This is an accepted article in press for IJMDC
The designed pdf version will be available soon.

Review Article:

Anesthesia management in patients with neurological diseases: an updated systematic review

Mohamed Ahmed Fayad 1, Abdulmajeed Alnahdi 2, Abdullah Abdulrahman Bin Bakor 3, Mohammed Bakr Mohammed Bosaeed 4, Ammar Ibrahim Hawsawi 5, Yasser Jabah Misfer Alsenadi 6

1: Consultant, Department of Anesthesiology, Maternity and Children Hospital, Makkah, Saudi Arabia

2: Resident, Department of Pediatric Surgery, Institution, Makkah, Saudi Arabia

3: Resident, Department of Anesthesiology, Maternity and Children Hospital, Makkah, Saudi Arabia

4: General Physician, Ashaoqiyah, Makkah, Saudi Arabia

5: Batterjee Medical College, Jeddah Saudi Arabia

6: Pharmacist, King Khaled Hospital, Najran, Saudi Arabia

Corresponding address:

Abdullah Abdulrahman Bin Bakor
Resident, Department of Anesthesiology, Maternity and Children Hospital, Makkah, Saudi Arabia

Email: binbakor@gmail.com
ABSTRACT

Background:

Prior literature discouraged anesthesiologists from administering regional anesthesia on patients with pre-existing neurologic disorders. Anesthesiologists are occasionally faced with adopting a regional anesthetic method in patients with pre-existing neurological diseases. There is uncertainty about whether secondary variables such as patient characteristics and anesthetic and surgical risk factors might influence the post-operative neurological outcome.

Aim:

To review the current literature on the anesthetic management of patients with neurological diseases.

Methods:

Studies related to our subject were explored using PubMed and Google scholar databases. The keywords included were “Anesthesia, anesthetic management, neurological disease, regional anesthesia,” and were used in various combinations. The inclusion criteria were original studies that reported Anesthesia management in patients with neurological disease and full text-articles.

Results:

A total of 100 articles were obtained, only eight articles were eligible for the inclusion criteria were published between 2004 to 2021. The detailed studies were conducted on 156 participants, two of them were case series, and six were case reports.

Conclusion:

Patients with CNS problems such as multiple sclerosis, amyotrophic lateral sclerosis, Tuberous sclerosis, and brain tumors were included in our study. General anesthesia has been associated with worsening multiple sclerosis. A bupivacaine-based scalp nerve block and Dexmedetomidine were used as the primary hypnotic-sedative medicine to perform awake craniotomies on 10 patients, allowing safe tumor removal. The study shows that the risks associated with neuraxial anesthesia and analgesia in those with pre-existing CNS illnesses may be less prevalent than previously thought.

Keywords: Anesthesia, anesthetic management, neurological disease, multiple sclerosis, amyotrophic lateral sclerosis.
INTRODUCTION:

Previous research has discouraged anesthesia physicians from using regional anesthesia on patients with pre-existing neurologic problems. The ‘double crush’ phenomenon proposed that individuals with first nerve damage may be more vulnerable to harm at a second location [1]. Regional anesthesia may cause needle trauma or neurotoxicity from local anesthesia [2]. Anesthesiologists are occasionally faced with adopting a regional anesthetic method in patients with pre-existing neurological diseases. There is uncertainty about whether secondary variables such as patient characteristics and anesthetic and surgical risk factors might influence the post-operative neurological outcome. [3]. Damage from the needle, catheter insertion, and/or local anesthetic solutions may occur during regional anesthesia. Most anesthesiologists would like to avoid being involved in a legal claim if neurological issues arose during surgery due to a localized method. [4]

The advantages of general anesthesia are immobility, pain management, and airway protection. The principal risks of general anesthesia are hemodynamic alterations with intubation, the likelihood of delayed time to recanalization, pulmonary aspiration, and the need for additional staff. Local anesthetic or sedation (including monitored anesthesia care) can preserve smoother hemodynamics due to reduced pharmacological vasodilator delivery and allow intra-procedural clinical neurological assessment. [5] However, these techniques have drawbacks such as a lack of airway protection, continuing patient movement, uncontrolled discomfort and agitation, and lengthy process duration. [6]

