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Case Report

Endotracheal Intubation without Neuromuscular Blocking Agent in Patient with Fracture Cervical Spine C1 and C4 Underwent Fusion C1–2 and C4–6

I Putu Pramana Suarjaya, Osmond Purwanto, Aldy, Ida Bagus Krisna Jaya Sutawan
Department Anesthesiology and Intensive Care, Faculty of Medicine Universitas Udayana–Prof. Dr. I.G.N.G. Ngoerah Central General Hospital, Denpasar
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correspondence: pramana@unud.ac.id

Abstract

About 30% of cervical spine fractures involve injuries to the C1 and C2 vertebrae, which are considered unstable. Ensuring the stability of the injured cervical spine throughout perioperative period, including preoperative examinations, anesthesia induction, laryngoscopy, and intubation, is crucial for anesthesiologists. A 40-year-old woman suffered neck pain following a motorcycle accident, suffering a Spinal Cord Injury ASIA Impairment Scale (SCI AIS) E, a fracture of the C5 vertebral body (CV) classified as AO Spine Type A2, a Jefferson Type IV fracture, and mild head trauma. She underwent surgical fusion of the C1–C2 and C4–C6 vertebrae under general anesthesia, which included dexmedetomidine, propofol, sevoflurane, and fentanyl without any neuromuscular blocking agents (NMBA). The primary goal of perioperative airway management in cervical injury is a secured airway, while maintaining cervical stability without inflicting secondary injury. The cervical muscle group is essential for maintaining cervical stability, and the use of NMBA may jeopardize this stability, necessitating external cervical stabilization, especially during laryngoscopy and intubation. Induction agents in combination with opioid, widely used to facilitate laryngoscopy and intubation without using NMBA. Anesthesiologists must precisely arrange the management of cervical spine injuries patient to avoid secondary injury and improve surgical outcomes.

Keywords: Endotracheal intubation, cervical fracture, neuromuscular blocking agent

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I. Introduction

Acute cervical spine injuries can cause considerable morbidity and death.[1,2] C1 and C2 injuries contribute for around 30% of cervical spine fractures.[3,4] Fractures in the C1-C2 complex are classified as unstable. While spinal injuries are often classified as stable or unstable, it's crucial to remember that all components of the spine contribute to its stability, thus any spinal structural lesion causes some amount of instability, albeit full instability is unusual.[5,6] The C1 segment, also known as the atlas, links with the occipital condyles of the skull's occiput bone to form the occipital-atlanto joint. This joint is largely used for flexion and extension motions. It acts as an important connecting point between the skull and the neck, providing support for specific neck muscles. The cervical muscle group, comprising both anterior and posterior neck muscles, plays a vital role in maintaining stability within the cervical region.[5,6] The use of NMBA would relax all the supportive muscles in the neck, possibly reducing cervical stability, necessitating external manoeuvres for cervical stabilization, particularly during laryngoscopy and intubation procedures. Compression fracture of the C1 vertebra, the Jefferson fracture, is the consequence of severe axial stress, with the fracture pattern determined by the head's position during impact. It causes the lateral mass to extend outward immediately, excessing the stretch limit, rupturing the transverse ligament and resulting in fractures of the anterior and posterior arches

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of the atlas.[7,8] Endotracheal intubation can be performed without using any NMBA. Propofol alone can assist intubation in 60% of cases. The combination of propofol and strong opioid has been used to safely facilitate intubation without the requirement for NMBAs.[10,11] Throughout the induction process, it is essential for the anesthesiologist to prevent hypotension and ensure the safe execution of laryngoscopy and intubation, all while preserving the stabilization of the injured neck. In this case, anesthesia was administered using general anesthesia without using any NMBA throughout the surgical procedure. The objective of the anesthesia was to offer neuroprotection to the cervical injury patient, aiming to prevent secondary neurological injury throughout the entire perioperative period.[1,2]

II. Case

Anamnesis

A 40-year-old female arrived alert, complained neck pain after motorbike accident. The pain was localized without any radiation. The patient had retrograde amnesia with loss of consciousness during the accident, and could not recalled what happened. There was no history of nausea, vomiting and seizures.

Physical Examination

Patient was with Glasgow Coma Scale (GCS) E4V5M6, airway was clear, respiration rate 16 per minute and peripheral oxygen saturation was 96-97% with room air. Blood pressure was 110/70 mmHg and pulse rate 83 beats per minute. The patient had very limited neck flexion and deflection and hard collar neck already applied to her. Neurological examinations found motoric functions; muscle strength was within normal limit with isotonus muscle tone. Sensory functions were within normal limit, physiologic reflexes were positive, and no pathological reflexes found.

