CASE REPORT

Management of Patients Post Laminectomy Decompression Et Causa Spinal Cord Injury Cervical Vertebrae 1-7 with Hyperglikemia in Intensive Care Unit

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ABSTRACT

Background: In the United States, in 2008 of 100,000 cases of spinal cord injury, 2/3 were cases of cervical injury. Patients who experience cervical to thoracic Spinal Cord Injury (SCI) above T8, usually have impaired function of the diaphragm and intercostal muscles which causes respiratory failure. Neurogenic shock occurs in patients who experience SCI above T6 which causes vasodilation, hypotension and severe bradycardia or asystole when stimulating vagal reflexes such as laryngoscopy or suctioning.

Case: The patient was diagnosed with SCI cervical vertebrae 1-7. The patient underwent decompressive laminectomy et causa SCI cervical vertebrae 1-7 and hyperglycemia. Management includes surgical therapy, management of respiratory failure in the Intensive Care Unit (ICU), pharmacological therapy include insulin for hyperglicemia control, and support for neurogenic shock and physioterapy.

Discussion: Patients with SCI require laminectomy, supportive therapy, pharmacotherapy include insulin, neurogenic shock, and respiratory support if there is respiratory failure. In cases of injury to cervical vertebrae 1-7, the patient requires ventilator support to assist the function of the diaphragm and intercostal muscles, pharmacological supportive therapy for neurogenic shock, as well as care from a sub-endocrine specialist to treat hyperglycemia. Stress-induced hyperglycemia was occurred due to CNS injury.

Conclusion: Spinal Cord Injury (SCI) is a disorder of the spinal cord or spinal cord with neurological symptoms ranging from motor, sensory and autonomic function. Respiratory failure in SCI above thoracic 8, is due to disturbances in the function of the diaphragm and intercostal muscles. The occurrence of neurogenic shock in SCI cases, especially above thoracic 6, manifests in the form of vasodilation, hypotension and severe bradycardia or asystole. Management in the ICU includes hemodynamic monitoring, respiratory failure, prevention of neurogenic shock, and pharmacology to treat hyperglycemia. Biochemical parameters, nutritional status, and respiratory function were also monitored.

Keywords: cervical; hyperglycemia; intensive care unit; laminectomy; spinal cord injury

INTRODUCTION

Cervical injury is one of the most common spinal injuries in trauma sufferers. In the United States in 2019, of the 12,000 cases of spinal cord injury, 2/3 were cases of cervical injury. Cervical injuries are the most common spinal injuries that can cause disability and death. From several studies it turns out that there is a correlation between the level of cervical injury and morbidity and mortality, meaning that the higher the location of the cervical injury, the higher the morbidity and mortality.[1,2]

Patients who experience spinal cord injury (SCI) from the cervical to thoracic regions, especially above T8, usually have problems with the function of the diaphragm and/or intercostal muscles which will cause respiratory failure so that supporting measures are needed in the form of providing breathing ventilation. Neurogenic shock usually occurs in patients who experience SCI above T6 which will cause vasodilation, bradycardia and hypotension and severe bradycardia or asystole can occur when treatments that stimulate the vagal reflex such as laryngoscopy or suction are carried out. The prognosis of patients with SCI can vary depending on the extent, completeness of the lesion, accompanying injuries, comorbid diseases, and the age of the patient. Even though currently there are various kinds of sophisticated equipment and qualified human resources, the lifespan of post-SCI patients is generally shorter than that of society in general with a mortality of 3.8%. The average patient will have a life expectancy of 18.1-88.4%.[2,3]

Management of cervical injuries, apart from surgery, also requires other measures in the form of supporting therapy with pharmacotherapy if the patient has comorbidities and other accompanying diseases and in the context of monitoring neurogenic shock, as well as supporting breathing equipment if there are indications of respiratory failure.

CASE

A male patient, 42 years old, height 167 cm, and weight 76 kg, came to the Hospital Emergency Department on June 23, 2023 at 01.00 with complaints of pain in the head and weakness of the upper and lower limbs. The patient was unable to move his limbs after his neck hit a felled tree on June 22, 2023 at 07.00. Chest X-ray is performed on the patient. From the orthopedic surgeon specialist, the patient was then scheduled for laminectomy surgery on June 23, 2023 at 20.00. Electrocardiogram on normal sinus rhytm, Laboratory result on complete blood lab, electrolytes, coagulation were within normal limits. Blood sugar were 407, HbA1c was 5,9 %, and patient in hypoalbumin 2,54. On examination of the neurological status, it was found that the upper and lower motor skills had contractions or muscle tone but there was no movement at all. The patient's muscle strength can move the extremities but this movement cannot resist gravity. Muscle tone or the amount of tension or resistance to movement in muscles within normal limits, muscle tissue within normal limits, Physiological Reflexes or reflexes that appear in normal people, positive, pathological reflexes or voluntary movements that arise as a result of a stimulus found from the hoffman reflex examination, namely scratching on the patient's middle finger nail (down) and tromer, namely a poke on the tip of the patient's middle finger (up) were positive, babinski, namely scratching the lateral sole of the foot from back to front, obtained positive results. Hypesthesia

sensitivity up to the level of cervical dermatome 3-5, the patient has a urinary catheter installed, the production of clear yellowish urine. On X-ray examination, the chest photo was within normal limits.

