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## IS IT REASONABLE TO PERFORM LATE DECOMPRESSIVE SURGERY OF CONUS MEDULLARIS AFTER TRAUMATIC SPINAL CORD INJURY?

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## CZY PÓŹNA CHIRURGICZNA INTERWENCJA OBARCZAJĄCA RDZEŃ KRĘGOWY PO URAZIE NA POZIOMIE STOŻKA RDZENIOWEGO JEST UZASADNIONA?

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### SUMMARY

#### Introduction

The consequences of spinal injuries that result in complete or incomplete damage to the spinal cord continue to be a therapeutic and social challenge. Although many advances have occurred in the treatment of spinal cord injuries which can be seen in an increasing number of promising experimental therapies, the prognosis remains poor for many patients. It is assumed that an early spinal decompression and stabilisation surgery after traumatic spinal cord injury provides better conditions for neurological recovery. Surgery performed within 24 hours after the spinal injury is considered an early intervention. There is lack of enough evidence regarding late spinal decompression surgery after traumatic injuries of the spinal cord.

#### Aim

The aim of this report is to present the outcomes of both surgical and physical rehabilitation treatment of a patient after traumatic lumbar spine injury, with an incomplete damage to the spinal cord, at conus medullaris level. The patient received a non-standard treatment: the timing of an effective surgical decompression of the spinal cord was late.

### STRESZCZENIE

#### Wstęp

Następstwa urazów kręgosłupa, prowadzące do całkowitego lub częściowego uszkodzenia rdzenia kręgowego stanowią istotny problem leczniczy i społeczny. Pomimo postępów w leczeniu uszkodzeń rdzenia kręgowego, wyrażonych w stale rosnącej liczbie obiecujących terapii eksperymentalnych, rokowania dla poprawy stanu neurologicznego pozostają niekorzystne u wielu pacjentów. Powszechnie przyjmuje się, że wczesne chirurgiczne odbarczenie i stabilizacja urazowych uszkodzeń z uciskiem rdzenia kręgowego zapewnia lepsze warunki dla poprawy stanu neurologicznego. Za wczesną interwencję chirurgiczną uznaje się zabieg wykonany w przeciągu 24 godzin od momentu urazu kręgosłupa. Doniesienia na temat późnych interwencji chirurgicznych są nieliczne.

#### Cel

Przedstawienie efektów leczenia chirurgicznego i usprawniającego u pacjentki po urazie kręgosłupa w części lędźwiowej z niecałkowitym uszkodzeniem rdzenia kręgowego na poziomie stożka rdzeniowego, u której przeprowadzono niestandardowe leczenie – późną chirurgiczną interwencją skutecznie odbarczającą uciśnięty rdzeń kręgowy.

### Material and methods

The patient presented in this case report had experienced a fracture of the L2 vertebra with an incomplete damage to the spinal cord, at conus medullaris level. An early surgical decompressive intervention (< 24h) had been unsuccessful, not having achieved sufficient spinal stabilisation and decompression of the spinal cord. The patient was reoperated on in a two-stage surgery, 34 days and 69 days post injury, which resulted in successful decompression of the spinal canal. At the same time an intense rehabilitation program was implemented.

### Results

As a result of provided treatment, 4 months post injury, a considerable neurological and functional recovery was achieved.

### Conclusions

The presented case report shows that late decompressive surgery of spinal cord after traumatic spinal cord injury seems to be reasonable, even if a significant amount of time has passed since the injury.

**Keywords:** spinal cord injury, spine trauma, conus medullaris, rehabilitation, late decompressive surgery

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### Introduction

Traumatic spinal cord injury, caused by an external mechanical force, may lead to following dysfunctions: motor and sensory neurological deficits, autonomic nervous system dysfunctions, bowel, urinary and erectile dysfunctions. The above mentioned functions may be impaired depending on the extent and level of the injury. Primary spinal cord injury mechanism is related to an abrupt compression of the spinal cord by

### Materiał i metody

Zaprezentowany został przypadek pacjentki, która doznała złamania kręgu L2 z niecałkowitym uszkodzeniem rdzenia kręgowego na poziomie stożka rdzeniowego. Chora poddana została wczesnej interwencji chirurgicznej (< 24h), nie uzyskując odpowiedniej stabilizacji i odbarczenia struktur nerwowych. Następnie pacjentkę reoperowano dwuetapowo – po 34 dniach i 69 dniach od momentu urazu, uzyskując prawidłowe odbarczenie rdzenia kręgowego. Prowadzono również intensywne leczenie usprawniające.

