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Case Report

TCI of Propofol Combined with Multimodal Analgesia for Neurophysiological Intraoperative Monitoring during Craniotomy for Meckel's Cave Meningioma Resection

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Abstract

Introduction: Meckel's cave meningioma is an intracranial tumor located in close proximity to critical neurovascular structures. An effective anesthetic strategy is essential to optimize outcomes and minimize complications.
Case: A 38-year-old woman with progressive ptosis, diplopia, and proptosis was diagnosed with Meckel's cave meningioma. She underwent craniotomy with intraoperative neurophysiological monitoring (IOM) under general anesthesia managed with Target-Controlled Infusion (TCI) of propofol and dexmedetomidine. TCI of propofol, with Schnider mode was adjusted to a target effect concentration of 2-6 µg/mL. Dexmedetomidine was administered at a dose of 0.3-0.7 mcg/kg/hour. A multimodal analgesic approach, including scalp block with ropivacaine and dexamethasone was performed to reduce opioid consumption and manage pain. The procedure was completed without complications. Postoperatively, the patient demonstrated stable hemodynamics, no new neurologic deficits, and effective pain control.
Discussion: Anesthesia protocol, including propofol TCI and dexmedetomidine, was performed to maintain signal integrity, allowing safe tumor resection while minimizing the risk of postoperative deficits. The combination of propofol TCI, dexmedetomidine, and multimodal analgesia was shown to achieve stable hemodynamic and neurophysiological conditions during craniotomy for Meckel's cave meningioma.
Conclusion: The combination of propofol TCI, dexmedetomidine, and multimodal analgesia is effective in maintaining stable hemodynamic and neurophysiological conditions during craniotomy for Meckel's cave meningioma.

Keywords: Dexmedetomidine, Meckel's cave meningioma, propofol, Target-Controlled Infusion.

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Introduction

Meckel's cave meningiomas are rare intracranial tumors that present unique surgical and anesthetic challenges due to their anatomical location and proximity to critical neurovascular structures, including the trigeminal nerve, internal carotid artery, and brainstem. These tumors often manifest with progressive cranial nerve deficits, such as ptosis, diplopia, or trigeminal neuralgia, necessitating surgical resection to alleviate symptoms and prevent further neurological compromise.[1,5] The surgical complexity of these cases requires precise intraoperative anesthetic management to maintain hemodynamic stability, optimize neurophysiological monitoring, and minimize postoperative complications.[1,2] Target-Controlled Infusion (TCI) of propofol has become a cornerstone of neuroanesthesia, offering precise titration of sedation levels and reducing cerebral metabolic demand. Its pharmacokinetic properties make it ideal for surgeries that require intraoperative neurophysiological monitoring (IOM), as it preserves signal

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integrity for motor-evoked potentials (MEPs) and sensory-evoked potentials (SSEPs).[1] However, achieving hemodynamic stability during prolonged craniotomies, particularly for skull base tumors, requires adjunctive agents such as dexmedetomidine. This α2-adrenergic receptor agonist provides sedative, analgesic, and sympatholytic effects while maintaining cardiovascular stability, complementing the use of propofol.[2] In addition to maintaining sedation and hemodynamic parameters, a multimodal analgesia strategy enhances pain control and promotes early recovery. Scalp blocks, systemic analgesics, and opioid-sparing regimens are essential components of this approach, aligning with enhanced recovery after surgery (ERAS) protocols to optimize postoperative outcomes.[3,4] This case study illustrates the integration of TCI propofol, dexmedetomidine, and multimodal analgesia in the anesthetic management of a patient undergoing craniotomy for Meckel's cave meningioma resection, highlighting its impact on intraoperative neurophysiological monitoring and postoperative recovery.[1,3,4]

Case

Anamnesis / Disease History

A 38-year-old woman was scheduled for tumor excision with intraoperative neurophysiological monitoring (IOM) due to a progressive left-sided cranial nerve deficit. She reported left ptosis, proptosis, and diplopia for one year, worsening over the last three months. Headache was chronic, intermittent over one year, with nocturnal exacerbation (NRS up to 8). Blurred vision on the left eye appeared three months prior. There was no history of hypertension, diabetes, cardiovascular disease, stroke, asthma, or previous surgery. Bowel and bladder function remained normal. No seizure, fever, vomiting, or trauma was reported. Neurology had diagnosed a suspected Meckel's cave meningioma.