Figure 1. Cervical Multi Slice Computerized Tomography (MSCT)

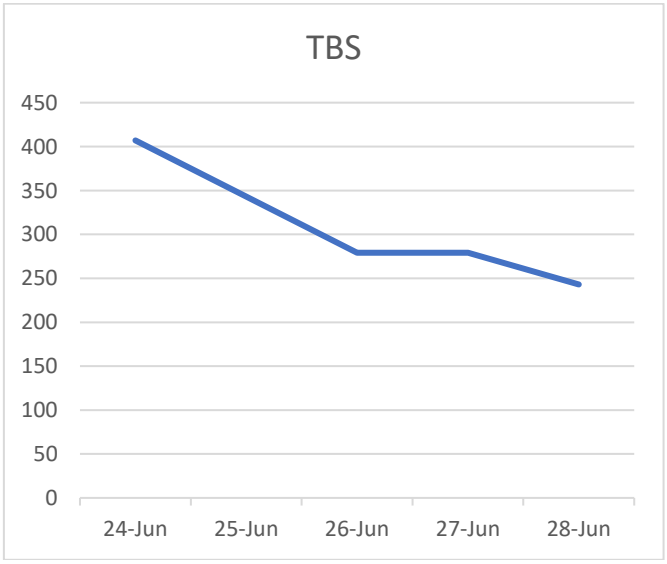
Cervical Multi Slice Computerized Tomography (MSCT) photo results on June 23 2023 showed a complete fracture of the left articular face and the left posterior arch of the vertebra cervical (VC) 1, according to the lateral mass C 1 fracture, complete fracture of the left articular process of the vertebra cervical (VC) 3, complete fracture of the left articular process and spinous process of the vertebra cervical (VC) 4, complete fracture of the right lamina and spinous process of the vertebra cervical (VC) 5, Brust fracture of the os corpus of the vertebra cervical (VC) 4 and unilateral facet joint dislocation dextra vertebra cervical (VC) 4-5, hypodense lesion in the spinal canal at the level of the vertebra cervical (VC) 3-6 suspicious of spinal cord injury.

Figure 2. Antero Posterior Lateral Cervical Photo

Lateral AP cervical examination was carried out, the results showed a compression fracture of the corpus of the cervical vertebrae 4 and 5, a complete fracture of the spinous process of the cervical vertebrae 4 and 5, Spondylolisthesis of the cervical vertebrae 5, 6 grade 1, prevertebral soft tissue edema, Spondylosis of the cervical vertebrae. Patient denied history of high blood pressure. On physical examination, it was found that his general condition looked weak, consciousness was compos mentis, nasal oxygen tube was installed 3 liters per minute, breathing was spontaneous, respiration rate (RR) 20 x/min, crackles -/, wheezing -/-, saturation 97%, blood pressure 110 /60 mmHg, heart rate (HR) 80 x/min, glasgow coma scale (GCS) Eye (E) 4, movement (M) 1, Verbal (V) 5.

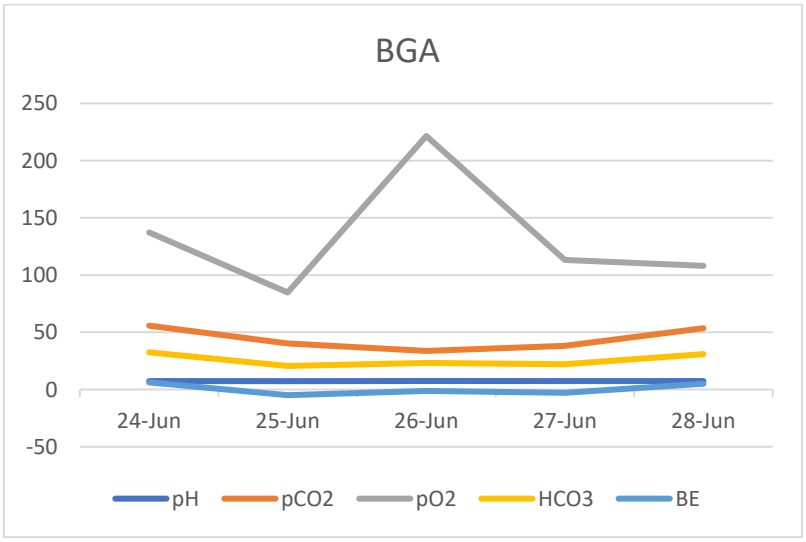
The patient underwent laminectomy for 4 hours 25 minutes with bleeding of approximately 470 cc. During surgery, the patient's hemodinamics were within stable limits with blood pressure around 108-116 mmHg in systole and diastole at 78-88 mmHg, heart rate at 67-98 beats/minute, respiration rate at 15-18 beats/minute, with saturation 97-100%. No neurogenic shock occurred during surgery.

The patient was admitted to the intensive care unit (ICU) on June 24, 2023 at 00.52 WIB from the central surgical installation with general condition: weak, GCS: E1, M1, V1et with sedation, installed IV line in left hand with 0.9 NaCl infusion. % 20 drops perminute, central venous catheter (CVC), naso gastric tube (NGT), arterial line, urinary catheter and collar neck. On Day 1 of the patient's treatment in the ICU, an endotracheal tube (ET) no. 7.5 was installed on a ventilator in pressure-synchronized intermittent mandatory ventilation (PSIMV), pressure control (PC) 12, positive end expiratory pressure (PEEP) mode. 5, FiO2 50%, SpO2 100%, RR 16. The patient received therapy with cefotaxim 1gr/12 hours, paracetamol 3x1000 mg, fentanyl titration, norepinefrin and dopamine titration, midazolam titration, insulin 16 international units (IU) was given to administered hyperglycemia, as the result of temporary blood sugar was 407. Ketorolac 30 mg/8 hours was given, and was proposed for installation percutaneous dilatational tracheotomy (PDT). PDT was recommended considering the long post-laminectomy care and to secure the airway and facilitated bronchial toilet so as to prevent pneumonia. The balance between fluid in (intake) and fluid out (output) is positive and does not exceed 400 ml per day. On day 2 of treatment, the ventilator weaning mode becomes pressure support and the patient receives correction of hypolbumin from 2,54 become 2,93. On the 3rd day of treatment, the patient received the antibiotic meropenem 1 gr/8 hours. On day 5th, the patient was stable and extubated. The results of the sputum culture examination (24/06/2023) showed the results of klebsiella pneumoniae. The results of urine fluid cytology examination (04/07/2023) showed negative for malignancy (NFM).



Graph 1. Results of temporary blood sugar (TBS) examination

When examining the temporary blood sugar (TBS), hyperglycemia results were obtained, for management, sliding scale insulin was given, for the first day the TBS 407 was given insulin 16 IU, then on D-2 and D-3 in the ICU , GDS 279 was given 8 IU of insulin, then on D-4 GDS 243 was given 4 IU of insulin. The results of the Hemoglobin A1C (HbA1C) examination are within normal limits.