Neurological and psychiatric diseases are diverse central nervous system (CNS) and neuromuscular diseases. The underlying pathophysiology varies greatly and may involve both acquired and hereditary illnesses. Patients with CNS diseases or disorders may be subjected to surgical operations that are directly connected to or unrelated to the CNS.
ailment. Anesthesiological risk is heightened in the presence of brain stem, spinal cord, and autonomic nervous system abnormalities. Co-existing CNS illnesses usually have significant anesthesiological consequences regarding anesthetic medication selection, methods, monitoring, cerebral protection, and patient resuscitation. [7, 8]

Higher susceptibility to anesthetic medications and cardiac and respiratory problems may result in a longer post-operative course. Despite these well-known facts, few large-scale research on individuals with neurologic and mental illnesses undergoing anesthesia and surgery have been published. Because of the intrinsic variety of CNS illnesses and the certain unpredictability of comorbidities, defining defined perioperative guidelines in these patients is challenging. [9]

Obstetric patients with neurological comorbidities might be difficult to anesthetize. Regional analgesia and anesthetic treatments provide several therapeutic advantages in the obstetric population. Still, they may be contraindicated in the case of high intracranial pressure, a tethered spinal cord, or unstable illness. Furthermore, aberrant anatomy, such as kyphoscoliosis, might make the insertion of an epidural or spinal needle problematic, if not impossible. The local anesthetic dose should be carefully titrated in all patients, but notably in those at risk of respiratory depression due to their underlying neurological disease. If general anesthesia is required, the concomitant elevations in systolic blood pressure and their negative influence on intracranial pressure pose a significant danger. [10, 11]

Unfortunately, literature on the neurological outcome of regional anesthesia in individuals with underlying neurological diseases is scarce. Regional anesthetic is used in individuals who have a pre-existing neurologic illness. [12, 13]
METHOD AND SEARCH STRATEGY:

This systematic analysis follows the PRISMA checklist guidance for systematic review and meta-analysis [14]. Two databases were used for searching purposes; PubMed and Google scholar databases. The two databases were used to search for studies conducted on our main subject, "Anesthesia management in patients with neurological diseases." The studies were published in 2004 and 2021.

The searching process involved using various keywords, including “Anesthesia, anesthetic management, neurological disease, multiple sclerosis, amyotrophic lateral sclerosis.” The involved keywords were used in several combinations to obtain all possible articles. All the titles produced from this primary exploration were revised.

ELIGIBILITY CRITERIA:

After reviewing the titles of the obtained articles, only articles focused on anesthesia management in patients with neurological diseases were included, whereas articles conducted on anesthesia management before 2004 were excluded. Also, articles conducted on anesthesia management in patients with diseases other than neurological diseases were excluded. The second step included reviewing the remaining articles on anesthesia management in patients with neurological diseases to select only articles written in English and original articles. In contrast, review articles, letters to editors were excluded. The final stage included original articles written in the English language and reported anesthesia management in patients with neurological diseases; these articles were further explored to exclude non-available full-text articles, duplicate articles, and articles with unsatisfying content, such as articles with overlapped or incomplete data. The full description of the search strategy is shown in figure 1.
Fig1: Planning of Eligible criteria

Identification

PubMed (N=65)

Google scholar (N=35)

Title screening (N=100)

Records after exclusion (N=73)

Records screened (N=73)

Articles not focusing on Anesthesia management in patients with neurological diseases Excluded (N=27)

Not original articles excluded (N=29)

Original articles assessed for eligibility (N=44)

Articles included for data extraction and analysis (N=8)

Full text articles excluded (N=36)

Non-available full-text (N=23)

Duplicate articles (N=6)

Content not satisfying criteria (N=7)