Figure 1. Clinical Photo of The Patient

Physical Examination

Pre-operatively, airway was patent with Mallampati II and good neck mobility. Vitals were stable (BP 120–135/70–92 mmHg, HR 80–91 bpm, SpO_2 98% RA). Neurologically, GCS 15, anisocoria 3/5 mm with reactivity, and paresis of CN III, IV, VI on the left. Motor strength 5/5 with no lateralization. Sensory deficit was present in the left frontal and mandibular regions (CN V distribution). No meningeal signs, no cerebellar dysfunction.

Supporting Exams

Pre-operative laboratory evaluation showed electrolytes and coagulation within acceptable surgical limits (Na 135 mmol/L, K 3.6 mmol/L, Cl 103 mmol/L, Hb 11.9 g/dL, leukocytes 11,400/µL, platelet 267,000/µL, PT 10.4 sec, APTT 26.4 sec, GDS 113 mg/dL). Post-operative monitoring revealed mild leukocytosis (14,780/µL), hemoglobin 12.3 g/dL, albumin 3.31 g/dL, sodium 134 mmol/L, potassium 4.2 mmol/L, and glucose 172 mg/dL. All laboratory results were clinically manageable, with no delay in surgical planning. (Table 1)

The supporting diagnostic examinations reinforced the suspicion of a Meckel's cave meningioma and documented postoperative structural changes. Pre-operative MRI demonstrated a solid extra-axial mass occupying the Meckel's cave, extending into the prepontine cistern and left cavernous sinus, compressing the trigeminal nerve and causing both transtentorial herniation and ipsilateral proptosis, features consistent with a Meckel's cave meningioma. Post-operative CT scan confirmed a partial debulking of the mass, with new findings of a

Table 1. Laboratory Examination

Parameter	Pre-operative (04–05 Dec 2024)	Post-operative (09–10 Dec 2024)
Sodium (Na)	135 mmol/L	134 mmol/L
Potassium (K)	3.6 mmol/L	4.2 mmol/L
Chloride (Cl)	103 mmol/L	106 mmol/L
Hemoglobin (Hb)	11.9 g/dL	12.3 g/dL
Leukocytes	11,400 /µL	14,780 /µL
Hematocrit	36.4 %	37.4 %
Platelets	267,000 /µL	237,000 /µL
PT	10.4 s	–
APTT	26.4 s	–
AST/ALT (OT/PT)	16 / 16	–
Albumin	3.84 g/dL	3.31 g/dL
Glucose (GDS)	113 mg/dL	172 mg/dL
Urea / Creatinine	13.7 / 0.69	–

small intraparenchymal hemorrhage (0.22 cc), subarachnoid hemorrhage, pneumocephalus, and subcutaneous emphysema, which are expected early post-surgical changes. Chest radiography showed no cardiopulmonary abnormality that could affect anesthetic or perioperative risk. Neurophysiological evaluations (EMG, SSEP, NCV, VEP, BERA) revealed only mild root compressions and mild eighth-nerve involvement, with no significant abnormalities in SSEP or blink reflex, supporting preserved functional pathways relevant to intraoperative neurophysiology monitoring. (Table 2)

Anesthesia Management

The patient was classified as ASA III due to neurological involvement. General anesthesia with intubation was chosen using brain-protective strategy to preserve IOM signal integrity. Induction used loading dexmedetomidine 60 mcg over 10 min for hemodynamic stability, followed by propofol TCI Schnider mode with targeted effect. The target-controlled infusion (TCI) system calculated the target effect-site concentration based on patient age, sex, height, weight, and lean body mass (LBM). Propofol was administered to achieve a target effect-site concentration (Ce) of 4–6 µg/mL, along with fentanyl 100 µg and atracurium 20 mg. After intubation, scalp block with ropivacaine 0.375% plus dexamethasone was administered for analgesic sparing.