Graph 2. Blood gas analysis (BGA) examination results

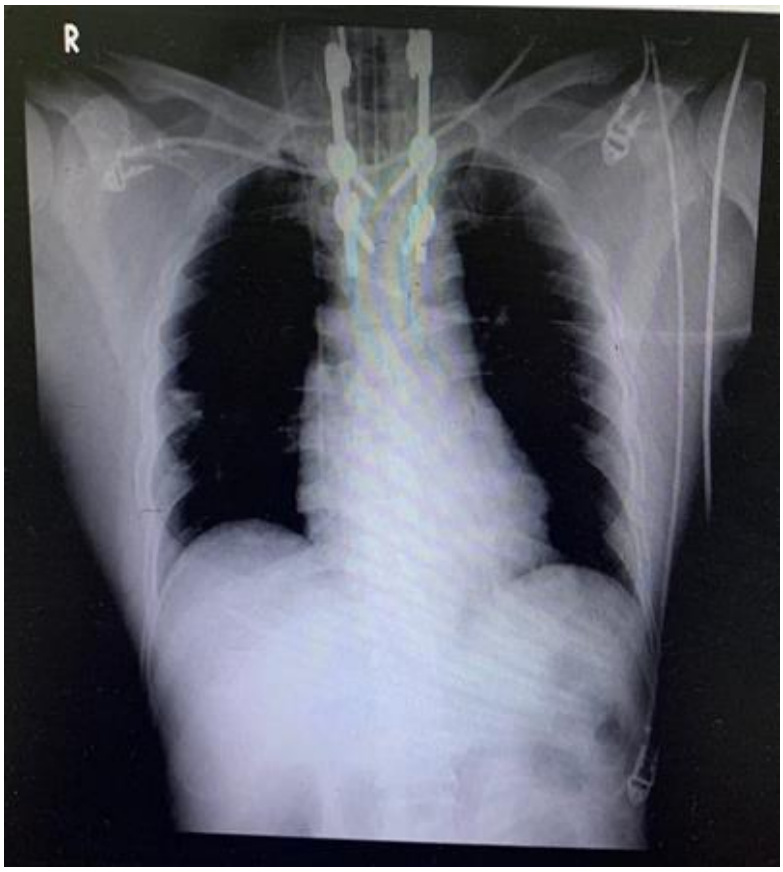


Figure 3. Chest X-ray
Result of Chest X-ray on June 23, 2023 showed within normal limits.

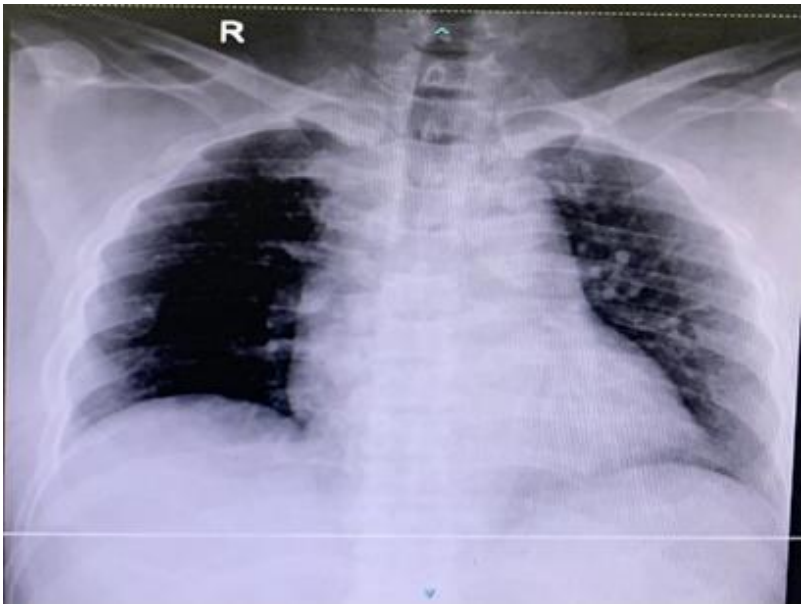
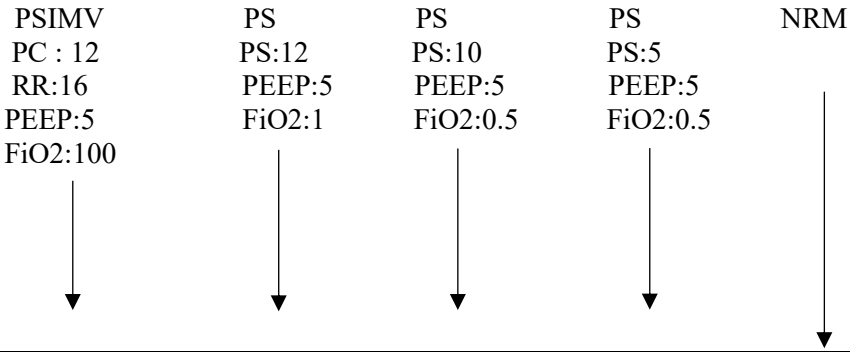


Figure 4. Chest X-ray
Results of Chest X-ray on July 2, 2023 showed pneumonia and right pleural effusion.

DISCUSSION

42-years-old male patient with Post Laminectomy et causa spinal cord injury vertebra cervical 1-7 with Hyperglycemia. The operation was carried out on June 23, 2023. Post decompression laminectomy surgery, the patient was managed in the ICU with a ventilator with PSIMV mode FiO2 50%, Trigger 3, PEEP 5, PC 12, RR 16. On the 4th day in the ICU, the ventilator setting was weaning into spontaneous mode, FiO2 50%, PS 12, Trigger 3, PEEP 5.

