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Spinal anaesthesia in a medically complex paediatric patient

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Keypoints

This case demonstrates that spinal anaesthesia can be successfully and safely performed in medically complex paediatric patients

Abstract

Background: Spinal anaesthesia in paediatric patients has experienced a resurgence driven by concerns regarding anaesthetic neurotoxicity and evidence demonstrating safety and efficacy. However, its application in medically complex children with multiple comorbidities remains underreported.

Clinical case: We report an 11-year-old female with a history of posterior fossa medulloblastoma treated with surgical resection, chemotherapy, and craniospinal radiotherapy at age of 2, followed by disease relapse at age of 4 requiring cervical spine surgery (C1-C5 laminectomy with fixation), high-dose chemotherapy, autologous bone marrow transplantation, and radiotherapy. She presented with bilateral proximal femoral epiphysiolysis requiring in situ fixation. Anaesthetic challenges included severe cervical spine restriction with complete inability to extend the neck, limited mouth opening creating a predicted difficult airway, subglottic tracheal stenosis immediately below the vocal cords further complicating airway management, and a radiation-exposed brain vulnerable to additional anaesthetic neurotoxicity. After preoperative MRI evaluation confirming no contraindications at the lumbar level, single-shot spinal anaesthesia was performed at L3-L4 with 6 mg of 0.5% isobaric bupivacaine plus 5 mcg fentanyl, complemented by light sedation with ketamine and propofol. The procedure was completed uneventfully in 50 minutes. The patient recovered rapidly with minimal motor blockade at 90 minutes, was hemodynamically stable, comfortable, and pain-free.

Discussion: This case illustrates three key advantages of spinal anaesthesia in this complex patient: (1) complete avoidance of airway instrumentation in a predicted difficult airway scenario compounded by subglottic stenosis, (2) minimization of cerebral anaesthetic exposure in a patient with radiation-induced brain vulnerability, and (3) demonstrated safety of neuraxial techniques in patients with prior cervical spine surgery when the lumbar spine is unaffected. The bilateral presentation of slipped capital femoral epiphysis is consistent with the 211-fold increased risk documented in paediatric cancer survivors receiving growth hormone therapy after total body irradiation.

Conclusion: Spinal anaesthesia can be safely and successfully performed in medically complex paediatric patients when applied with appropriate patient selection, thorough preoperative evaluation including spinal imaging, multidisciplinary collaboration, and meticulous technique. This case supports broader consideration of spinal anaesthesia in paediatric patients with difficult airways,

prior neurotoxic exposures, or conditions where general anaesthesia poses elevated risks.

Keywords

Paediatric anaesthesia; Spinal Anaesthesia; Medulloblastoma; Slipped Capital Femoral Epiphyses; Orthopedic Procedures; Case Reports

Introduction

Spinal anaesthesia in paediatric patients has experienced a resurgence in recent years, driven by concerns regarding potential neurotoxic effects of general anaesthesia and accumulating evidence demonstrating the safety and efficacy of neuraxial techniques in children. Despite robust supporting data, spinal anaesthesia remains underutilized in paediatric practice, with many anaesthesiologists reserving the technique primarily for high-risk infants. [1-5]

The Vermont Infant Spinal Registry demonstrated a 97.4% success rate with minimal complications in 1,554 infants. [6] The Paediatric Regional Anaesthesia Network, encompassing over 100,000 regional blocks, reported no permanent neurological deficits and a transient complication rate of only 2.4:10,000. [7] Contemporary single-center experiences report success rates exceeding 90% with rapid postoperative recovery. [4][8]

Indications for paediatric spinal anaesthesia have expanded beyond neonates to include older children undergoing diverse surgical procedures, including orthopaedic interventions. However, application in medically complex patients—particularly those with airway abnormalities, prior cervical spine surgery, or significant comorbidities—requires careful individualized assessment. [1-2][9-12]

This case report describes an 11-year-old female with complex medical history including posterior fossa medulloblastoma treated with surgical resection, chemotherapy, and craniospinal radiotherapy, followed by disease relapse requiring extensive cervical spine surgery (C1-C5 laminectomy with fixation). She presented for bilateral in situ fixation of proximal femoral epiphysiolysis with significant anaesthetic challenges: severe cervical spine restriction with complete inability to extend the neck, small mouth opening, subglottic tracheal stenosis with significant risk of difficult or failed intubation and a brain rendered vulnerable to additional anaesthetic exposure by prior radiotherapy.