Table 2. Supporting Diagnostic Examinations

Exam	Key Findings
MRI Head + Contrast (Pre-op)	Extra-axial solid mass at Meckel's cave extending to prepontine cistern & left cavernous sinus; compressing trigeminal nerve; transtentorial herniation; proptosis 4.8 mm; consistent with Meckel's cave meningioma
CT Scan Post-op	Debulked residual mass; postoperative ICH 0.22 cc; SAH in temporal sulci; pneumocephalus; subcutaneous emphysema; persistent herniation downward
CXR	Normal cardiac and pulmonary fields
EMG/SSEP/NCV/VEP/BERA	Mild bilateral C8–T1 and L4–S1 root compression; mild VIII nerve compression; SSEP, blink reflex and VEP within normal limits

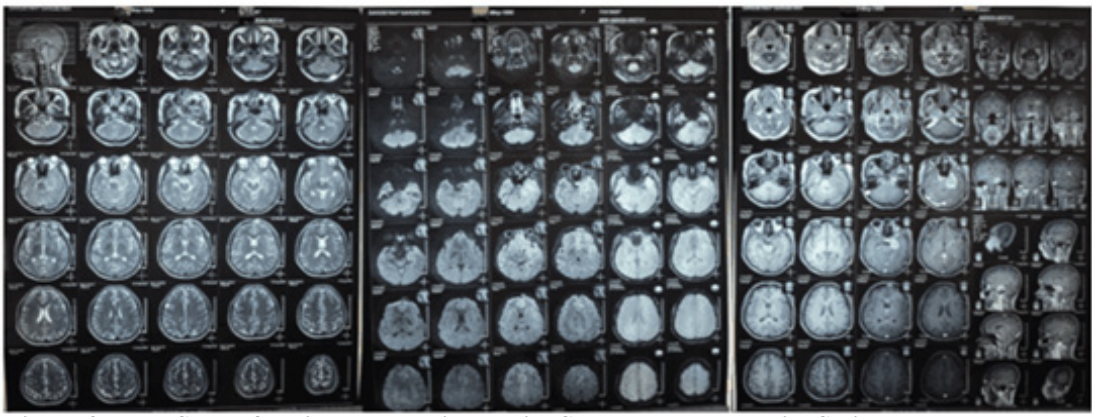
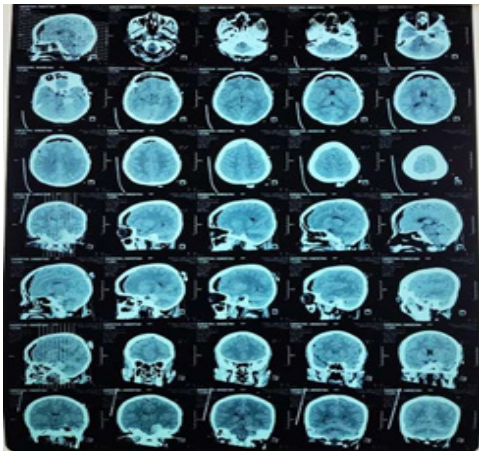


Figure 2. MRI Scan of Patient. MRI Diagnostics Showed an Extraaxial Solid Mass at the Meckel's Cave Area causing Transtentorial Herniation and Iinvolving the Trigeminal Nerve



Maintenance used propofol TCI Schnider mode with target effect (Ce 2–6 µg/mL titrated to BIS targets) and dexmedetomidine 0.3–0.7 mcg/kg/h to maintain stable MAP and avoid interference with MEP/SSEP signals. Intraoperative analgesia was supported with fentanyl 50 mcg/h infusion. The procedure lasted for four hours with blood loss ≈550 cc and transfusion of 2 PRC units. IOM remained interpretable throughout.