Table 1. Development of ventilator weaning



Day	1	2	3	4	5
Respiration	RR: 16-20 PP:20-22 TV:376-450 SpO23:97-100	RR: 22-30 PP:20-22 TV:383-430 SpO2:98-100	RR: 25-28 PP:20-24 TV:378-483 SpO2:98-100	RR: 18-24 PP:20-22 TV:385-510 SpO2:97-100	RR:18-20 SpO2 :98-100
P/F Ratio	274	170	443	226-326	216-312

The patient was managed by administering asering infusion 40 cc/hour, NaCl 0.9% 20 cc/hour, cefotaxim injection 1 g/12 hours IV then on the 3rd day the antibiotic was replaced with meropenem 1g/8 hours based on culture results showing klebsiella pneumoniae and improvement leukocytes from 13,800/μL to 19,700/μL, injection of Paracetamol 1 g/8 hours IV, fentanyl, insulin 16 IU, norepinephrine and midazolam titration, Paracetamol 1 g/8 hours IV, N-acetylcysteine 200 mg/8 hours. Omeprazole 40 mg/8 hours iv on 3rd day. After laminectomy, the patient was taken off the ventilator on June 28, 2023 and underwent a 24 hours evaluation. The patient was in stable condition and then moved to another room. The results of the sputum culture examination (June 24, 2023) showed klebsiella pneumoniae. The results of urine fluid cytology examination (July 4, 2023) showed negative for malignancy (NFM).

Cervical injury is the most common spinal injury that can cause disability and death. From several studies it turns out that there is a correlation between the level of cervical injury and morbidity and mortality, meaning that the higher the level of cervical injury, the higher the morbidity and mortality.[1,3,21]

In this patient, pneumonia was found on culture and radiology results. This is associated with a high mortality rate due to SCI. Spinal Cord Injury Associated Pneumonia (SCI-AP) is associated with poor functional recovery and is the leading cause of death after SCI. Frequently requested additional

diagnostics are microbiological analysis, C-reactive protein, and procalcitonin. The procalcitonin results for this patient were within normal limits. For empirical antibiotic therapy, (acyl) aminopenicillin/β-lactamase inhibitors, cephalosporins, or a combination of (acyl)aminopenicillin/β-lactamase inhibitors with fluoroquinolones or carbapenems are used. This patient was given the antibiotic cefotaxim 1 gr/12 hours on day 1 in the ICU, then on the 3rd day it was replaced with meropenem 1 gr/8 hours based on the culture results showing klebsiella pneumoniae and an increase in leukocytes from 13,800/μL to 19,700/μL.[2,20,23,24]

The main goal of SCI therapy is basically to prevent and stop secondary spinal cord injuries. Surgical procedures for SCI aim to stabilize the spine or decompress the spinal cord as prevention of secondary injury. This is especially true in situations where there is a compression lesion or narrowing of the canal, with the hypothesis that relieving pressure on the spinal cord will help the healing process by minimizing secondary injuries. Absolute indications for surgery in SCI include progressive neurological deficits with compression of the spinal cord, as well as dislocation of the vertebral column. [2,4]

Neurogenic shock usually occurs in patients who experience SCI above T6 which will cause vasodilation, bradycardia and hypotension and severe bradycardia or asystole can occur when treatments that stimulate the vagal reflex such as laryngoscopy or suction are performed. Treatment of patients with neurogenic shock requires vasopressor drugs such as noradrenaline, phenylephrine, or metaraminol, and positive inotropic dopamine is recommended to treat vascular tone and prevent secondary injury. It is recommended to monitor blood pressure using an arterial line and central venous catheter to administer medication as well as monitor central venous pressure.[3]

The etiology of hyperglycemia following central nervous system (CNS) injury is multifactorial. First, stress-induced hyperglycemia is considered an adaptive immune-neurohormonal response to stress involving two mechanisms: 1) increased glycogenolysis and hypermetabolism caused by the secretion of stress hormones. such as catecholamines, cortisol, glucagon, and growth hormone following activation of the hypothalamic-pituitary-adrenal axis and the sympathetic autonomic nervous system; and 2) transient increase in insulin resistance as another catecholamine-related effect. Second, SCI is often accompanied by a systemic inflammatory response syndrome that can cause hyperglycemia because: 1) the release of several cytokines (eg tumor necrosis factor alpha [TNF-α], interleukin [IL]-6) provokes hyperglycemia and insulin resistance; and 2) release of corticotropin-releasing hormone and release of adrenocorticotropic hormone from the anterior pituitary. Third, preinjury diabetes mellitus, estimated global prevalence at 9.3% in 2019, is a potential cause of hyperglycemia in individuals with neurotrauma. Fourth, pituitary and hypothalamic dysfunction have multiple effects on the stress response, and directly influence glucose homeostasis, hepatic gluconeogenesis, and insulin sensitivity. Lastly, many other factors inherent in the management of individuals with acute CNS injury can precipitate hyperglycemia including fluid infusion, surgery, anesthesia, and medications (e.g., corticosteroids).[16, 19]

In this patient, stress-induced hyperglycemia was occurred due to CNS injury. Therefore, this patient was treated with sliding scale insulin according to the current blood sugar laboratory test.

Spinal cord injury (SCI) is a disorder of the spinal cord or spinal cord with symptoms of neurological function ranging from motor, sensory and autonomic function, which can lead to permanent disability and even death. According to WHO, SCI is estimated to occur in 40-80 cases per 1 million population in a year. This means that there are around 300,000 – 600,000 cases of SCI throughout the world every year. This of course cannot be separated from the risk of SCI, which is mostly caused by traumatic cases (90%), including traffic accidents (50%), falls (25%), sports or work-related accidents (10%).[4] The results of other studies show that more than 70% of SCI patients will also experience some other injury, which is evidence that the incidence of SCI in traumatic cases is very high. So every time a traumatic event is found that results in multiple injuries, whether with neurological deficits or not, SCI must be considered. The spinal cord is located in the spine and has complex structures and networks that function to transmit information and instructions from the brain to various parts of the body and vice versa. The structure of the spine consists of 7 cervical bones, 12 thoracic bones, 5 lumbar bones, 5 sacrum bones, 5 coccygeal bones. Each spine will transmit a number of nerve fibers that function neurologically which regulate each sensory and motor function according to the dermatome. Approximately 55% of SCI incidents occur in the cervical region and are followed by thoracic (15%), thoracolumbar (15%), and lumbosacral (15%).[2,3]

According to research, around 80% of SCI patients affecting the cervical spine, most of whom will die on the spot. Apart from the high level of injury lesions, the cervical part has a high level of mobility and exposure so that disruption of the patient's organs will be easier. Thoracic SCI is less common due to simpler mobility and protection by the ribs, but this case cannot be ruled out because the patient may suffer difficulty breathing due to paralysis of the intercostal muscles and/or diaphragm.[2,3,12]