Slipped capital femoral epiphysis (SCFE) represents a well-recognized late complication in paediatric cancer survivors, particularly those exposed to cranial or total body irradiation, chemotherapy, and growth hormone replacement therapy. The incidence in childhood cancer survivors treated with total body irradiation and receiving growth hormone therapy is markedly elevated, with rates 211-fold higher than in children with idiopathic growth hormone deficiency. [13-15]

The objectives of this case report are: to describe successful application of spinal anaesthesia in a medically complex paediatric patient with multiple contraindications to general anaesthesia, to discuss specific considerations in selecting neuraxial anaesthesia for a patient with prior extensive cervical spine surgery, and to highlight the importance of multidisciplinary collaboration, comprehensive preoperative evaluation including spinal imaging, and informed consent in optimizing outcomes for high-risk paediatric patients.

Case report

The patient was a 11 years-old female child with a two-month history of pain in her left thigh and hip. After orthopaedic evaluation, she was diagnosed with bilateral proximal femur epiphysiolysis needed for surgical treatment - *in situ* fixation (percutaneous pinning). Due to multiple comorbidities, a detailed history and examination were performed during preoperative anaesthesia appointment.

The patient had suffered from posterior fossa malignant medulloblastoma at 2 years old. She had a surgical resection of the medulloblastoma and postoperative chemotherapy. She completed one year chemotherapy. One and

half years later, when the patient was 4 years old, a relapse was detected with spread into the spinal canal and an extensive metastasis in the cervical spinal canal. Surgical decompression and resection, including laminectomy, were made from cervical vertebra C1 to C5, with fixation of these levels (Figures 1 and 2). She also did high-dose chemotherapy followed by autologous bone marrow transplantation (tandem transplantation) and radiotherapy. Since then, six years have passed with no signs of oncological relapse. The patient presented with long-term sequelae including focal idiopathic epilepsy, mild mental disorder due to brain damage and short stature due to hyposomatotropism, under treatment with growth hormone.

At physical examination, the patient height was 117cm and 25kg, according to CDC growth curves [16] stature and weight for age percentiles girls' charts it would correspond to six years old child on the 50th percentile. She had restrictions on movements of head and neck, with complete restrictions of head and neck extension. Airway evaluation also showed a small mouth opening. She had normal blood tests, including coagulation. At cervical MRI images there was a visible unexpected mild subglottic tracheal stenosis (Figure 3).

After careful discussion with orthopaedics' team, estimated surgical intervention time was 60 minutes and it would be compatible with single-shot spinal anaesthesia. After MRI analysis of the spinal cord (Figures 4 and 5) and having no contraindications for spinal anaesthesia we discussed this plan with the patient parents. Additionally, sedation would complement spinal anaesthesia for better comfort during surgery. The technique was explained to the child and parents also sedation and a free and informed consent was signed.

On the day of the surgery, the patient maintained the usual medication for focal epilepsy. Premedication with 7mg oral midazolam was given in the ward 30 minutes before arriving to the operating room. Cream local anaesthesia mixture with prilocaine and lidocaine was applied on dorsal surface of both hands. On the operating room, the patient was monitored according to the standards of the ASA and one 22 Gauge IV canula was inserted.