The surgical procedure lasted 4 hours with a total bleeding of approximately 550 cc. No significant interference with neurophysiology

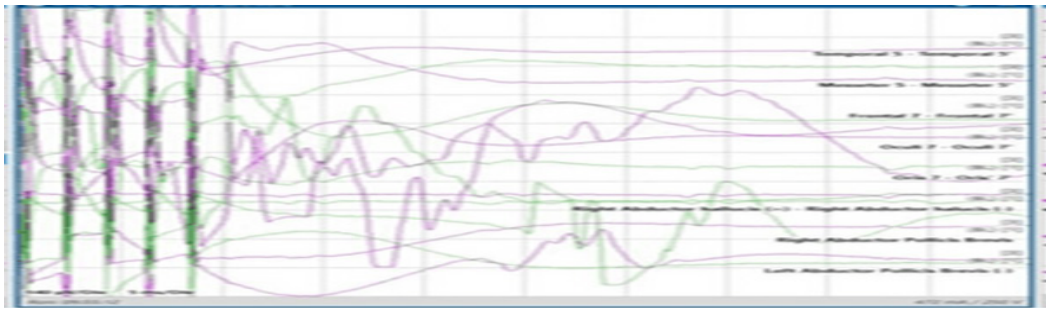


Figure 4. Neurophysiological Intraoperative Monitoring

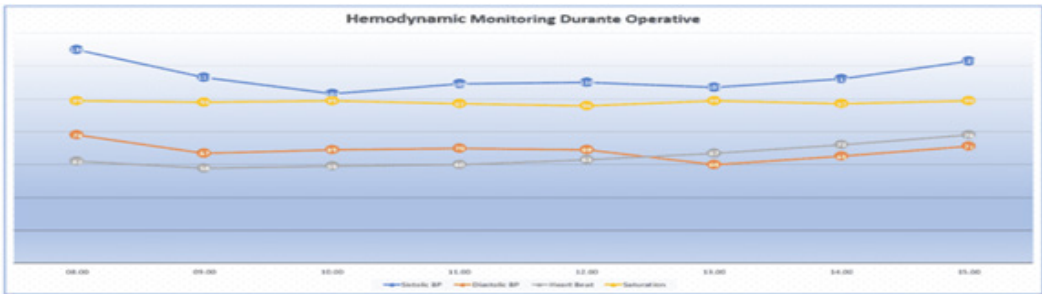


Figure 5. Haemodynamic Monitoring Evaluation Graphic

signals was found during the procedure. IOM helps the surgical team to identify important neural structures, thus minimizing the risk of nerve injury. Dexmedetomidine proved effective in preventing blood pressure fluctuations due to tumor manipulation, while propofol TCI ensured optimal depth of anesthesia and compatibility with IOM.

Post-Surgical Management

The patient was extubated and transferred to ICU with a stable airway, GCS 15, and no lateralization. Headache persisted with NRS 8; motor function remained 5/5. Sensory deficit persisted in the left trigeminal region. Post-operative analgesia continued with fentanyl 30 mcg/h and metamizole 1 g TID. Circulation targeted MAP >65 mmHg; fluid therapy maintained urine output 0.5–1 mL/kg/h. Ongoing care included oxygen via NRBM 10 L/min, ceftriaxone prophylaxis, steroids, antiemetics, and temperature/glucose/osmolarity control. Lumbar drain was maintained under sterile protocol for 2 days in ICU. No neurological deterioration was noted in early postoperative monitoring. Patient was monitored in ICU for 2 days before being moved to the lowcare wards and discharged home 5 days postoperative with no additional neurological deficit.