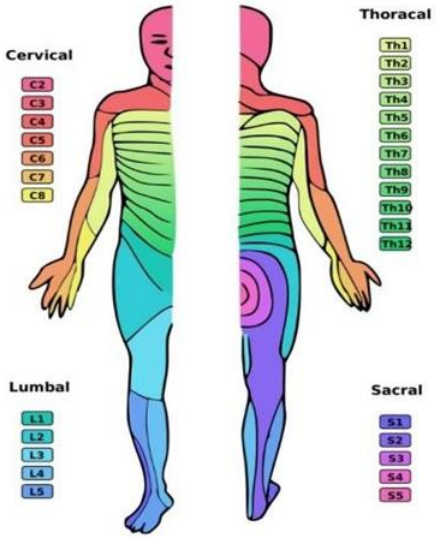


Figure 5. Dermatomes in humans [1,18]

Spinal cord injury (SCI) can be divided into 2, namely traumatic and non-traumatic. Traumatic cases have a higher incidence rate (90%) than non-traumatic cases (10%) with the most frequent traumatic cases including traffic accidents, followed by falls, sports or work-related accidents and recreation, and violence. [1,4,5]

In this patient, spinal cord injury occurred which was caused by trauma factors that had high compressive forces.

The mechanism of how SCI occurs can occur based on its onset into 2, namely primary injury and secondary injury. Primary injury is an initial injury that is acute and sudden, caused by mechanical factors such as traumatic cases which have high compressive forces and energy transformations, which will cause structural failure of the biomechanical integrity of the spine. Primary injuries can occur directly or indirectly. Direct or direct injuries are caused by transient and persistent spinal cord compression disorders, direct distraction can occur due to kinetic transmission through nerve tissue, without any structural damage such as fractures. An example is hyperextension injury in cervical central cord syndrome which occurs in elderly patients when they fall. Primary injury has four main mechanisms, including: (1) transient (temporary) spinal cord compression disorder; (2) persistent or ongoing spinal cord compression disorders; (3) distraction injuries; (4) laceration or direct transection.[1,5,6]

Secondary injury is a further injury caused by an exacerbation or continuation of a primary injury. The results of primary injury such as local or systemic inflammation and edema, hypotension, hypoxemia, and bleeding, trigger a pathophysiological cascade that will result in impaired perfusion and delivery of oxygen and blood flow to the damaged part of the spinal cord. Secondary injury can be divided into several phases. that is: (1) immediate phase (<2 hours): bleeding, cellular necrosis, glutamate release, increased cytokine regulation; (2) initial acute phase (<48 hours): ischemia, increased edema, free radical production, ion dysregulation, glutaminergic exocytosis, immunological neurotoxicity; (3) sub-acute phase (<2 weeks): macrophage infiltration, reactive astrocytosis.

This phase can progress to an intermediate phase, where gliosis occurs which develops in less than 6 months, causing scar tissue to appear on the axons. In more than 6 months, the intermediate phase will develop into a chronic phase which causes the formation of syringomyelia or cysts in the spine, which is currently still being carried out further research regarding its formation.[1,6,7]

Table 2. Differences in lesions in complete and incomplete injuries[1]

Characteristics	Complete lesion	Noncomplete lesion
Motoric	(-) along the bottom of the lesion	Often (+)
Protopatic	(-) along the bottom of the lesion	Often (+)
Propioseptic	(-) along the bottom of the lesion	Often (+)
Sacral sparing	Negatif	Positif
Radiology vertebra	Fraktur, luksasi, listesis	normal
MRI	Bleeding (often), kompresion, kontusio	Edema (often), kontusio, normal

In this patient, complete lesions occurred including motor disorders, where the patient was unable to move his upper and lower limbs. Protopathic stimulation was also negative in this patient, likewise proprioseptic stimulation was also negative. Radiology vertebra showed complete fracture on several part of cervical.

Cervical Multi Slice Computerized Tomography (MSCT) photo results on June 23 2023 showed a complete fracture of the left articular face and the left posterior arch of the vertebra cervical (VC) 1, according to the lateral mass C 1 fracture, complete fracture of the left articular process of the vertebra cervical (VC) 3, complete fracture of the left articular process and spinous process of the vertebra cervical (VC) 4, complete fracture of the right lamina and spinous process of the vertebra cervical (VC) 5, Brust fracture of the os corpus of the vertebra cervical (VC) 4 and unilateral facet joint dislocation dextra vertebra cervical (VC) 4-5, hypodense lesion in the spinal canal at the level of the vertebra cervical (VC) 3-6 suspicious of spinal cord injury.

Lateral AP cervical examination was carried out, the results showed a compression fracture of the corpus of the cervical vertebrae 4 and 5, a complete fracture of the spinous process of the cervical vertebrae 4 and 5, Spondylolisthesis of the cervical vertebrae 5, 6 grade 1, prevertebral soft tissue edema, Spondylosis of the cervical vertebrae.

Table 3. Types of Spinal cord syndrome[1]

Characteristics	Central cord syndrome	Brown sequard syndrome	Anterior cord syndrome	Posterior cord syndrome
Incident	Often	Seldom	Seldom	Rarely
Biomekanic	Hiperextention	penetration	hiperflektion	Hiperextention
Motoric	Varies, paralisis complete seldom	Paresis ipsilateral	Paralisis complete bilateral	Varies
Protopatic	Varies and not typical	Contralateral completely disappeared	Completely lost, Intact bilaterally	Varies, usually light
Proprioseptic	Rarely glitches	Ipsilateral Completely disappeared	Intact	disturbed
Repair	Real and fast	Bad function ipsilaterally, good independence	The worst	real

In this patient, the type of spinal cord injury is anterior cord syndrome, where the protopathic and proprioseptic disorders are positive, there is complete bilateral paralysis, in the protopathic there is complete loss, the proprioseptic condition is intact, and the repair tends to take a long time.