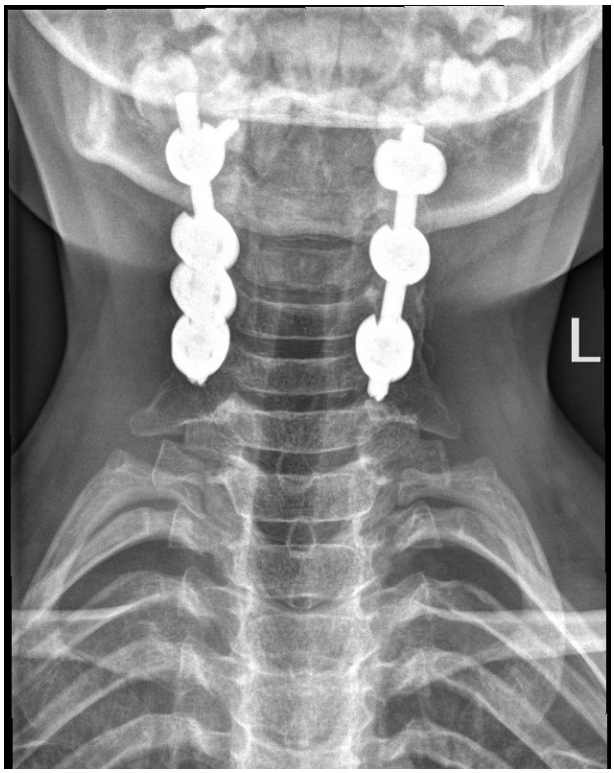

Figure 1. Anteroposterior cervical spine x-ray

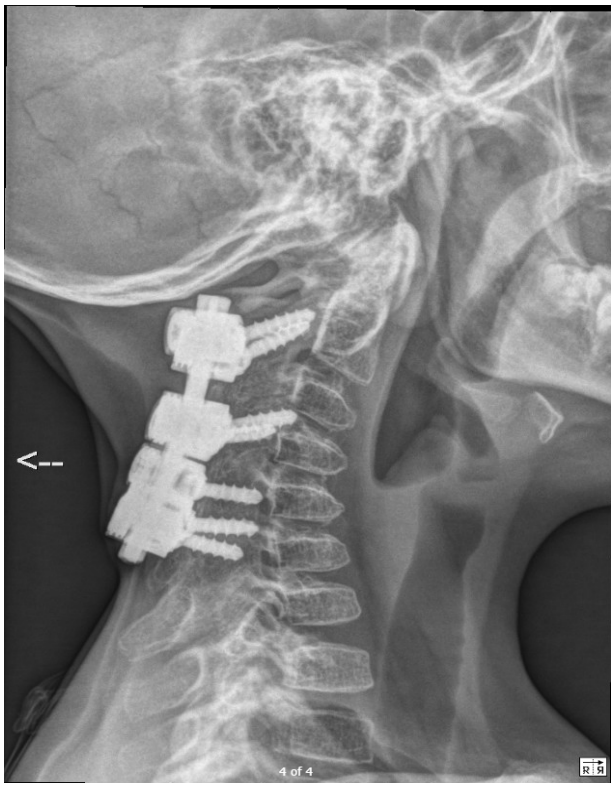

Figure 2. Lateral cervical spine x-ray

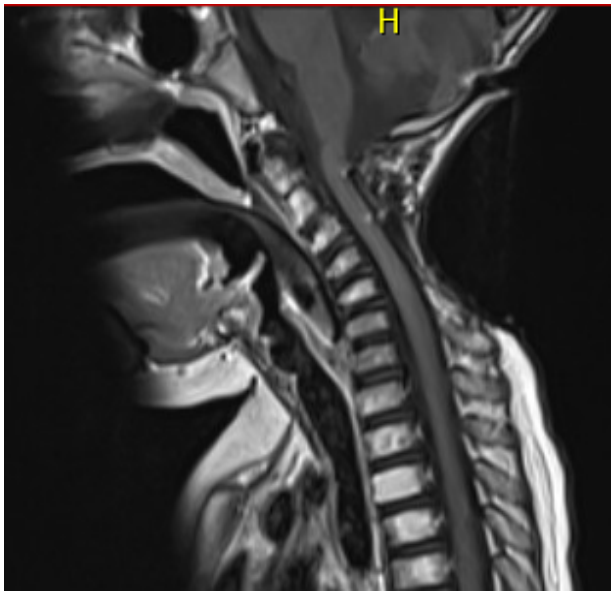

Figure 3. Cervical sagittal plane MRI