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Axillary Nerve Block in Radial Open Reduction and Internal Fixation in Traumatic Brain Injury Patients: A Case Report

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ABSTRACT

Patients with traumatic brain injury (TBI) and multi-trauma often require multiple surgical procedures, with prioritization based on urgency. Neurological impairment and hemodynamic instability pose significant challenges in delivering safe and optimal anesthetic management. A 23-year-old male presented with a basilar skull fracture, tension pneumocephalus, maxillofacial fractures, and a complete left forearm fracture. The patient underwent emergency craniotomy followed by elective internal fixation six days later using regional anesthesia with ultrasound-guided axillary peripheral nerve block (PNB). The block was performed using 0.5% ropivacaine and was confirmed successful by the absence of significant clinical or hemodynamic responses during surgery. This study shows that upper limb fracture fixation in patients with TBI can be safely performed using ultrasound-guided peripheral nerve block (PNB)-based regional anesthesia. The use of ropivacaine 0.5% provides optimal anesthetic effect with good hemodynamic stability and without significant complications. Postoperative monitoring revealed no local or systemic complications. Regional anesthesia with axillary PNB is a safe anesthetic modality for patients with upper extremity fractures and a history of TBI.

Keywords: *Axillary Nerve Block, Regional Anesthesia, Radial Open Reduction and Internal Fixation*.

1. INTRODUCTION

Traumatic brain injury (TBI) is a condition characterized by impaired brain function due to traumatic mechanisms, often marked by a decrease or loss of consciousness, neurological deficits, or altered mental status. The severity of TBI is typically categorized based on the Glasgow Coma Scale (GCS) score and is often accompanied by extracranial trauma at other body sites, which adds complexity to its management. Patient outcomes can be influenced by the severity of the TBI as well as factors related to other injuries, such as their location and severity. Consequently, most TBI patients with multi-trauma also require surgical interventions for body regions other than the head [1], [2].

The primary goal in managing polytrauma patients is to stabilize the most life-threatening conditions, requiring careful consideration and decision-making to identify and prioritize procedures with greater urgency. In cases of TBI, operative procedures for the head are typically prioritized, with extracranial procedures performed once the patient's condition is stabilized. This presents a challenge for anesthesiologists to optimize perioperative management, aiming to provide safe and effective anesthesia for high-risk patients [3], [4].

Patients with recent head injuries may be uncooperative, exhibit unpredictable responses to sedation, and face risks of hemodynamic and respiratory instability. As a result, general anesthesia (GA) has limitations in this population, making regional anesthesia (RA) a preferred modality. In orthopedic cases, peripheral nerve block (PNB) is a popular choice due to its ability to provide optimal anesthetic effects with high success rates and minimal systemic complications [5], [6], [7]. In this case, we present a patient admitted with a TBI and an upper extremity fracture who underwent emergency craniotomy followed by elective internal fixation using an axillary PNB.

CASE REPORT

A 23-year-old male presented to the Emergency Room (ER) with altered consciousness following a traffic accident 11 hours prior to hospital admission. The patient was not wearing a helmet while riding a motorcycle and, after the collision, vomited twice and complained of bleeding from the left ear and nose. The patient's Glasgow coma scale was E3V3M5 with stable hemodynamic status. Physical examination revealed wounds and swelling on the face and head, along with deformity of the left arm. After stabilization, imaging examinations were performed. A CT scan revealed a basal skull fracture accompanied by tension pneumocephalus and multiple maxillofacial fractures (Fig 1). Chest X-ray showed no abnormalities, while left antebrachium X-ray revealed a complete fracture of the distal one-third metaphysis of the left radius and a fracture of the left ulnar styloid, categorized as Frykman Classification II (Fig. 2)

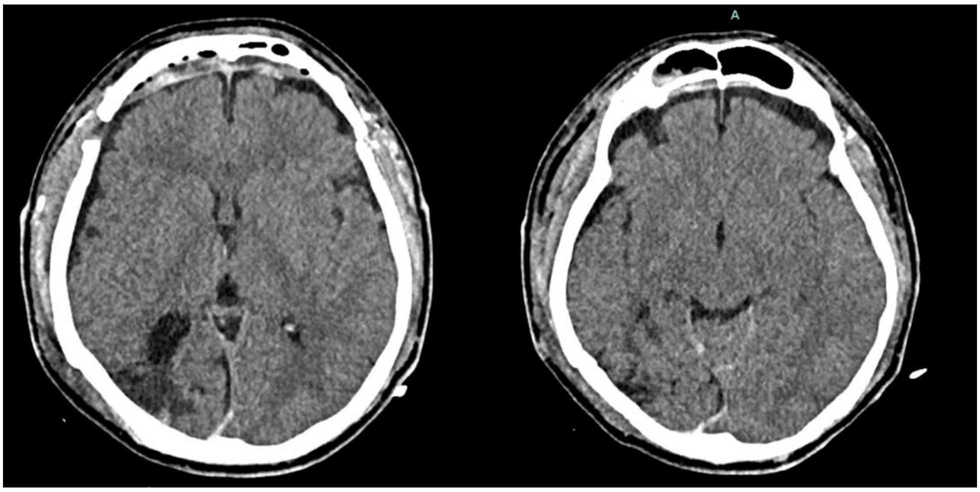

Figure 1. Head CT scan revealed a basal skull fracture accompanied by tension pneumocephalus and multiple maxillofacial fractures

