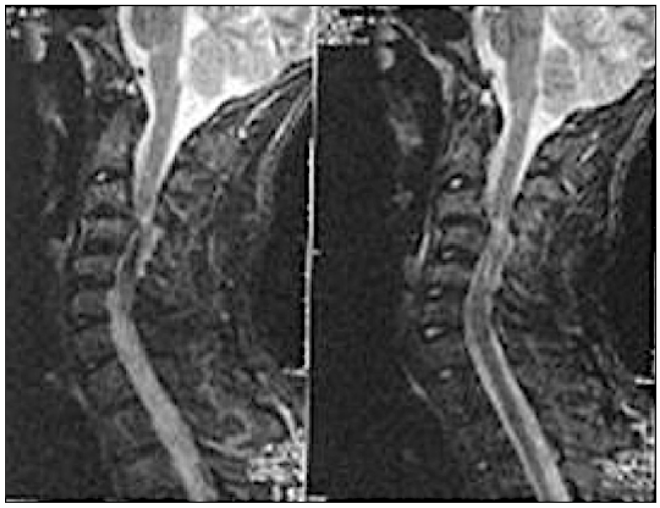

Figure 2. Case no. 2. MRI shows C3 vertebra dislocation

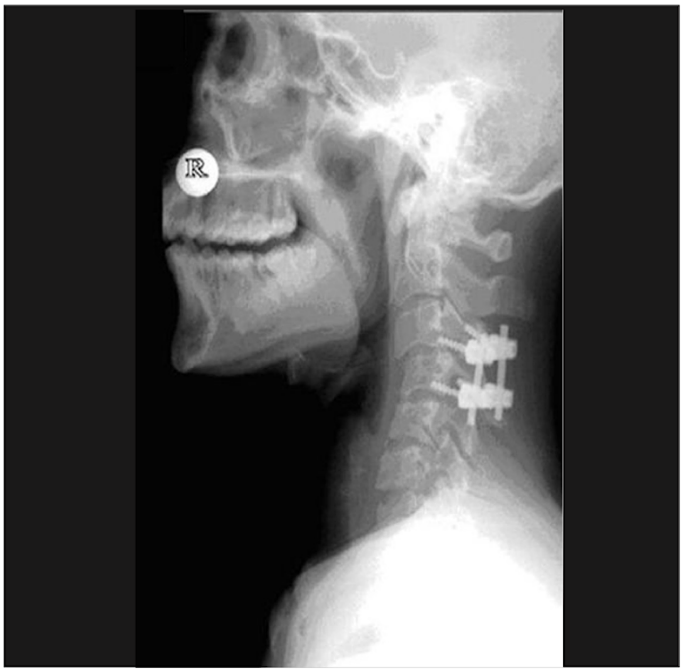

Figure 3. Case no. 2. Plain radiograph of surgical C3-C4 stabilization

3. Discussion

The debate between early versus late decompression surgery in subaxial spinal cord injuries remains an area of ongoing clinical interest. In the cases presented, early decompression (Case 1) yielded significantly better outcomes in terms of rapid recovery and functional improvement. The prompt decompression in this case, performed within hours of injury, was crucial in minimizing spinal cord ischemia and preserving neurological function. Early decompression allows for the restoration of spinal cord perfusion and prevention of irreversible neuronal damage, which is key to achieving optimal recovery. This aligns with numerous studies suggesting that early intervention is linked to better outcomes, especially in cases involving acute spinal cord compression.[5]

In contrast, the patient in Case 2, who underwent delayed decompression surgery, experienced a slower recovery trajectory. Despite an initial period of conservative management and rehabilitation, the patient showed minimal improvement until three months post-injury when decompression surgery was finally performed. Although the late decompression was associated with substantial neurological recovery, the delayed intervention likely prolonged the period of spinal cord compression, leading to a longer rehabilitation phase. Studies consistently show that delayed decompression often results in a slower and less predictable recovery, with patients requiring extended rehabilitation to regain function. However, even with delayed surgery, this case demonstrates the potential for recovery, particularly with dedicated post-surgical rehabilitation.[4]

One of the key factors influencing the outcomes of early versus late decompression surgery is the extent of spinal cord ischemia and neuronal damage. In the case of early decompression, the likelihood of preserving spinal cord function is higher because surgical intervention prevents prolonged compression, which can lead to irreversible damage. In contrast, delayed decompression may result in increased spinal cord ischemia, potentially leading to permanent motor and sensory deficits. While some studies have shown that delayed decompression can still provide functional improvement, the extent of recovery is often reduced compared to early intervention. The recovery observed in Case 2, despite the delay in decompression, underscores that with intensive rehabilitation, even patients who undergo delayed surgery can experience substantial recovery, though at a slower pace.[6]