showing a subglottic tracheal stenosis

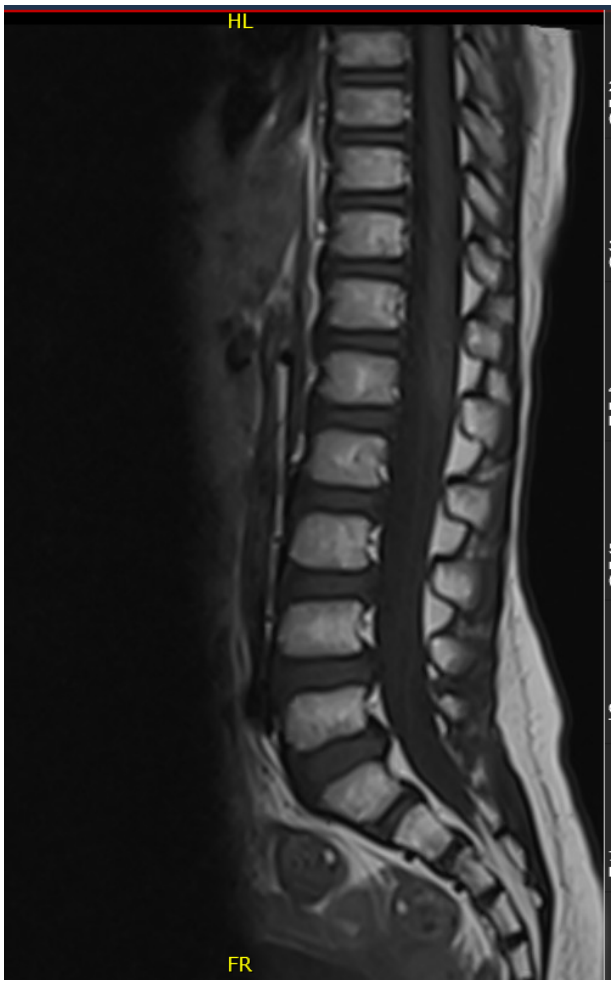

Figure 4. Lumbosacral sagittal plane MRI

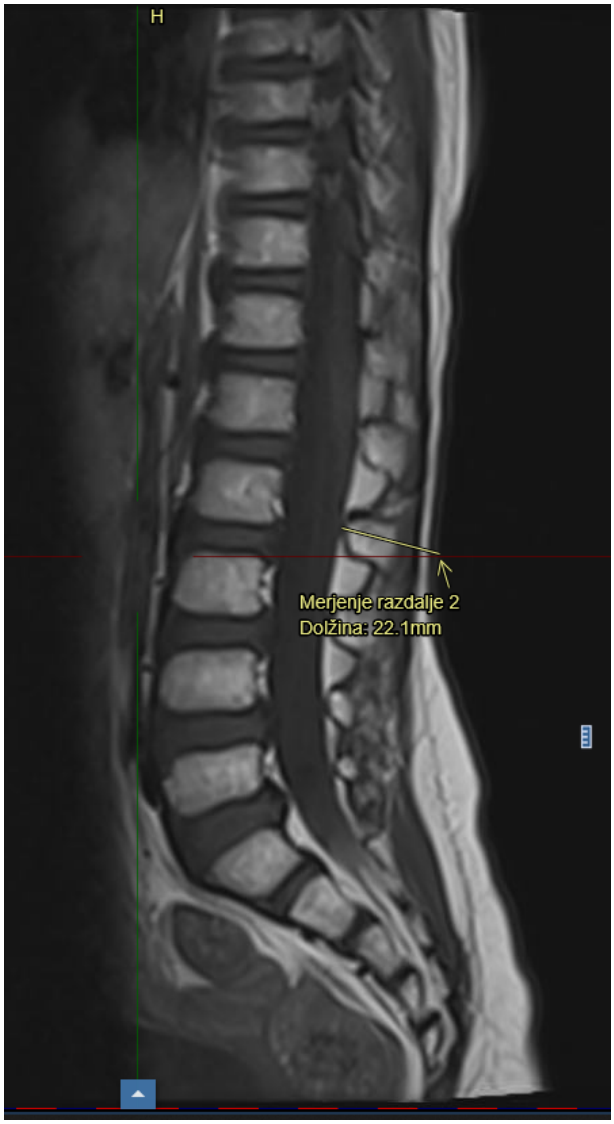

Figure 5. Lumbosacral sagittal plane MRI. Red line marking the end of the spinal cord