Figure 2. X-ray of the left antebrachium revealed a complete fracture of the distal one-third metaphysis of the left radius and a fracture of the left ulnar styloid, categorized as Frykman Classification II

The fracture in the patient's left arm was temporarily managed with closed reduction and immobilization using a long arm cast. Subsequently, the patient underwent exploratory craniotomy and dural repair, resulting in good and stable outcomes. After six days of recovery, the patient was scheduled for elective open reduction and internal fixation (ORIF) surgery. Preoperative evaluation showed a GCS of E2V2M4 with stable hemodynamic status. Preoperative laboratory tests revealed anemia (Hb 9.9 mg/dL) and hypoalbuminemia (2.89 g/dL). The patient was assessed as ASA Class III and planned to undergo RA with an ultrasound (US) guided axillary PNB.

Upon arrival in the operating room, the patient had a blood pressure of 126/63 mmHg, a heart rate of 99 bpm, a respiratory rate of 20 breaths per minute, and oxygen saturation of 99%. The patient was positioned supine with the left arm abducted at 90 degrees. The block site was sterilized, and a transducer was positioned in a short-axis orientation, placed distal to the pectoralis major muscle insertion on the humerus. The transducer was moved proximally to visualize the axillary artery and terminal branches of the brachial plexus. Axillary PNB was performed using an injection of 0.5% ropivacaine (20 mL) diluted with 10 mL of normal saline (total volume 30 mL). Once the needle tip was visualized, 10 mL of the anesthetic was injected posterior to the axillary artery to avoid displacement of the target structures (Fig 3a). The needle tip was then withdrawn toward the skin surface and redirected to the median and ulnar nerves for the injection of another 10 mL of anesthetic (Fig 3b). The final 10 mL injection was administered to the musculocutaneous nerve located near the median nerve (Fig 3c). Due to the patient's altered mental status, the success of the nerve block was confirmed by the stable heart rate and blood pressure during the first incision. The ORIF surgery lasted approximately 3 hours, during which the patient's hemodynamic remained within the desired range with no adverse events or local anesthetic systemic toxicity (LAST) noted.

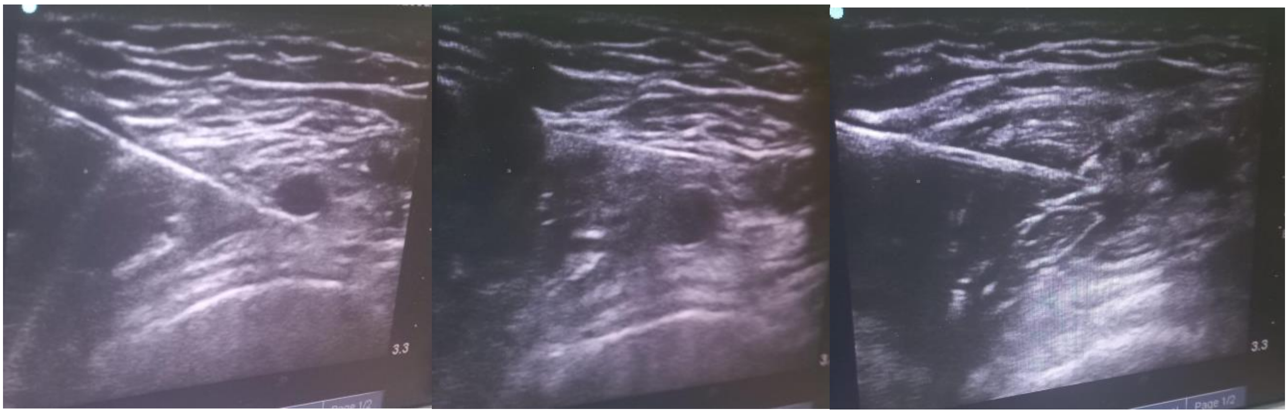

Figure 3. US guided PNB axillary with ropivacaine injection at (a) posterior to the axillary artery, (b) the median and ulnar nerves, and (c) the musculocutaneous nerve.

2. DISCUSSION

The majority of patients with TBI will experience systemic disturbances that require prompt management and stabilization. The potential for secondary brain injury following the initiation of primary injury makes the management of TBI a top priority before addressing other procedures. In this case, the patient underwent an emergency craniotomy to address a basilar skull fracture and tension pneumocephalus. The patient's left antebrachial fracture, which had been stabilized upon admission, was evaluated and determined to be managed electively. Currently, there is no concrete evidence supporting the timing of early versus delayed long bone fracture fixation in patients with head injuries. Research has identified several factors to consider for early fracture stabilization, including the degree of the brain injury, the severity of pulmonary dysfunction, and the presence of hypotension. Although long bone fixation is generally preferred within 48–72 hours, the procedure may be postponed until the patient's physiological parameters have stabilized [8], [9].