Laboratory Findings

Laboratory examination found leukocytosis with leucocytes 11.69 x 103/µL, hemoglobin 12.8 g/dl, hematocrit 38.7%, platelets 384 x 103/µL. Hemostatic profile was PT 10.3 seconds, aPTT 23.5 seconds, INR 0.90. Clinical chemistry tests

Figure 1 : Cervical AP/Lateral X-Ray showed mal-alignment, straightening neck curve, visible complete fracture of CV C5 anterior aspect, displacement of fracture fragments. Impression: A complete fracture displaces the anterior aspect of CV C5, paracervical muscle spasm

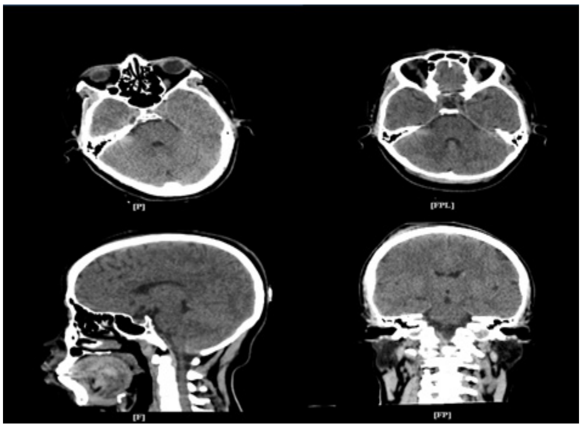

Figure 2: Head CT-Scan showing no signs of intracranial bleeding. Comminuted fracture of the right lateral mass of C1, mild cerebral edema, soft tissue disruption accompanied by soft tissue swelling in the right frontal region, and right pneumo-orbita

found increased liver enzymes SGOT 25.7, SGPT 24.10, BUN 12.40, Creatinine 0.79, random blood sugar 91, Sodium 140 mmol/L, K 3.25 mmol/L, Albumin 4.30 g/dL. Kidney function, HbA1c, and blood gas analysis were within normal limits. The patient had undergone a COVID-19 swab with negative polymerase chain reactions result. Electrocardiography examination found normal rhythm. Chest x-ray showed cardiomegaly with a CTR of 63%, the lung showed no abnormalities. Cervical X-Ray which was done on anterior-posterior and lateral position, showed corpus vertebra mal-alignment and straightening neck curve, visible complete fracture of anterior aspect CV C5, with displacement of fracture fragments. Bone trabeculation was normal. The superior and inferior end plates, the corpus, pedicles and intervertebral space outside the lesion appeared normal. No visible compression. The retro-pharyngeal and retro-tracheal spaces were within normal limit. There was no visible soft tissue swelling. Impression: A complete fracture, displaced anterior aspect of CV C5, and para-cervical muscle spasm. Head CT-scan showed no abnormal hypodense nor hyperdense lesions in the brain parenchyma. Sulci and gyri snuggled lightly. The ventricular and cisternal systems were normal. No midline deviation of the structure. The pons and cerebellum showed no abnormalities. The calvaria and cranial bases showed no signs of fracture. A comminuted fracture was seen in the right lateral mass of CV C1. There were soft tissue disruptions accompanied by soft tissue swelling in the right frontal region. An air-filled lesion was seen in the right periorbital soft tissue.

Actual Problems

Patient suffered Spinal Cord Injury ASIA Impairment Scale (SCI AIS) E, fracture corpus vertebra C5 AO Spine Type A2, fracture Jefferson D Type IV, mild head injury, GCS E4V5M6 without any signs of increased intracranial pressure. and was classified as ASA physical class II. She underwent surgical fusion of C1-C2 and C4-C6.

Anesthetic Management

Dexmedetomidine infusion was initiated before anesthesia induction, with a loading dose of 1 mcg/kg over 10 minutes, followed by continuous infusion at 0.3–0.6 mcg/kg/hour. Prior to induction, intravenous fentanyl 150 mcg and lidocaine 80 mg were administered. Anesthesia induction was performed using propofol via targeted controlled infusion (TCI) of Schnider plasma mode, with a plasma concentration of 4 mcg/ml. Topical lidocaine spray was applied to the airway before laryngoscopy. Laryngoscopy, conducted with a video-laryngoscope, was followed by successful tracheal intubation using a non-kinking endotracheal tube (ETT), while performing manual in-line stabilization to minimize upper cervical spine movement. ETT placement was confirmed by chest auscultation for bilateral symmetry and end-tidal carbon dioxide (ETCO2) measurement after connection to the anaesthesia circuit. The patient was then positioned prone, with reassessment of ETT placement to ensure no jugular vein congestion or compromised ventilation, and padding applied to vulnerable areas to prevent pressure injuries.