Articles not written in English excluded (N=8)

Included

Articles not written in English excluded (N=8)

Articles not written in English excluded (N=8)
DATA REVIEWING AND ANALYSIS:

Articles were reviewed for abstracts and the full text to extract the data of interest and transfer data into a pre-designed excel sheet. The selected data were then revised through the excel sheet, and then the data was transferred to one stable to summarize the chosen data to facilitate the analysis of data.
RESULTS:

This systematic review included eight articles that met the eligible criteria [15-22] (table1). The included studies were either published in 2004 [15], or 2006 [16] or 2008 [17] or 2010 [18, 19] or 2012 [20] or 2014 [21] or 2021 [22]. Two studies were cases series [16, 21] and six case report studies [15, 17, 18, 19, 20, and 22].

A total of 156 people were included in the included studies. The study population was patients with neurological diseases. Three studies included patients with amyotrophic lateral sclerosis (ALS) [15, 17, and 20], while one study included one patient with CNS disorders [16]. One study included a patient with multiple sclerosis (MS) [18]. Two studies included patients with a brain tumor [19, 21], while one included a pregnant woman with Tuberous sclerosis [22].

The age of patients included in the studies of our results was between 16 and 65. One study included 46-year-old and 65-year-old women [15]. Another study included a 55-year-old man [17]. In addition, a 33-year-old male patient was included [18]. Another study included a 16 years old male [19], while one last study included a 64-year-old man [20].

Two studies discussed Anesthetic management in patients with ALS [15, 17], while one study assessed neuraxial anesthesia and analgesia in patients who already had CNS problems [16]. One study investigated the anesthetic management of laparotomy for a patient with MS [18]. Another study evaluated anesthetic management with a scalp nerve block and propofol/remifentanil infusion during awake craniotomy in an adolescent patient [19]. In contrast, one study discussed spinal anesthetic management for discectomy in ALS patients [20]. One study examined the anesthetic approach to high-risk patients and prolonged awake craniotomy using dexmedetomidine and scalp block [21], and one last study investigated anesthetic management in women with Tuberous sclerosis [22].
Epidural anesthesia was used in two cases [15, 16]. In the first case [15], the patient with ALS who underwent an emergency operation for gastric fistula malfunction. She was in good general condition during and after the operation and had no pain. In the other study [16], epidural anesthesia or analgesia was performed in 42% of the patients with CNS disorders.

Combined spinal and epidural anesthesia (CSE) was used in three cases [15, 16, and 22]. In a case with ALS [15], a 46-year-old woman underwent an emergency operation for ileus. In case [16], combined spinal-epidural technique was used in 1% of the patients with CNS disorders. Finally, in case [22], a parturient with Tuberous sclerosis underwent a category two cesarean section.

Spinal anesthesia was used in two cases [16, 20] to avoid respiratory complications associated with general anesthesia. In one study [16], Spinal anesthesia was performed in 75 (54%) patients with CNS disorders Continuous spinal anesthesia was used in 3% of the patients [16]. In the other case [20], Spinal anesthesia was done between lumbar 3 and 4 via a midline approach in the left lateral position in a patient with ALS.

Anesthesia was induced with Bupivacaine in one case with CNS disorder [16]. Additionally, bupivacaine-based scalp nerve block, and Dexmedetomidine were used as the primary hypnotic-sedative agent in prolonged awake craniotomy [21].

Epinephrine was added to the injectate in 52% of the patients with CNS disorders [16].

In a patient with ALS [17], anesthesia was performed by sevoflurane, nitrous oxide, and fentanyl.

Propofol and remifentanil were used in two cases to induce anesthesia [18, 19], while anesthesia was maintained with nitrous oxide, sevoflurane, and remifentanil in a patient with ALS [18]. In another case with ALS, Spinal anesthesia injected 10 mg of 0.5% hyperbaric bupivacaine, plus fentanyl 20 µg using a 25 guage Quinke spinal needle [20].
Tracheal intubation was done using sevoflurane, a non-depolarizing muscle relaxant in a case with ALS [17], Rocuronium in another case with MS [18]. In contrast, awake intubation without muscle relaxants was performed in another case with ALS [15] to avoid prolongation of muscle relaxation.