Table 4. Neurological disorders based on level of injury to the spine[1]

Level of injury	Potential interference
C2-C3	Fatal, there is damage to diaphragmatic breathing
C4	Quadriplegia with disorders of the diaphragmatic nerves and chest wall muscles which makes it difficult breathe
C5	Quadriparesis with dysfunction of the shoulders and elbows accompanied by disorders of the diaphragm nerves and chest wall muscles which makes it difficult breath
C6	Quadriparesis with dysfunction of the shoulders and elbows accompanied by disorders of the diaphragm nerves and chest wall muscles which makes it difficult breath
C7	Quadriparesis with impaired function of the shoulders, elbows, wrists and poor finger function (can only extend fingers)
C8	Quadriparesis with normal function of the arms but weak carpals
T1-T6	Paraplegia with the function of the lower part of the middle chest lost but still possible control the arm
T7-T12	Paraplegia with loss of function from the waist down and impaired control of the trunk
L1-S5	Paraparesis of the leg muscles

This patient had a spinal cord injury in cervical vertebrae 1-7. Which potential interference is fatal, there is damage to diaphragmatic breathing. Quadriparesis with dysfunction of the shoulders and elbows accompanied by disorders of the diaphragm nerves and chest wall muscles which makes it difficult breath are occurred in this patients so mechanical ventilator support was needed.

Box 3 | **ASIA Impairment Scale**

The American Spinal Injury Association (ASIA) Impairment Scale grade is a global measure of injury severity and is largely based on the concept of sacral sparing (that is, some degree of maintained perineal sensation, voluntary anal contraction and/or great toe flexion indicating an incomplete lesion). The scale is used to determine the grade of spinal cord injury (SCI), which ranges from ASIA Impairment Scale grade A (the most severe injury with complete sensorimotor loss) to ASIA Impairment Scale grade E (the least severe injury with no neurological deficit).

Grade A
Sensory or motor function below the neurological level (that is, the lowest segment where sensorimotor function is normal on both sides) of injury, including absent sacral function (that is, no voluntary anal contraction, no great toe flexion, and no perineal, genital, anal pinprick or light touch sensation).

Grade B
Sensory but not motor function is preserved below the neurological level of injury, including the distal sacral segments (S4–S5). No motor function is present more than three levels below the neurological level, on either side of the body.

Grade C
Motor function below the neurological level of injury (including the distal sacral segments) is preserved, with more than half of the key muscles (that is, elbow flexors and extensors, wrist extensors, finger flexors and abductors, hip flexors, knee extensors, ankle dorsiflexors, long toe extensors and ankle plantar flexors) having a grade of <3 on the ASIA motor score (against gravity without additional resistance).

Grade D
Motor function below the neurological level of injury (including the distal sacral segments) is preserved with more than half of the key muscles having a grade of ≥3 (antigravity) on the ASIA motor score.

Grade E
Neurologically intact patients (that is, sensorimotor function is normal in all segments) who previously had deficits secondary to a suspected SCI.

Figure 6. ASIA SCI scoring assessment classification[5]

The main goal in managing acute spinal cord trauma is to carry out therapy that causes primary SCI and prevent further or secondary injuries in SCI by implementing A (airway), B (breathing), C (circulation), D (disability), E (exposure) if the patient is in an emergency condition.[2,12]

In Airway management, providing adequate oxygenation is important to prevent ischemia and secondary spinal cord injury. Patients who have respiratory symptoms such as shortness of breath, tachypnea, difficulty speaking, or decreased consciousness can undergo an initial assessment of breathing, including airway patency and adequate oxygenation. Airway examination generally involves the "head tilt - chin lift - jaw thrust" maneuver in patients who experience decreased consciousness, but this maneuver is not recommended in patients with suspected spinal cord trauma who require limited manipulation. Currently the maneuver recommended for patients with suspected spinal cord trauma is "jaw thrust - open mouth".[2,12]

The implementation of airway management in this patient was that when he came to the emergency room, the patient had a cervical collar installed, and this was maintained until day 5 post op laminectomy. Adequate oxygenation was also provided from the time the patient arrived in the emergency room with a nasal cannula of 3 lpm oxygen. PDT was recommended considering the long post-laminectomy care and to secure the airway and facilitated bronchial toilet so as to prevent pneumonia.

Treatment of the airway is usually carried out in patients with various causes such as obstruction due to foreign objects, blood, or the patient's vomit. In patients who experience cervical injury in traumatic cases, it may cause disruption of the larynx and trachea or bleeding in the tissue, causing partial airway obstruction, and it is necessary to provide definitive airway therapy immediately. Treatment can take the form of drugs or airway patency equipment using techniques that are familiar to clinicians. Teamwork in this treatment is the main key, where in handling airway patency it can require a minimum of 2 people to carry out a series of anesthetic procedures, intubation, and keeping the spine immobilized. [1,12]

In breathing management, patients who experience SCI from the cervical to thoracic sections, especially above T8, usually have problems with the function of the diaphragm and/or intercortical muscles which will cause respiratory failure so that supportive measures are needed in the form of providing respiratory ventilation. Patients with the threat of respiratory failure can be treated in the form of endotracheal tube intubation and mechanical ventilation. Difficulty in installing a ventilator in patients with SCI is often found, especially in patients who experience complete cervical SCI, so treatment with a tracheostomy is recommended. Patients who have complete lesions at C2 and above require long-term ventilation. In patients who have lesions at C3-C5 which have direct innervation to the diaphragm, the treatment varies but requires immediate intubation. Lesions at C5 and below are considered for long-term ventilation because the intercostal muscles can potentially cause muscle spasms. [1,7,12,20]

In this patient's breathing management, because the lesion is in cervical vertebrae 1-7. the problem of respiratory failure is