Intraoperative

Anaesthesia maintenance included dexmedetomidine infusion at 0.3-0.6 mcg/kg/hour, a mixture of oxygen and compressed air to achieve an FiO_2 of 50%, propofol TCI at 3.0-4.0 mcg/ml, and intermittent fentanyl 0.25-0.5 mcg/kg, without any NMBA. Controlled ventilation was managed with tidal volume of 7-8 ml/kg of body weight, at a frequency of 11-12 per minute, targeting an $ETCO_2$ of 35 mmHg, while peripheral oxygen saturation was maintained between 99–100%. During anesthesia, the patient received intravenous paracetamol 1000 mg, tranexamic acid 500 mg, ondansetron 8 mg, and methylprednisolone 125 mg. Anesthesia lasted for 4 hours and 50 minutes, with stable hemodynamics observed throughout.

Postoperative

The patient was extubated in the operating theater, exhibiting full consciousness with a GCS score of E4V5M6, normal motor and sensory functions, and cooperative behavior during post-extubation neurological assessment. The patient was observed in the intensive care unit (ICU) for 24 hours. Pain management in the ICU was included morphine 20 mg/24 hours, ketorolac, and paracetamol intravenously, along with ondansetron 4 mg two times daily. The patient was discharged home on the 4th day. Surgical intervention involved making an incision to access the vertebrae C1-C2 and C4-C6. Screws were placed on both sides of C1-C2 and C4-C6 and secured with a rod, with a sublamina wire inserted on the left side of C1-C2. Blood loss during surgery was approximately 80 ml, and a subfascial drain was inserted. The surgery proceeded without complications and lasted for 4 hours and 20 minutes.

Figure 3. Surgical Position and Surgical Field during Surgery

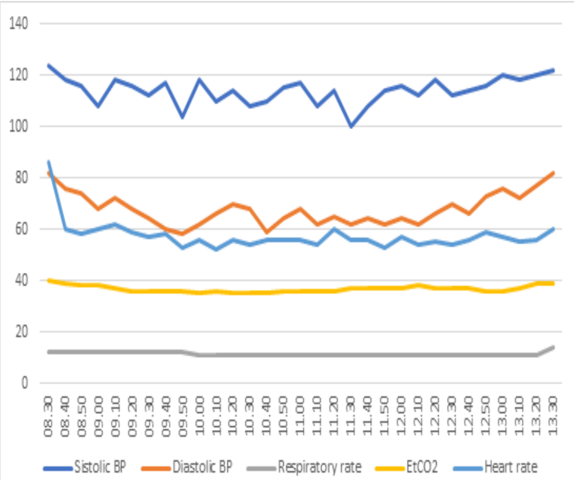

Figure 5. Hemodynamics, respiratory rate and $EtCO_2$ during surgery

III. Discussion

Following the stabilization of the airway and ensuring respiratory and hemodynamic stability, acute cervical trauma patients should undergo a CT scan of the vertebrae. A comprehensive neurological assessment, including evaluation of rectal tone, is conducted to evaluate vertebral injury and is categorized using the ASIA scale.[7,8] Cervical spine injuries are categorized according to their location. Occipital-cervical vertebral injuries range from the occiput to C2, whereas sub-axial cervical spine injuries affect C3 to C7. Flexion often results in wedge fractures, whereas vertical compression generates burst fractures. Laminar fractures can occur vertically or horizontally, and they are frequently accompanied with other fracture forms. The Jefferson fracture, characterized by compression, is an unstable fracture of the C1 vertebra.[11,12] The stability of the spine hinges on its nonlinear load-motion relationship. When subjected to smaller loads and at the initial stages of motion, particularly near neutral posture (referred to as the neutral zone), the motion segments offer minimal resistance, allowing the spine to deform easily.

However, as loads increase and motion progresses towards the end of the range, the spine's resistance rapidly escalates due to the heightened tension in ligaments and joint capsules, resulting in reduced displacement.[6] The main objective in the airway management for this patient is to keep the injured neck stable, minimize neck movement to avoid secondary injury, while swiftly and effectively securing the airway. While cricoid pressure is considered safe, all standard airway manoeuvres movements may increase the risk of secondary neurological injury.[1,2] The muscles supporting cervical stability can be divided into anterior and posterior neck muscles.[6]