The ORIF procedure was performed six days after the emergency craniotomy, during which the patient demonstrated good recovery with stable clinical and hemodynamic conditions. Preoperative evaluation indicated the patient had an ASA III status, defined as a patient with severe systemic disease, necessitating optimal anesthetic management due to an increased risk of complications. Considering the risks of general anesthesia for the patient's condition, regional anesthesia was chosen with the aim of minimizing hemodynamic effects. The selected modality was an axillary PNB, targeting the terminal branches of the brachial plexus innervating the arm. The use of PNB has been shown to offer several advantages over neuraxial anesthesia, including improved intraoperative hemodynamics, enhanced postoperative analgesia, reduced pain intensity, lower incidence of nausea and vomiting, and increased patient satisfaction [10], [11]. There are two main approaches to PNB: the landmark technique and the ultrasound (US)-guided technique. The US-guided PNB approach was chosen rather than landmark technique due to evidence supporting its benefits in shortening procedure duration and onset time, improving block success rates, and significantly reducing the incidence of local complications such as direct nerve trauma, incomplete block, infection, and local hematoma. This is because the use of ultrasound enables the operator to visualize target structures and deliver anesthetic precisely to the desired location [12], [13].

The success of a PNB is determined not only by the technique used but also by the choice of anesthetic. Currently, ropivacaine is the most widely used anesthetic due to its safer profile regarding central nervous system effects and cardiac toxicity. We used ropivacaine as both the induction and maintenance anesthetic because of its long-acting properties, providing anesthesia and analgesia for a longer duration compared to lidocaine, with some studies reporting its effects lasting up to 12 to 16 hours. Another determining factor is the concentration used for the block; we selected 0.5% ropivacaine. Meta-analyses have shown that a 0.5% concentration is the most commonly used for upper extremity surgeries, offering similar motor and sensory block durations to a 0.75% concentration [14].

The use of ultrasound-guided nerve blocks not only increases the success rate of the block but also helps prevent local anesthetic systemic toxicity (LAST), a potentially life-threatening adverse event caused by the uptake of local anesthetic into the central nervous system (CNS) and cardiovascular system. Ultrasound has been shown to reduce the risk of LAST by

60%-65%. CNS toxicity is the most common manifestation, often presenting as seizures, but it can also appear as confusion, audio-visual disturbances, agitation, or a reduced level of consciousness. Some cases have also been reported with cardiovascular toxicity symptoms, including arrhythmias, bradycardia, hypotension, and hemodynamic collapse. If LAST occurs, management involves maintaining airway, oxygenation, and ventilation, along with administering an intravenous bolus of 20% lipid emulsion at a dose of 1.5 mL/kg body weight (BW) over 1 minute, followed by a continuous infusion at 0.25 mL/kg BW over 30-60 minutes. The maximum recommended dose is 12 mL/kg BW [15], [16].

The benefits of choosing regional anesthesia with PNB were evident in the perioperative effects achieved. The success of a nerve block is typically assessed through motor and sensory evaluations in the blocked region. However, due to the patient's altered neurological status caused by the TBI, the success of the block was evaluated based on hemodynamic and clinical responses during the perioperative period. At the time of the first incision, the patient exhibited no painful response and hemodynamic monitoring remained stable, indicating a successful block. Intraoperative monitoring showed no significant hemodynamic changes or clinical signs, and no evidence of local or systemic toxicity was observed throughout the anesthesia duration [17].

In conclusion, internal fixation surgery for distal upper-extremity fractures can be safely performed using regional anesthesia techniques in high-risk patients with TBI. A well-executed PNB can provide optimal anesthetic effects, minimal hemodynamic disturbances, and no significant side effects. The use of ultrasound guidance and the long-acting effects of ropivacaine contributed to delivering optimal and safe anesthesia for high-risk patients.

3. CONCLUSION

The use of regional anesthesia with axillary peripheral nerve block (PNB) technique is a safe and effective approach for patients with upper limb fractures who have a history of traumatic brain injury (TBI). This technique provides significant benefits in terms of perioperative hemodynamic stability, adequate analgesia, and minimal risk of systemic and local side effects. The use of ultrasound guidance in PNB procedures also increases the block success rate and decreases the risk of complications such as Local Anesthetic Systemic Toxicity (LAST). In addition, the selection of ropivacaine as the anesthetic agent contributes to a longer duration of anesthetic effect and a better safety profile. Thus, PNB-based regional anesthesia can be an optimal choice in the anesthetic management of high-risk post-TBI patients who require elective surgery on the upper extremities.

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