### Wyniki

W wyniku zastosowanego leczenia chirurgicznego i intensywnej rehabilitacji, po 4 miesiącach od momentu powstania urazu kręgosłupa, uzyskano istotną poprawę stanu neurologicznego i funkcjonalnego pacjentki.

### Wnioski

Na podstawie opisanego przypadku klinicznego wydaje się uzasadnione wykonanie interwencji chirurgicznej odbarczającej rdzeń kręgowy po urazowym uszkodzeniu kręgosłupa, nawet mimo znacznego upływu czasu od momentu urazu.

**Słowa kluczowe:** uszkodzenie rdzenia kręgowego, uraz kręgosłupa, stożek rdzeniowy, rehabilitacja, późna operacja odbarczająca

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dislocated vertebrae and their fragments. Secondary injury mechanisms include: damage to the blood-spinal cord barrier, inflammation of the nervous tissue, oxidative stress and secondary ischemic injury (Amar *et al.*, 1999). The increased understanding of the pathophysiology of traumatic spinal cord injury has led to clinically relevant neuroprotective therapies to attenuate the effects of the secondary injury (Gupta *et al.*, 2015).

There is also convincing evidence that early decompression of spinal cord after injury improves neurologic outcomes (Fehlings *et al.*, 1999; Fehlings *et al.*, 2001; Fehlings *et al.*, 2006; Fehlings *et al.*, 2010). Therefore it is assumed that the decompressive surgery should be early, performed the in quickest possible time. Surgery performed within 24 hours after the spinal injury is considered an early intervention (Fehlings *et al.*, 2010).

### Aim

It has been attempted to answer to following question: Is it reasonable to perform late decompressive surgery of conus medullaris after traumatic spinal cord injury? The patient received a non-standard treatment: after unsuccessful early surgical intervention, the timing of an effective surgical decompression of the spinal cord was late. The patient was reoperated on in a two-stage surgery, 34 days and 69 days post injury, which resulted in successful decompression of the spinal canal after the first intervention. Functional and neurological examination of the patient was performed: after the first (early) operation with unsuccessful decompression of the spinal cord, after the second operation (34 days post-injury) with successful reposition and decompression of the spinal cord, and after having completed the rehabilitation programme.

### Material and methods

An 18-year-old female patient was involved in a car accident as rear seat passenger. She was admitted to hospital, having complained of severe low back pain with lower limb paralysis. Physical examination showed paraplegia with global muscle strength score 1 in Medical Research Council muscle test, and bilateral hypoesthesia distally from L2 dermatome. Computed tomography scan showed an unstable, tri-column, flexion-distraction fracture of L1/L2, with L2 compression fracture penetrating the spinal canal. The bony injury level and presented symptoms corresponded to injury of the conus

medullaris. An early (< 24h) surgical intervention was performed (first operation): laminectomy of L2 and partly L3, transpedicular stabilization of L1-L3 – not having achieved successful spinal canal decompression (Figures 1 and 2).

After the first surgical operation there was partial skin sensation improvement. Subsequently, the patient was admitted to the Clinic for Rehabilitation and started physical rehabilitation programme. On 34th day post injury the patient was reoperated on (second operation). The second operation consisted of : removing of previous L1-L3 stabilization, extending of the spinal stabilization from Th12 to L4, extending of the spinal canal decompression by L1 laminoplasty and L1/L2 discectomy which enabled to achieve a satisfactory reposition and decompression of the spinal canal (Figures 3 and 4).

After the second operation the patient underwent an intense physical rehabilitation treatment in the Clinic for Rehabilitation. The rehabilitation programme included: neuromuscular reeducation, muscle strengthening exercises, balance exercises, verticalization, and gait training – which started with partial body weight support. Gradual neurological and functional recovery was observed during the rehabilitation process. Subsequently, on 69th day post injury, next operation was performed (third operation): L2 anterior vertebrectomy, vertebral body replacement and L1-L3 intercorporeal stabilization with a titanium implant (Figures 5 and 6).