Technical complications within and after surgery were found in one study [16]. In contrast, no technical complications were found in six cases [15, 16, 17, 18, and 20].
DISCUSSION:

Patients with previous central nervous system (CNS) illnesses, such as multiple sclerosis (MS), amyotrophic lateral sclerosis (ALS), or postpolio syndrome (PPS), pose a particular challenge to the anesthesiologist. [23] Historically, the use of regional anesthetic methods in this patient population has been considered risky due to the risk of poor neurologic prognosis. Several theoretical variables contribute to this notion, including an increased risk of neurologic damage from needle- or catheter-induced mechanical trauma, local anesthetic toxicity, brain ischemia caused by local anesthetic additives, patient prejudices, and potential medico-legal ramifications. However, it is unclear whether these risk variables are linked to worsening neurologic status in individuals with chronic neurologic deterioration.[24]

The duration of action of non-depolarizing muscle relaxants and the controversy surrounding the use of the neuraxial block are two significant challenges in the anesthetic management of patients with motor neuron disorders. [25]

Our study included four ALS patients [15, 17, and 20]. A 46-year-old woman received emergency ileus surgery [15], while a 65-year-old woman received emergency gastric fistula surgery [15]. In addition, a 55-year-old man with ALS was planned for hemicolectomy and colostomy [17], and a 64-year-old man with ALS was scheduled for hemicolectomy and colostomy [20].

Amyotrophic lateral sclerosis (ALS) is a rare but rapidly progressing degenerative neuromuscular illness that clinical anesthesiologists provide unique perioperative issues. Motor neuron degeneration generates many symptoms, including muscle weakness, atrophy, fasciculations, spasticity, and hyperreflexia. There are descriptions of therapeutic and experimental therapies such as riluzole, beta-lactams, methylcobalamin, dexpramipexole,
antiepileptics, antioxidant agents, neutrophin, anti-inflammatory agents, and antiapoptosis medications. [26]

Specific measures must be taken during the anesthetic management of ALS patients due to the underlying muscular weakness and accompanying respiratory insufficiency. Certain neuromuscular drugs, in particular, are contraindicated, and anesthetics that leave the body more quickly provide reasonable and appealing possibilities in this group. A thorough grasp of the disease process, therapeutic approaches, and anesthetic concerns is critical for effectively managing an ALS patient in the operating room. [27]

Prolonged muscle relaxation and persistent neuromuscular block effect in ALS patients may result in difficult tracheal extubation and post-operative respiratory problems. In our investigation, a patient with multiple sclerosis (MS) had a laparotomy. [18] Propofol and remifentanil were used to produce anesthesia, while nitrous oxide, sevoflurane, and remifentanil were used to keep it going. For tracheal intubation, rocuronium was employed. The four ratios and the bispectral index scale were also used to ensure proper muscle relaxation and anesthetic depth. The patient recovered quickly from general anesthesia and was extubated without incident.

MS is a chronic, debilitating demyelinating inflammatory disease of the central nervous system (CNS) with a varied course and severity. Multiple sclerosis is characterized by demyelination in many parts of the central nervous system. This slows conduction along with the damaged brain circuits. In addition, the inspiratory function may be affected by lesions impacting the medulla oblongata or the cervical or thoracic spinal cord [28]. Although total lung volume and vital capacity may be normal, maximum inspiratory and expiratory efforts are frequently subnormal and may even reach 50% of normal values [29].
This suggests a reduced functional residual capacity and emphasizes the significance of preoxygenation during anesthesia induction. There have been reports of diaphragmatic paralysis caused by cervical cord involvement, resulting in pulmonary symptoms [28]. Furthermore, central ventilation regulation may be changed, and responsiveness to high arterial PCO2 may be hindered [30]. Although some recommend preoperative pulmonary function tests and arterial blood gases to assess the degree of dysfunction, others argue that clinical signs such as the patient's ability to clear pulmonary secretions, cough, and exhale deeply are better predictors of respiratory muscle function [30]. Difficulties with the airway are uncommon. Despite this, cranial nerve damage may increase the risk of chronic aspiration due to poor regulation of the pharyngeal and laryngeal muscles [31].