The patient was calm and co-operative. On right lateral decubitus, proper sterile preparation for performing the spinal anaesthesia. Anatomical references were easily palpated and local anaesthesia infiltration with 1mL of 2% lidocaine was made in the L3-L4 space. Spinal anaesthesia with 27Gauge Pencil Point need (name) was made with administration of 6mg of 0,5% isobaric bupivacaine (1.2mL, 0.24mg/kg) plus 5 micrograms of fentanyl (total volume: 1,3mL). The technique was performed at the first attempt with no complications. The child was positioned in dorsal position and 5 minutes later thermic block was at the umbilicus level (T10). At this point, oxygen cannula was placed and sedation was achieved with

10mg of ketamine, 20mg of 2% lidocaine administered intravenously followed by 1% propofol perfusion at 1,6mg/kg/h. The surgery began approximately 15 minutes after spinal anaesthesia and proceeded uneventfully. Prophylactic antiemetic therapy with dexamethasone and ondansetron was administered. Analgesia with Paracetamol (500mg) plus Ibuprofen (100mg) was administered intravenously and additionally local infiltration anaesthesia with levobupivacaine 0,25% was applied by surgeons. Total time of the surgery was 50minutes. The child was transferred to the recovery room hemodynamically stable. In the recovery room, after full recovery of consciousness and around 90minutes after spinal anaesthesia the motor blockade was grade 1 according to modified Bromage scale. The child was comfortable, calm and denied pain. After 40 minutes in the recovery room the patient was discharged to the ward. Two postoperative visits were made, one in same day of the surgery and the other the next day, more than 24 hours after surgery. The child and parents were really satisfied with the recovery after surgery. Pain was mild and controlled with paracetamol and NSAID and they were not registered any neurological symptoms, headache or other complications after spinal anaesthesia.

Discussion

Rationale for Spinal Anaesthesia

The most compelling indication for spinal anaesthesia was severe cervical spine pathology with complete restriction of neck extension, limited mouth opening, and fixed cervical anatomy following C1-C5 laminectomy and fixation. The presence of subglottic tracheal stenosis further compounded the airway risk, as patients with this condition have a high incidence of difficult or failed intubation, with potential for hypoxemia and trauma to already compromised stenotic tissue. [17-18] These constraints created a predicted difficult airway scenario where standard laryngoscopy would have been impossible and potentially dangerous. By selecting spinal anaesthesia, the team eliminated airway instrumentation, avoiding substantial risks of difficult or failed intubation and potential cervical spine injury during airway manipulation. [19-21]

Additionally, the patient's craniospinal radiotherapy created significant vulnerability to additional anaesthetic neurotoxicity. Emerging evidence demonstrates that cumulative general anaesthesia exposure is associated with measurable neurocognitive decline in paediatric medulloblastoma survivors, with each additional hour correlating with progressive deficits in intelligence quotient, attention, and processing speed. Radiation-induced brain injury renders the brain more susceptible to additional insults from general anaesthetic agents. By utilizing spinal anaesthesia with minimal sedation rather than general anaesthesia, the team substantially reduced cerebral anaesthetic exposure—a neuroprotective strategy particularly important in paediatric cancer survivors. [22-27]

Safety Considerations with Prior Spine Surgery

An important consideration was the safety of neuraxial anaesthesia in a patient with prior extensive cervical spine surgery. Hebl et al. studied 937 patients with preexisting spinal stenosis, lumbar disk disease, or prior spine surgery who underwent neuraxial blockade, reporting a neurological complication rate of 1.1% (95% CI 0.5%-2.0%), with spine surgery history not affecting success rate or technical complications. [10]

In this case, several factors supported safety: (1) cervical pathology was anatomically remote from the lumbar puncture site, (2) preoperative MRI confirmed absence of lumbar spinal stenosis or contraindications at the intended level, and (3) the patient had no active lumbar neurological symptoms. Vercauteren et al. recommend that in patients with spinal pathology, spinal techniques may be preferable to epidural techniques due to greater reliability. [10-12] The team appropriately selected single-shot spinal technique with appropriate local anaesthetic dose (0.24 mg/kg of bupivacaine), consistent with these recommendations and ESRA/ASRA guidelines. [28-29]