On first day after the third operation, clinically asymptomatic diaphragmatic hernia was found in X-ray image. The patient was referred to a thoracic surgery center where the diaphragmatic dome was sutured. The morphological changes of the diaphragmatic dome observed during the operation suggested a post-traumatic rupture of the diaphragm. After the third surgical operation an intense rehabilitation programme was continued.

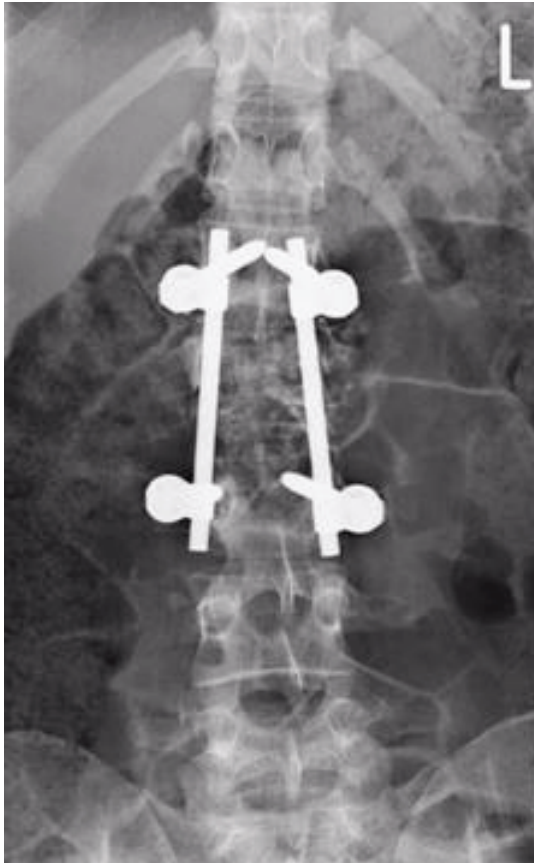


Figure 1. X-ray after first operation.



Figure 2. X-ray after first operation.

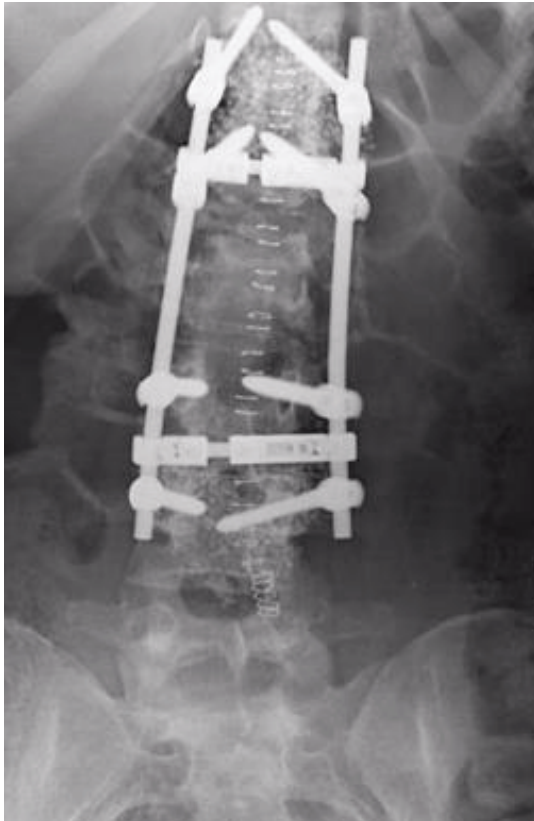


Figure 3. X-ray after second operation.