Moreover, the timing of decompression surgery plays a significant role in determining the severity of secondary complications, such as muscle atrophy, joint contractures, and pressure ulcers. In the case of Case 1, early decompression allowed for more rapid mobilization and rehabilitation, which minimized the risk of such complications. On the other hand, the delayed decompression in Case 2 meant that the patient remained in a more immobile state for a longer period, increasing the risk of complications associated with prolonged bed rest and lack of early rehabilitation. Despite this, the patient in Case 2 demonstrated remarkable functional recovery, highlighting that a delayed surgical approach does not necessarily preclude good outcomes if accompanied by rigorous rehabilitation.[7]

An important aspect of the cases presented is the role of rehabilitation in the recovery process. In both cases, intensive rehabilitation played a pivotal role in improving functional outcomes. However, the timing of surgery can influence the effectiveness of rehabilitation. In Case 1, where early decompression led to rapid neurological recovery, rehabilitation could be more effective, as the patient was able to engage in functional therapy sooner. In Case 2, although rehabilitation was extended over a longer period, the initial delay in decompression likely slowed the patient's recovery, requiring more intensive rehabilitation to achieve similar results. This suggests that while rehabilitation is critical in both early and late decompression cases, the timing of the surgery significantly impacts the pace and success of rehabilitation.[7, 8]

Another consideration is the impact of delayed decompression on the long-term prognosis of spinal cord injury patients. While the early decompression surgery in Case 1 led to a quicker recovery and potentially better long-term outcomes, patients who undergo late decompression may face a longer road to recovery. Long-term rehabilitation may still lead to significant improvements, but the delay in surgery increases the risk of residual deficits. In Case 2, despite the delayed intervention, the patient achieved a notable recovery, suggesting that late decompression can still be effective if the injury is not too severe and appropriate post-operative care is provided. However, the delayed intervention may have limited the patient's recovery potential compared to the early decompression case.[9]

The patient's age, health status, and the mechanism of injury are also important factors in determining the outcomes of early versus late decompression surgery. In both cases, the patients were relatively young and in good health, which may have contributed to their ability to recover, even in the case of delayed surgery. However, in older patients or those with significant comorbidities, delayed decompression may result in poorer outcomes due to factors such as decreased spinal cord plasticity and slower recovery. The ability of younger patients to engage in intensive rehabilitation and recover from delayed decompression emphasizes the importance of considering individual patient characteristics when deciding on the timing of surgery.[7, 9, 10]

The complications associated with decompression surgery are also an important factor in evaluating early versus late intervention. Early decompression surgery carries its own set of risks, including infection, bleeding, and nerve damage, but these risks are generally lower when performed in a timely manner before the spinal cord suffers from prolonged compression. Delayed decompression, while offering the potential for recovery, may come with increased risks of complications due to the longer period of spinal cord ischemia and the increased need for more invasive surgical techniques to address established damage. In Case 2, despite the successful outcome, the patient faced a longer recovery time, which may have been exacerbated by the extended period of injury before surgery.[7, 9]

While early decompression surgery is generally associated with better outcomes, delayed decompression surgery can still result in significant functional recovery in certain patients. The extent

of recovery following delayed decompression is often slower and may be accompanied by a longer rehabilitation period. Factors such as the severity of spinal cord injury, the patient's overall health, and the timing of intervention all influence the outcome. Early decompression surgery remains the preferred approach in cases of acute spinal cord injury, as it minimizes ischemia and maximizes the potential for recovery. However, the cases presented here demonstrate that with appropriate management, including rehabilitation, patients who undergo delayed decompression surgery can still achieve favorable outcomes, though the recovery trajectory may differ. Further studies are needed to clarify the optimal timing for decompression surgery in subaxial spinal cord injuries, considering both the immediate and long-term outcomes of early and late interventions.[9,10]

4. Conclusion

Early decompression surgery for subaxial spinal cord injuries leads to better outcomes by preventing irreversible spinal cord damage and enabling faster recovery. While delayed decompression can still result in improvement, it typically involves slower recovery and higher risk of incomplete recovery. Early intervention remains the preferred approach for maximizing functional recovery, although individualized management is important for cases requiring delayed surgery.

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