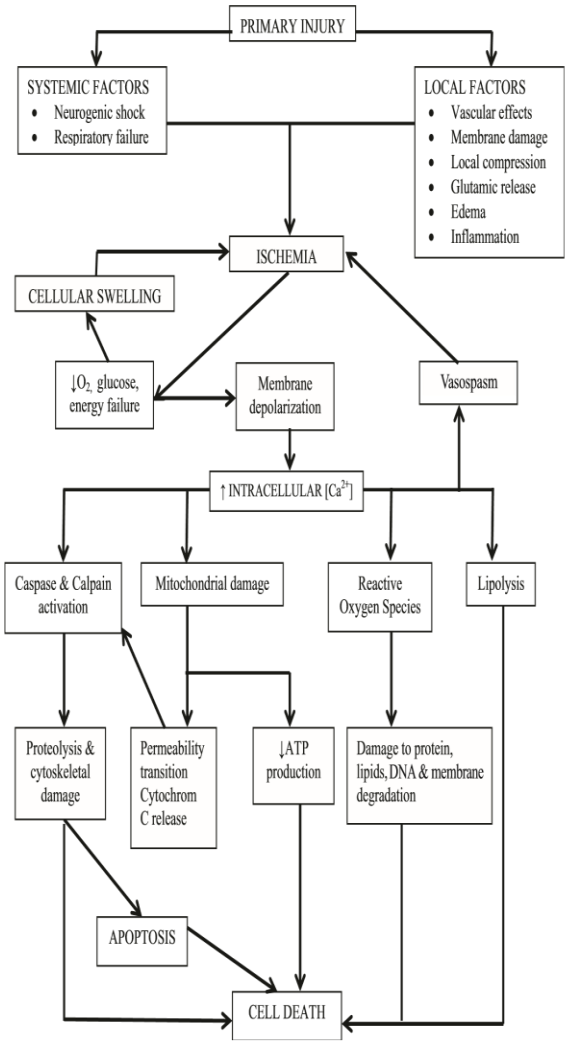
overcome by installing an endotracheal tube and mechanical ventilation due to disturbances in the function of the diaphragm and intercostal muscles. Post decompression laminectomy surgery, the patient was managed in the ICU with a ventilator with PSIMV mode FiO2 50%, Trigger 3, PEEP 5, PC 12, RR 16. On the 4th day in the ICU, the ventilator setting was weaning into spontaneous mode, FiO2 50%, PS 12, Trigger 3, PEEP 5. Extube was done on 5th day after laminectomy prosedure.

In circulation management, the American Society of Anesthesiologists recommends monitoring vital signs in patients with SCI such as heart rate, electrocardiogram, blood pressure, pulse oximetry, capnography, and temperature. Patients who experience traumatic SCI generally experience severe bleeding which can lead to hypovolemic shock hypotension (SBP <90 mmHg). In this condition, the patient requires immediate fluid administration for resuscitation so that he becomes euvolemic again. However, under certain conditions, patients who have been given fluids but are still hypotensive may be suspected of suffering from neurogenic shock. [1,2,8,17,22]

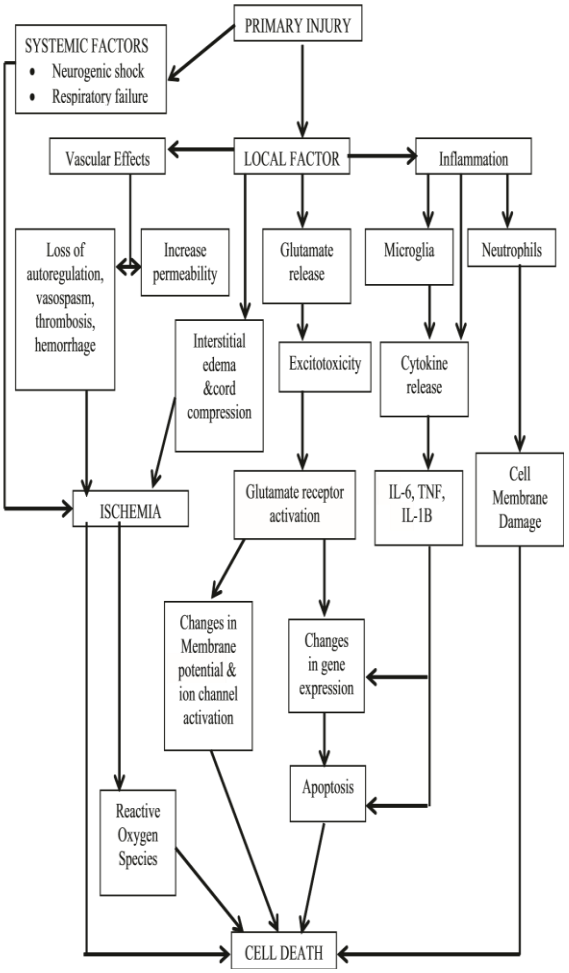
Neurogenic shock usually occurs in patients who experience SCI above T6 which will cause vasodilation, bradycardia and hypotension and severe bradycardia or asystole can occur when treatments that stimulate the vagal reflex such as laryngoscopy or suction are performed. Treatment of patients with neurogenic shock requires vasopressor drugs such as Noradrenaline, phenylephrine, or metaraminol, and positive inotropic dopamine is recommended to treat vascular tone and prevent secondary injury. It is recommended to monitor blood pressure using an arterial line and central venous catheter to administer medication as well as monitor central venous pressure. [1,6,8,9] In this patient, received vasopressor drugs, both dopamine and norepinephrine titration to maintain blood pressure and to treat vascular tone, until day 3rd post laminectomy, the support was tappering off. Because the lesion location on cervical vertebrae 1-7, neurogenic shock can be occurred.

In disability management, a complete neurological examination must be carried out immediately and can be carried out simultaneously with other examinations to assess the location and severity of the neurological deficit. Monitoring of the neurological examination can be assessed using the American Spinal Injury Association Spinal Cord Injury (ASIA SCI) scoring which can see the patient's motor and sensory neurological function as a whole.[1,10,11]

Disability management for this patient, he underwent post op laminectomy physiotherapy. Physiotherapy is very important to help improve the patient's physiological function and prevent further secondary injury, especially in the acute phase of SCI. As progress progressed, post laminectomy day 5th, the patient was able to make minimal movements in the upper extremities. The patient's muscle strength movement cannot resist gravity in first day on hospital, after surgery, he able to resist gravity.