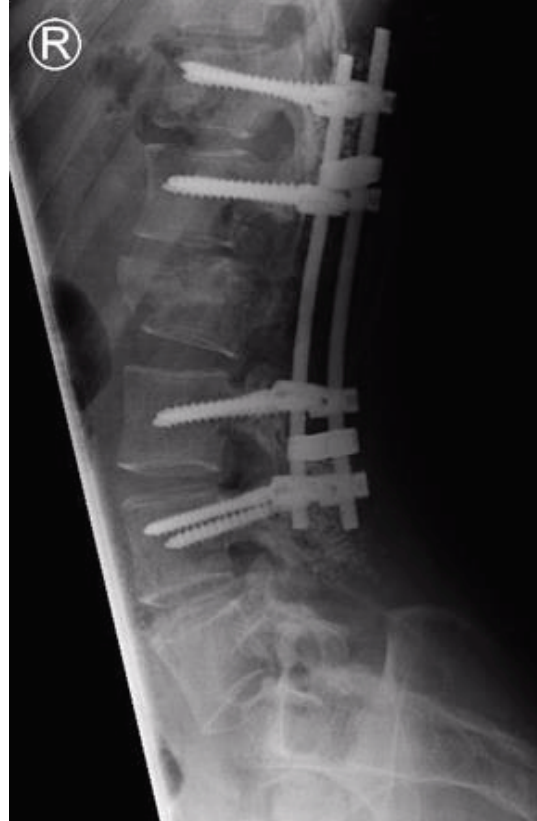


Figure 4. X-ray after second operation.





Figure 6. X-ray after third operation.

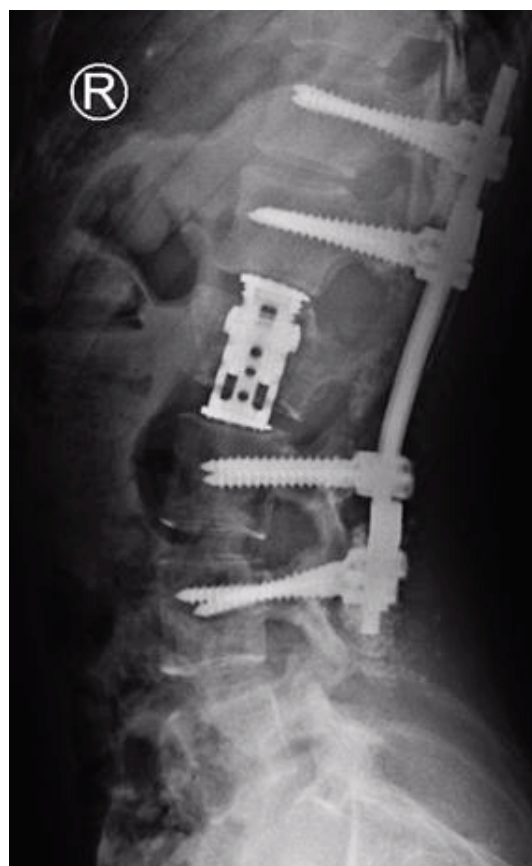


Figure 5. X-ray after third operation.

The patient underwent specific clinical assessment three times:

1. 10 days after the first operation (10 days post injury),
2. 10 days after the second operation (45 days post injury),
3. after having completed in-patient rehabilitation programme (134 days post injury).

Each assessment was composed of following elements:

1. American Spinal Injury Association (ASIA) Impairment Scale (A-E categories),
2. Barthel Index of Activities of Daily Living (0–20 points),
3. bladder function assessment – based on clinical status of the patient together with urodynamic test and ultrasonographic post-void residual urine volume,
4. Frequency of use of non-steroidal anti-inflammatory drugs by the patient due to low back pain.

## Results

Table 1 shows the results of each of the patient assessments: 10 days after the first operation, 10 days after the second operation and at the end of in-patient rehabilitation process.

When admitted to the Clinic for Rehabilitation – after the first surgical operation with unsuccessful attempt to decompress the spinal canal – the patient presented paraplegia with global muscle strength score 1 in Medical Research Council muscle test, and bilateral hypoesthesia distally from L2 dermatome. The patient was almost entirely dependent in activities of daily living – she scored 5 points in Barthel Index ADL. Due to serious bladder dysfunction, she required an indwelling urinary catheter. The patient complained of severe low back pain. Her ASIA Impairment Scale (AIS) grade was B (incomplete injury: sensory, but not motor). As a result of provided treatment, both surgery and rehabilitation, 4 months post injury,

**Table 1.** The results of patient assessments: after the first operation, after the second operation, at the end of rehabilitation process.