General anesthesia has also been linked to the aggravation of multiple sclerosis. Nonetheless, there have been several effective inhalational anesthetic usages in multiple sclerosis patients [32, 33].

Patients with multiple sclerosis should be closely followed after surgery. Elevated body temperature should be expected and aggressively managed. Blood pressure fluctuations may be attributed to autonomic dysfunction. Airway compromise, hypoventilation, and atelectasis are risks for bulbar and respiratory involvement patients. Furthermore, people with multiple sclerosis may be more seriously affected by residual neuromuscular block than those with a normal neurological state. Finally, a neurologic impairment may occur after surgery. Examining for indications of such exacerbations regularly should be done to determine the necessity for suitable action. [12]

The post-operative aggravation of MS symptoms did not occur in the instance included in our research. However, he was re-hospitalized since deep vein thrombosis (DVT) reappeared after release, and he was promptly given heparin. He was eventually discharged following a
complete recovery from DVT. With the use of sevoflurane, a safe anesthetic treatment of a patient with MS was described, with no exacerbation of MS throughout the post-operative phase. [18]

Our systematic included a case of a parturient with Tuberous sclerosis who underwent a category two cesarean section under combined spinal-epidural anesthesia (CSE). During the intraoperative and early post-operative periods, no problems occurred. The patient complained of left-side facial-brachial hypoesthesia and headache 24 hours after surgery. A brain CT revealed a glioblastoma multiforme tumor in the right frontal cortical area. The patient was discharged after 15 days, and a neurosurgical approach was recommended. [22]

Anesthesia care for the pregnant and parturient with a neurological disease necessitates (1) expertise in neuroanesthesia and obstetric anesthesia care, (2) accurate preoperative physical examination of the neurological system, (3) safe choice and conductance of the anesthesia technique (mostly regional anesthesia), (4) avoidance of unfavorable drug effects for the fetus and the mother’s nervous system, and (5) intraoperative neuromonitoring together. The most crucial lesson is that, in the ideal scenario, any woman with a known, pre-existing neurological condition should consult with her doctor before becoming pregnant. There are three types of neurological illnesses that can occur during pregnancy: (a) Existence of pre-existing chronic neurological illnesses such as epilepsy and multiple sclerosis (b) Pregnancy-related diseases, such as certain brain tumors or cerebrovascular accidents. (c) Pregnancy-related disorders such as eclampsia and hemolysis result in increased liver enzymes and a low platelet count [9, 10, 34, 35].

Our study employed a bupivacaine-based scalp nerve block and Dexmedetomidine as the principal hypnotic-sedative medication to perform awake craniotomies for ten patients,
allowing safe tumor excision while intraoperative intraoperative electrocorticography for motor and speech mapping. [21]

In our study, Dexmedetomidine with contemporaneous scalp block was an effective and safe anesthesia technique for awake craniotomy. In addition, Dexmedetomidine reduces the difficulty and duration of the surgery in people who would not usually be deemed candidates for it.

The awake craniotomy method was developed for the surgical treatment of epilepsy. It has since been employed in patients undergoing surgical management of supratentorial tumors, arteriovenous malformations, deep brain stimulation, and mycotic aneurysms near key brain areas. This method optimizes lesion resection while protecting critical regions such as the motor, somatosensory, and language domains. The patient's full participation is required during this surgical method to assist cortical mapping. [36, 37, 38]

Our study comprised 139 individuals with CNS diseases in a case series. [16] Spinal anesthesia was used in 54% of the patients, epidural anesthesia or analgesia in 42% of the patients, continuous spinal anesthesia in 3% of the patients, and a combination spinal-epidural method in 1% of the patients. Bupivacaine was the most widely utilized local anesthetic in all procedures. In 52% of cases, Epinephrine was added to the injectate.