Gambar 1 Patofisiologi kerusakan primer[1]



Gambar 2 Patofisiologi kerusakan sekunder[1]

Figure 7. Pathophysiology of damage due to spinal cord injury[2]

Apart from mechanical factors that damage spinal cord function, tissue perfusion and oxygenation also influence the extent of damage due to mechanical stress. Other processes that occur in the trauma area can include edema, hemorrhage, axon degeneration, demyelination, and can also change cellular bioenergetics. At the cellular level, there is an increase in levels of excitatory amino acids, glutamate, production of free radicals, endogenous opioids and depletion of Adenosine Triphosphate (ATP) reserves which ultimately causes cell death. Increasing understanding of the physiology of spinal cord trauma will increase pharmacological treatment options. Pharmacological therapy, such as corticosteroids, 21-amino steroids, opioid receptor antagonists, gangliosides, thyrotropin-releasing hormone (TRH), antioxidants, calcium, including immunomodulators, are being researched; all of them gave good results but until now only corticosteroids have been clinically significant.[2,10,11]

Spinal cord trauma most often causes neurogenic shock which is related to the severity of the trauma and the level of damage that occurs. Initially, there will be an increase in blood pressure, heart rate and pulse, and high catecholamine levels, followed by hypotension and bradycardia. Therapy is aimed at preventing systemic hypoperfusion which will worsen spinal cord damage, using vasopressors; However, the use of vasopressors must be balanced with monitoring fluid status because excessive use of vasopressors will actually cause peripheral vasoconstriction which will reduce blood flow to the periphery. Secondary damage therapy is the next therapeutic target because this will worsen the outcome if appropriate pharmacological intervention is not carried out considering the very varied pathophysiology.[1,2]

Steroids function to stabilize membranes, inhibit lipid oxidation, suppress vasogenic edema by improving the spinal cord blood barrier, inhibit the release of endorphins from the pituitary, and inhibit inflammatory responses. Its use began in the 1960s as an anti-inflammatory and anti-edema. Methylprednisolone is an option compared to other steroids because of its antioxidant levels, can penetrate nerve cell membranes more quickly, more effectively neutralizes circulating complement factors, inhibits lipid peroxidation, prevents post-traumatic ischemia, inhibits degradation of neurofi lamens, neutralizes the buildup of calcium ions, and inhibits prostaglandins and thromboxanes. The NASCIS I study (The National Acute Spinal Cord Injury Study) recommends a high dose of 30 mg/kgBW as prevention of lipid peroxidation, given as soon as possible after trauma because the distribution of methylprednisolone will be hindered by damage to the spinal cord blood vessels in the secondary damage mechanism. The NASCIS II study compared methylprednisolone at a dose of 30 mg/kgBW IV bolus over 15 minutes followed by 5.4mg/kgBW/hour intravenously over the next 23 hours with naloxone (opioid antireceptor) 5.4 mg/kgBW IV bolus, followed by 4 mg/ kgBW/hour intravenously for 23 hours. As a result, methylprednisolone is better and can be used up to 8 hours post-trauma. In NASCIS III, the same dose of methylprednisolone given intravenously for up to 48 hours apparently provided better results than 24 hours administration. Apart from that, tirilazad mesylate (TM), a non-glucocorticoid lipid peroxidation inhibitor, was also tried, and it turned out to be no better than methylprednisolone. This therapy is still controversial; The latest study states that there are no class 1 and 2 studies on the basis of this therapy, and found side effects in the form of gastric bleeding, infection, sepsis, increased length of stay in the ICU, and death.[2,3,13,15]

This patient received corticosteroid therapy in the form of methylprednisolone 125 mg IV/8 hours to prevent inflammation until second days after surgery.

Table 5. Corticosteroids and their dosage, Kinetics steroids and Potential to induce hyperglycemia

Gluco corticoids	Appropriate Equivalent Dose (mg)	Plasma Peak Concentration (minutes)	Elimi-nation Half-life (hours)	Dura tion of Action (hours)	Onset	Peak	Reso-lution
Short-Acting Hydro-cortisone	20	10	2	8-12	1	3	6
Inter Mediate-Acting							
Predniso (lo)ne	5	60-180	2.5	12-36	4	8	12-16
Methyl-predni solone	4	60	2.5	12-36	4	8	12-16
Long-acting Dexame-thasone	0.75	60-120	4	36-72	8	Vari able	24-36

A meta-analysis study conducted by Liu Z, et al. in 2019, there were no differences in motor and sensory function outcomes in SCI patients who received high doses of methylprednisolone and those who did not. The use of high doses of methylpredisolone even increases the occurrence of side effects, especially gastrointestinal bleeding and respiratory tract infections. Therefore, some of these patients are no longer given steroid therapy. The target blood sugar values in this patient are fasting plasma glucose < 126 mg/dl, plasma glucose < 200 mg/dl 2 hours after oral glucose tolerance test (OGTT) with a load 75 grams, and plasma glucose examination when < 200 mg/dL.[15]

Post op ICU management by considering the threat of respiratory failure, by installing a ventilator, the risk of neurogenic shock, namely by administering supportive drugs, whether there is an underlying disease, the need for nutrition are monitored. Spinal cord injuries can cause chronic paralysis that affects energy and protein requirements. The long healing process due to trauma to the nervous system and complications due to prolonged bed rest have an impact on reducing a person's life expectancy and quality of life. The risk of malnutrition due to chronic inactivity can cause loss of muscle mass which also affects nutritional status. Medical nutritional therapy aims to reduce metabolic responses, maintain fat-free mass, and prevent complications.
Hemodynamic monitoring are also monitored.[14]

CONCLUSION

Patients with spinal cord injuries require management that includes various aspects. Starting from airway management, the patient must ensure airway patency, for example by installing a neck collar, and ensuring adequate

oxygenation. Breathing management who experience SCI from the cervical to thoracic sections, especially above T8, usually have problems with the function of the diaphragm and/or intercortical muscles which will cause respiratory failure so that supportive measures are needed in the form of providing respiratory ventilation. In circulatory management, patient received vasopressor drugs titration to maintain blood pressure and to treat vascular tone. Because the lesion location on cervical vertebrae 1-7, neurogenic shock can be occurred. In disability management, a complete neurological examination must be carried out immediately and can be carried out simultaneously with other examinations to assess the location and severity of the neurological deficit.

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