	Assessment after first operation	Assessment after second operation	Assessment at the end of rehabilitation
ASIA Impairment Scale (AIS)	B	D	D
Barthel Index ADL (20-points)	5	14	20
Average frequency of use of NSAIDs due to low back pain	Every day, few times a day	Once every few days	Once a week
Urinary bladder function	Dysfunction: indwelling catheter	Dysfunction: intermittent catheterization	Normal Function

a considerable neurological and functional recovery was achieved. In the final assessment, the patient's AIS grade improved to D (incomplete injury: motor function is preserved below the neurologic level, and most key muscles below the neurologic level have a muscle grade that is greater than or equal to 3). Therefore, there was a significant improvement in neurologic outcome of 2 AIS grades. At the end of in-patient rehabilitation the patient was able to walk on level grounds and climb up stairs. There was also a conversion in the patient's Barthel Index, to 20 points.

### Discussion

The thoracolumbar junction is the region where the rigid thoracic kyphosis transitions into the mobile lumbar lordosis and is therefore susceptible to traumatic injuries. A majority of injuries occurring at this level are either compression or burst fractures. In the vicinity of the thoracolumbar junction the spinal cord terminates as the conus medullaris. Anatomically, this is a dilation of the distal portion of the spinal cord and is the site of transition from the central to peripheral nervous system, cauda equina (Harrop *et al.*, 2004). Conus medullaris injury may result from trauma of vertebrae Th12-L2 and it involves damage starting from spinal cord segment Th12 to nerve root S5. Cauda equina injury may result from an injury of vertebrae L3-L5, and it involves damage to nerve roots L3-S5 (Brouwers *et al.*,

2017). Patients with an injury at level of conus medullaris or above, present with common symptoms of spinal cord injury. Patients with injuries below this level may present with lumbosacral radiculopathies. Lesions affecting the transition between the two regions may result in symptoms of both upper and lower motor neuron damage. The patient described in this case report presented with symptoms of conus medullaris injury, consistent with the bony level of spine injury – L2. Traumatic injuries of both conus medullaris and cauda equina are relatively rare therefore in the literature they are often classified and described as one group of injuries. There is also lack of enough evidence verifying the effectiveness of treatment of conus medullaris and cauda equina injuries (Tokhie *et al.*, 2013). Considering all types of traumatic spinal cord injuries, there is a lack of existing guidelines regarding the timing of surgical decompressive intervention after spinal cord injury. Although it was shown by many authors that an early decompressive intervention is associated with an improved neurologic outcome. Fehlings *et al.*, (2010) performed a prospective study verifying change of AIS grade at 6 months follow-up after traumatic spinal cord injury. Of the 222 patients available at 6 months post injury, 19.8% of patients undergoing early surgery (< 24h) showed a  $\geq 2$  grade improvement in AIS compared to 8.8% in the late decompression group. However, in the mentioned study patients

that underwent an operation > 7 days post injury, were excluded. Furthermore, Yousefifard *et al.* (2017) showed that the efficacy is most prominent when the surgery is performed within the first 12 hours after injury. On the other hand there is a lack of evidence and recommendations regarding the effectiveness of late or very late decompressive interventions. Only Mirzashahi *et al.* (2016) described two cases of patients after incomplete traumatic spinal cord injury – the first patient due to L2 fracture and the second patient due to vertebral fracture of L1. The first patient underwent a decompressive operation of the spinal cord 18 days post injury, the second patient – 10 days post injury. In both cases a considerable neurological and functional recovery was achieved after few months: the first patient's AIS improved of 1 grade and the AIS of the second patient improved of 2 grades.

In our patient, there was a significant, 2 AIS grade neurologic improvement after the effective decompressive surgery of spinal cord. Satisfactory spinal cord decompression was achieved after 34 days post injury. Therefore, based on results of other authors, the operation of our patient should be considered as very late decompressive intervention which is rarely described in the literature. However, apart from the decompressive surgery that was performed, in the overall treatment assessment of our patient, the important role of early started physical rehabilitation should also be stressed. In persons after spinal cord injuries, neuroplasticity processes that enable neurologic recovery can be effectively induced by early implemented physical rehabilitation (Dietz *et al.*, 2014). The overall treatment effect is in fact composed of many overlapping mechanisms, such as surgical intervention, physical rehabilitation process and spontaneous sensorimotor recovery due to spinal shock resolution.

## Conclusions

There is a need for further reports on the effectiveness of late or very late decompressive interventions for the spinal cord, in particular its distal portion. Based on presented case report and literature review, late decompressive surgery of spinal cord after traumatic spinal injury seems to be reasonable and beneficial for patients, even at late stages post injury.

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