The choice to use regional anesthetic in individuals who have pre-existing neurologic impairments should be based on each specific instance's risks and possible advantages. Many individuals with neurologic diseases, for example, may also have concurrent respiratory or cardiovascular deficits that might benefit from a regional method. Although this study looked at a wide range of individuals with varying comorbidities and neurologic problems, conclusive conclusions about the safety of neuraxial anesthesia or analgesia in a specific patient population cannot be drawn. However, the study suggests that the dangers usually
linked with neuraxial anesthesia and analgesia in individuals with pre-existing CNS diseases may be less common than previously assumed. Indeed, it may be advisable to rethink the long-held view that neuraxial anesthesia and analgesia are absolute contraindications in this patient population [13, 39].
CONCLUSION:

Patients with previous central nervous system (CNS) problems such as multiple sclerosis (MS), amyotrophic lateral sclerosis (ALS), Tuberous sclerosis (TS), and brain tumors were included in our study. There are two significant issues in the anesthetic care of patients with motor neuron diseases: the duration of the action of non-depolarizing muscle relaxants and the dispute surrounding the use of the neuraxial block. Because of the underlying muscle weakness and concomitant respiratory insufficiency, specific measures must be followed during the anesthetic care of ALS patients. Certain neuromuscular medicines, in particular, are contraindicated, and anesthetics that leave the body faster give plausible and appealing alternatives in this category. Unfortunately, general anesthesia has also been associated with worsening multiple sclerosis.

Nonetheless, some effective inhalational anesthetics have been used in multiple sclerosis patients. The postoperative exacerbation of MS symptoms did not occur in the case studied in this study. Our study used a bupivacaine-based scalp nerve block and Dexmedetomidine as the primary hypnotic-sedative medicine to perform awake craniotomies on 10 patients, allowing safe tumor removal. In contrast, intraoperative electrocorticography was used for motor and speech mapping. The decision to employ localized anesthesia in people with pre-existing neurologic deficits should be based on each case's risks and potential benefits. Many people with neurologic disorders, for example, may also have concurrent respiratory or cardiovascular problems that might benefit from a regional approach. Even though this study included a diverse group of people with various comorbidities and neurologic issues, solid conclusions concerning the safety of neuraxial anesthesia or analgesia in a specific patient population cannot be formed. However, the study shows that the risks associated with
neuraxial anesthesia and analgesia in those with pre-existing CNS illnesses may be less prevalent than previously thought.

Conflict of interests:
The authors declare that there is no conflict of interest regarding the publication of this article.

Funding:
None

Consent for participation:
Not applicable

Ethical approval:
Not applicable
REFERENCES:


https://doi.org/10.4103/2152-7806.156598


https://doi.org/10.1097/AAP.0000000000000297


https://doi.org/10.1097/ANA.0000000000000120

https://doi.org/10.1093/bja/aeu372

https://doi.org/10.1097/ACO.0b013e3283620121

https://doi.org/10.1007/978-3-319-74838-2_31

https://doi.org/10.1007/978-3-030-73503-6

https://doi.org/10.4103/0259-1162.118940

https://doi.org/10.1093/bjaceaccp/mkr023


https://doi.org/10.1016/B978-0-323-03938-3.50065-8


https://doi.org/10.1097/00001503-200206000-00015


https://doi.org/10.1097/AAP.0000000000000179


https://doi.org/10.1371/journal.pmed.1000100

https://doi.org/10.1213/01.ane.0000220896.56427.53


https://doi.org/10.4097/kjae.2010.59.5.359

19. Sung B, Kim HS, Park JW, Byon HJ, Kim JT, Kim CS. Anesthetic management with scalp nerve block and propofol/remifentanil infusion during awake craniotomy in an