The administration of NMBA causes relaxation of all supporting neck muscles, potentially reducing cervical stability and necessitating the application of effective external cervical support. Additionally, the use of nondepolarizing NMBA may lead to prolonged neuromuscular blockade, increased side effects of anticholinesterases used for reversal agents, and difficulty in rapidly reversing the neuromuscular blockade in cases of unexpected difficult intubation. When the use of NMBA is undesirable, it is crucial to administer appropriate dose of induction agents to ensure optimal intubation conditions.[15] Historically, the combination of propofol alongside fast-acting opioids has been deemed effective in achieving favourable conditions for successful intubation. Nevertheless, the reduction in mean arterial pressure observed during the initial 15 minutes following anaesthesia induction was notably more pronounced in patients who did not receive nondepolarizing NMBA compared to those who were administered rocuronium.[16] Direct laryngoscopy elicits the most significant movement at the craniocervical junction, moderate movement at the C1 to C2 joints, and minimal movement below C4 in individuals without cervical injury. Even with manual in-line immobilization (MILI), which involves the use of a cervical collar and traction, direct laryngoscopy can still induce vertebral movement, albeit within a small range that typically falls within physiological limits in models of cervical injury. Various laryngoscope blades (such as Macintosh, McCoy, and Miller) have similar effects on vertebral motion during direct laryngoscopy. MILI is utilized during the process of securing the airway in cases of cervical injury to restrict neck movement. Although MILI enhances safety during laryngoscopy, it poses a higher rate of failed intubation during the initial 30 seconds. Nonetheless, compared to collar immobilization alone, MILI reduces overall vertebral motion and enhances laryngeal visualization during oro-tracheal intubation. MILI is recommended as the standard approach to airway management in patients with confirmed or suspected cervical injury.[1,2]

Video laryngoscopy serves as a popular alternative to traditional direct laryngoscopy, with several studies comparing the two techniques yielding conflicting results. Devices like the Airtraq® intubation device reduce cervical movement and aid in intubation, whereas the GlideScope® may extend intubation duration. Some studies have shown that the GlideScope® decreases movement in specific cervical segments, while others found no difference in cervical segment movement. Additional tools such as fiberoptic laryngoscopes and gum elastic bougies are valuable adjuncts during laryngoscopy in patients suspected of having vertebral trauma, as they can minimize cervical spine movement. The use of a laryngeal mask airway may cause some posterior displacement at the upper cervical level. Despite the potential for cervical spine movement associated with these techniques, their use should not be discouraged as they are crucial in life-saving interventions. In scenarios where intubation and ventilation are not possible ("cannot intubate, cannot ventilate"), a cricothyroidotomy or surgical airway should be promptly performed.[1,2] There are no strict guidelines regarding the choice of anaesthetic's agents for cervical injury patients. However, the anaesthesiologist should be cautious in patients with hypovolemia when using propofol or barbiturates during induction, as these induction agents may potentially precipitate severe hypotension. Ketamine has the potential to increase blood pressure and intracranial pressure, although this effect can be mitigated by simultaneous administration of hypnotics like propofol. Anaesthesiologists should be refrained from using depolarizing NMBA such as succinylcholine between three days and nine months following a vertebral injury, as they can provoke fatal hyperkalaemia. If NMBAs are deemed necessary, nondepolarizing NMBA are preferred.[1,2]

Airway manipulation during laryngoscopy and intubation can induce tachycardia, deep bradycardia, hypertension, hypotension, and even cardiac arrest.[1,2] To diminish noxious stimulation of the airway during laryngoscopy and intubation, several strategy can be employed. Topical anaesthesia such as lidocaine sprayed to the pharynx, larynx or trachea is known to be effective in blocking cardiovascular responses due to sympathetic stimulation during laryngoscopy intubation.[17] Neurophysiological monitoring is important for assessing real time spinal cord physiology during surgical procedure of the cervical fracture and avoiding perioperative surgical complications. Neurophysiological monitoring allowing immediate correction of risk factors such as hypoperfusion, hypotension, hypothermia, and surgery-related factors.[1,2]

There are no convincing data showing the advantage of single anesthetic regimen. Anaesthesia management goals for cervical injury and cervical surgery are to provide neuroprotection, maintaining adequate spinal cord perfusion, and avoiding secondary injury. Ventilation should be adjusted to maintain normocarbia to avoid vasoconstrictions. With unimpaired CO_2 reactivity on spinal cord perfusion, as demonstrated in the majority of patients after cervical injury, excessive hyperventilation can cause inadequate perfusion on injured area.[1,2]

Anaesthesiologists must carefully consider several factors when determining whether to extubate a patient immediately after surgery, such as preoperative neurologic conditions, extent of the surgical procedure, volume of blood loss, any surgical complications, and the ease of intubation.[1,2]

IV. Conclusion

Injury to the cervical spinal structure, such as a fracture of the vertebral body in the neck, inherently introduces a degree of instability. The administration of NMBA will loosen up all the supporting neck muscles, potentially exacerbating cervical instability. In clinical conditions where the use of NMBA is not preferred, it is crucial to administer appropriate dose of hypnotic agents to ensure optimal intubation conditions. Traditionally, the combination of propofol with short acting opioids is providing safe and effective conditions for intubation, leading to high success rates. Anesthesiologists bear the responsibility of preventing secondary injuries to the nervous system and enhancing patient outcomes by comprehensively understanding the pathophysiology of cervical vertebral injuries. They must devise specific plans to anticipate and mitigate risks of neurological injury during the perioperative period, particularly during procedures like laryngoscopy and intubation.

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