Discussion

Meckel's cave meningiomas are rare and challenging tumors that involve critical neurovascular structures, including the trigeminal nerve. Surgical resection is often curative but requires meticulous planning to preserve neurological function. Anesthetic management, particularly with intraoperative neurophysiological monitoring (IOM), is vital to optimizing patient outcomes. This case highlighted the use of Target-Controlled Infusion (TCI) of propofol combined with multimodal analgesia and dexmedetomidine to maintain stable hemodynamic and neurophysiological conditions during craniotomy for Meckel's cave meningioma. Propofol administered via TCI Schnider mode is well-suited for neuroanesthesia due to its rapid onset, precise titration, and predictable recovery profile. The use of TCI allows precise control of plasma and effect-site concentrations, ensuring optimal sedation depth without compromising IOM signals. Propofol reduces cerebral metabolic rate and intracranial pressure, both critical for surgeries involving intricate cranial anatomy. In this case, TCI propofol was set in Schnider mode with effect-site concentration was adjusted between 2-6 μg/mL to maintain compatibility with motor-evoked potentials (MEPs) and sensory-evoked potentials (SSEPs), critical for IOM-guided surgeries.[1,5,6]

Dexmedetomidine, a selective α2-adrenergic receptor agonist, provides sedation and analgesia without respiratory depression. Additionally, it ensures hemodynamic stability, crucial during tumor resections involving vital neurovascular structures. In this case, dexmedetomidine infusion at 0.3–0.7 mcg/kg/hour maintained stable blood pressure and heart rate, preventing fluctuations that might disrupt surgical precision or IOM accuracy. Dexmedetomidine also attenuates stress responses and offers neuroprotection, supporting its use in neurosurgical cases.[2] Multimodal analgesia was employed to reduce opioid consumption and enhance recovery. Scalp block with ropivacaine and dexamethasone provided effective regional anesthesia, while intraoperative fentanyl infusion and postoperative paracetamol addressed systemic pain control. This approach aligns with enhanced recovery after surgery (ERAS) protocols, which aim to minimize opioid-related side effects and improve postoperative outcomes.[3] IOM is essential in surgeries like this, allowing real-time evaluation of neurological function. MEPs and SSEPs were monitored to identify potential compromises to cranial nerves or motor pathways.[6,7] The anesthetic protocol, including TCI propofol and dexmedetomidine, was tailored to preserve signal integrity, enabling safe tumor resection while minimizing the risk of postoperative deficits.

This strategy highlights the critical interaction between anesthetic techniques and neurophysiological monitoring in high-risk surgeries.[4,9] During the 4-hour surgery, the patient maintained stable hemodynamics and intact IOM signals. Postoperatively, no new

neurological deficits were observed. Pain was effectively controlled with multimodal analgesia, and the patient demonstrated progressive recovery of motor and sensory function. These outcomes underscore the effectiveness of this anesthetic strategy in balancing sedation depth, hemodynamic stability, and neuroprotection in complex neurosurgical cases.[7,8] The combination of TCI (Schnider mode) propofol, dexmedetomidine, and multimodal analgesia proved instrumental in this case, achieving stable hemodynamic and neurophysiological conditions during craniotomy for Meckel's cave meningioma. This anesthetic approach aligns with modern neuroanesthesia principles and highlights the importance of individualized management to optimize patient outcomes in complex cranial surgeries. Future research should continue to refine the integration of TCI systems and IOM in neuroanesthesia.

Conclusion

This case report describes the anesthetic management of craniotomy for Meckel's cave meningioma resection against the effectiveness of propofol TCI Schnider mode for proper sedation and dexmedetomidine for hemodynamic stability. Combined with multimodal analgesia, this approach supports optimal intraoperative neurophysiologic monitoring and improves postoperative outcomes. The integration of advanced anesthetic techniques ensures safety and aligns with enhanced recovery protocols, providing a framework for managing complex neurosurgical cases.

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State if any of the authors has a conflict of interests. If there is none, please state: The authors report no conflict of interests.

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