https://doi.org/10.4097/kjae.2010.59.S.S179


https://doi.org/10.4097/kjae.2012.63.6.547


https://doi.org/10.1097/ANA.0b013e3182a58aba


https://doi.org/10.5554/22562087.e957

https://doi.org/10.1213/01.ane.0000220896.56427.53


https://doi.org/10.2174/1874609809666151124233206


https://doi.org/10.1097/ACO.0000000000000466


https://doi.org/10.1016/S0140-6736(10)61156-7

https://doi.org/10.1378/chest.98.2.499

https://doi.org/10.1378/chest.101.2.479

https://doi.org/10.1378/chest.105.4.1163


https://doi.org/10.1111/j.1365-2044.1980.tb03947.x


https://doi.org/10.1227/00006123-198903000-00002


https://doi.org/10.1007/s007010050413
https://doi.org/10.1227/01.NEU.0000144491.14623.92

https://doi.org/10.1097/ACO.0000000000000107
Table 1: List of included studies

<table>
<thead>
<tr>
<th>Author and Publication year</th>
<th>Study design</th>
<th>Population, Sample Size, and characterization</th>
<th>Main points</th>
<th>Results and main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Otsuka et al. 2004</td>
<td>Case report</td>
<td>Two patients of amyotrophic lateral sclerosis (ALS).</td>
<td>Anesthetic management of two patients with ALS.</td>
<td>Case 1. A 46-year-old woman underwent an emergency operation for ileus. Abdominal muscle relaxation and analgesia were obtained by combined spinal and epidural anesthesia. To avoid prolonging muscle relaxation, awake intubation without muscle relaxants was performed. After the operation, she awoke smoothly and was extubated without any complications. Case 2. A 65-year-old woman underwent an emergency operation for gastric fistula malfunction. Epidural anesthesia was performed. She was in good general condition during and after the operation and had no pain.</td>
</tr>
<tr>
<td>2. Hebl et al. 2006</td>
<td>Case series</td>
<td>139 patients with CNS disorders.</td>
<td>Assessing the neuraxial anesthesia and analgesia in patients with preexisting CNS disorders</td>
<td>Out of 139 patients with CNS disorders, Spinal anesthesia was performed in 75 (54%) patients, epidural anesthesia or analgesia in 58 (42%) patients, continuous spinal anesthesia in 4 (3%) patients, and a combined spinal-epidural technique in 2 (1%) patients. Bupivacaine was the local anesthetic most commonly used in all techniques. Epinephrine was added to the injectate in 72 (52%) patients. There were 15 (11%) technical complications, with the unintentional elicitation of paresthesia and traumatic needle placement occurring most frequently. A satisfactory block was reported in 136 (98%) patients. No new or worsening postoperative neurologic deficits</td>
</tr>
<tr>
<td></td>
<td>Study</td>
<td>Case Report</td>
<td>Description</td>
<td>Anesthetic Management</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
<td>-------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3.</td>
<td>Iwanaga et al. 2008</td>
<td>A 55-year-old man who has ALS was scheduled for hemicolecotomy and colostomy.</td>
<td>Anesthetic management of laparotomy for a patient with ALS.</td>
<td>General anesthesia was performed by sevoflurane, nitrous oxide, and fentanyl. Since muscle relaxation needed for tracheal intubation and surgical procedure was obtained sufficiently using sevoflurane, a non-depolarizing muscle relaxant was not necessary throughout the anesthetic management. The patient awoke easily from general anesthesia and was extubated without incident. For postoperative pain management, opioids were administered intravenously, providing good analgesia. The postoperative course was uneventful, with no worsening of ALS-related neurological signs and symptoms.</td>
</tr>
<tr>
<td>4.</td>
<td>Lee et al. 2010</td>
<td>A 33-year-old male patient suffering from multiple sclerosis (MS)</td>
<td>Anesthetic management of laparotomy for a patient with MS.</td>
<td>Propofol and remifentanil were used to induce anesthesia, while nitrous oxide, sevoflurane, and remifentanil were used to keep it going. For tracheal intubation, rocuronium was employed. The train of four ratio and the bispectral index scale were also used to ensure proper muscle relaxation and anesthetic depth. The case emerged from general anesthesia smoothly and was extubated without any complication. There was no evidence of postoperative worsening of MS symptoms. He was rehospitalized, however, since deep vein thrombosis (DVT) reappeared after release, and he was promptly given heparin. He was eventually discharged following a complete recovery from DVT. The use of sevoflurane for safe anaesthetic treatment of a patient with MS was documented, with no exacerbation of MS throughout the postoperative phase.</td>
</tr>
<tr>
<td>5.</td>
<td>A case report</td>
<td>A 16-year-old adolescent would have an awake craniotomy to remove a tumour.</td>
<td>Anesthetic management with a scalp nerve block and propofol/remifentanil infusion during awake craniotomy in an adolescent patient</td>
<td>Local anesthetics were utilised to block the scalp nerves, and propofol and remifentanil were administered in a target-controlled infusion. Before scalp sewing, the patient tolerated the surgery well and was obedient, but after the surgeon sutured the scalp, he complained of discomfort and became agitated. They made the decision to switch to general anesthesia. The neurosurgeon did complete neurologic examinations, and there was no neurologic deficit except facial palsy of the right side. Facial palsy had improved with time.</td>
</tr>
</tbody>
</table>
### 6. Park et al. 2012