SCFE in Paediatric Cancer Survivors

The patient's bilateral proximal femoral epiphysiolysis is consistent with well-documented increased risk in paediatric cancer survivors. Mostoufi-Moab et al. demonstrated childhood cancer survivors exposed to total body irradiation have markedly elevated SCFE incidence during growth hormone therapy (35.9 per 1,000 person-years)—representing a 211-fold greater rate than children with idiopathic growth hormone deficiency, with 70% bilateral at presentation. [13] The pathophysiology is multifactorial, involving radiation-induced physeal damage, chemotherapy effects on bone metabolism, and mechanical stress of growth hormone therapy on weakened physis. [14][30-32]

Technical Execution and Outcomes

The technical execution demonstrated best practices: 27-gauge pencil-point spinal needle to minimize post-dural puncture headache risk, appropriate bupivacaine dosing (6 mg, 0.24 mg/kg) with fentanyl 5 mcg, and complementary sedation with ketamine and propofol maintaining spontaneous ventilation. The multimodal analgesic approach incorporating intravenous paracetamol and ibuprofen, local infiltration with levobupivacaine, and prophylactic antiemetic therapy reflects contemporary enhanced recovery principles. [2][8][29][32-33]

The patient's postoperative course demonstrated significant recovery advantages. She was transferred to recovery hemodynamically stable with minimal motor blockade (Bromage grade 1) at 90 minutes post-spinal anaesthesia, comfortable and pain-free. These outcomes are consistent with published data showing 72% of paediatric patients receiving spinal anaesthesia bypass Phase I recovery, with median postoperative length of stay of 84 minutes. [8] Additional benefits included avoidance of postoperative nausea and vomiting, preservation of airway reflexes, and elimination of postoperative apnea risk. [5-6][34]

Broader implications

This case exemplifies the underutilization of spinal anaesthesia in paediatric practice despite compelling safety and efficacy evidence. In carefully selected patients—particularly those with difficult airways, significant comorbidities, or prior neurotoxic exposures—spinal anaesthesia represents a superior alternative to general anaesthesia. The successful outcome reflects careful preoperative planning, multidisciplinary collaboration with orthopaedic surgery, preoperative MRI evaluation, and comprehensive informed consent. [1-5][10][28]

Conclusion

This case demonstrates that spinal anaesthesia can be successfully and safely performed in medically complex paediatric patients when applied with appropriate patient selection, thorough preoperative evaluation, multidisciplinary collaboration, and meticulous technique. The decision to utilize spinal anaesthesia in this patient with severe cervical spine pathology, predicted difficult airway, and prior neurotoxic exposures exemplifies evidence-based anaesthetic decision-making that prioritizes patient safety and optimizes outcomes.

The successful outcome—characterized by avoidance of airway manipulation, minimization of anaesthetic neurotoxicity, excellent surgical conditions, and rapid recovery—validates the selection of spinal anaesthesia as the optimal anaesthetic technique. As concerns regarding anaesthetic neurotoxicity continue to drive interest in alternative techniques, and as the population of paediatric cancer survivors with complex medical needs continues to grow, spinal anaesthesia will likely play an increasingly important role in providing safe, effective anaesthesia for carefully selected paediatric patients.

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Competing interests

The authors declare that they have no competing interests.

Author contributions

M.J. Quelhas, S.D. Stanković, P. Poredos, V. Tripković contributed to clinical case conception, literature search and drafting of the manuscript. M.J. Quelhas, S.D. Stanković, P. Poredos, V. Tripković contributed to manuscript revision. M.J. Quelhas, S.D. Stanković, P. Poredos and V. Tripković participated in critical revision of the manuscript and approved the final version. All authors meet the ICMJE criteria for authorship.

Consent for Publication

Patient and both parents accepted with the conception, writing and publication of this clinical report.

Availability of Data and Material

No new data were created or analyzed in this study.

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