<table>
<thead>
<tr>
<th>Case report</th>
<th>A 64-year-old man with ALS</th>
<th>Spinal anesthetic management for discectomy in a patient with ALS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinal anesthesia for discectomy was chosen to avoid respiratory complications associated with general anesthesia. Spinal anesthesia was done between lumbar 3 and 4 via a midline approach in the left lateral position. It was injected with 10 mg of 0.5% hyperbaric bupivacaine, plus fentanyl 20 µg using a 25 guage Quinke spinal needle. There were no complications for one and a half-hour of the surgery. The patient was monitored for one hour in postoperative anesthetic care units (PACU) and then was discharged from PACU. The patient was fully recovered at 5 hours after the spinal anesthesia, and no worsening of neurologic signs or symptoms was revealed. The patient was discharged two days after surgery, and at the three-month follow-up, there were no neurologic complications due to spinal anesthesia.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 7. Garavaglia et al. 2014

<table>
<thead>
<tr>
<th>Cases series</th>
<th>Ten patients with brain tumors.</th>
<th>Anesthetic approach to high-risk patients and prolonged awake craniotomy using Dexmedetomidine and scalp block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anesthetic approach to high-risk patients and prolonged awake craniotomy using Dexmedetomidine and scalp block utilizing a bupivacaine-based scalp nerve block, and Dexmedetomidine as the primary hypnotic-sedative agent for performing awake craniotomy facilitating safe tumor resection, while utilizing intraoperative electrocorticography for motor and speech mapping. With concurrent scalp block, Dexmedetomidine is an effective and safe anesthetic approach for awake craniotomy. In addition, Dexmedetomidine facilitates the extension procedure complexity and duration in patients who might traditionally not be considered candidates for this procedure.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 8. Rodríguez et al. 2021

<table>
<thead>
<tr>
<th>Cases report</th>
<th>women with Tuberous sclerosis admitted to hospital for the delivery of a twin gestation</th>
<th>Anesthetic management for a parturient with Tuberous sclerosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>A parturient with Tuberous sclerosis underwent a category two cesarean section under combined spinal-epidural anesthesia (CSE). No complications developed during the intraoperative and early postoperative period. 24 hrs after surgery, the patient, presented left-side facial-brachial hypoesthesia and headache. A brain CT revealed a right frontal cortical bleeding tumor diagnosed as glioblastoma multiforme. After fifteen days, the patient was discharged, and a neurosurgical approach was advised.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>