Managing Conflicting Anesthetic Goals in a Child with Mitochondrial Disease Undergoing Scoliosis Surgery

Mark Goldman, MD, Eliot Grigg, MD, Vincent Hsieh, MD
Department of Anesthesiology and Pain Medicine, Seattle Children's Hospital

Introduction

- Mitochondrial diseases are a group of discorders that are caused by genetic mutations in mtDNA or nuclear DNA that codes for mitochondrial components
- In general, organ systems with high metabolic demands are most affected: CNS, heart, GI tract, musculoskeletal system
- Nearly all anesthetic agents affect mitochondrial metabolism.
- Mitochondrial patients often require smaller doses of anesthetic medications
- Care should be taken to avoid situations which could increase metabolic demand, such as prolonged fasting, hypoglycemia, hypothermia, acidosis, and hypovolemia
- Lactate-containing IVF should be avoided, due to the potential for impaired lactate metabolism
- Propofol infusions are generally avoided due to increased susceptibility for development of propofol infusion syndrome.
- Routine use of succinylcholine is avoided due to potential up regulation of nicotinic ACh receptors in skeletal muscle

Table 1. Listed below are Common Anesthetic Agents and the Sites Affected by Each. The References Match those in the Manuscript.

Medication	Mitochondrial Effects	References
Barbiturates	Complex I inhibition	33
Etomidate	Complex I inhibition, mild inhibition complex III	32
Propofol	Acylcarnitine transferase, complexes I/II/IV inhibition	25,37,38
Benzodiazepines	Complex I/II/III inhibition	34
Ketamine	Increase energy consumption +/− reports of complex I	35,36
Dexmedetomidine	None reported	None
Fentanyl/remifentanil	Minimal	39
Morphine	Mild complex I inhibition	39,40
Volatile Anesthetics	Complex I inhibition	20,21,27
Bupivacaine (Etidocaine)	Acylcarnitine translocase Mild complex I	24

Case Summary

A 12 year-old girl with scoliosis and mitochondrial complex IV deficiency presented for a T2 to pelvis posterior spinal fusion with the aid of MEPs and SSEPs.

The patient was induced with sevoflurane, followed by transition to a balanced anesthetic with 0.5 MAC desflurane supplemented with remifentanil and ketamine. A D5NS infusion was also used. Monitors included standard ASA monitors, an arterial line, and a BIS monitor.

Initial dissection proceeded smoothly. BIS was noted to remain static at approximately 60 regardless of end-tidal desflurane concentration, so neurophysiology EEG was used as an adjunct to assess anesthetic depth.

During the correction phase, MEPs were decreased, and so a phenylephrine infusion was started to augment spinal cord perfusion, with improvement in MEPs.

Point-of-care ABGs were done hourly to monitor metabolism. No significant changes from baseline were noted aside from acute anemia to a hematocrit of 23 and mild hypocalcemia, both of which were corrected.

The patient emerged from anesthesia uneventfully, and was extubated on arrival to the PICU immediately following surgery. She was transferred to the floor on POD #1, and discharged to home on POD #5.

Discussion

In this challenging case, we found it necessary to balance the metabolic needs of the patient with both anesthetic and monitoring needs.

Our usual approach to a posterior spinal fusion is TIVA with propofol and remifentanil infusions to achieve anesthesia and allowing for adequate MEP and SSEP monitoring. Volatile anesthetics are generally avoided or only used in low doses due to their interference with neuromonitoring.

However, given this patient's mitochondrial disease, a prolonged propofol infusion posed a risk of propofol infusion syndrome. Other options, such as dexmedetomidine, are reported to be safe for use in these patients, however it causes a decrease in MEP amplitude and would not achieve an adequate depth of anesthesia as a sole agent.

Despite the drawbacks of volatile agents, we chose 0.5 MAC desflurane supplemented with remifentanil for analgesia and ketamine for analgesia and to potentiate SSEP and MEP signals. We anticipated that this patient would be sensitive to volatile anesthetics, and that 0.5 MAC desflurane along with remifentanil and ketamine would be sufficient to achieve adequate anesthesia.

Blood gases were followed closely to assess for any metabolic derangements. Intervention to correct abnormal metabolic function was done as needed.

	SSEP Effect	MEP Effect	Mitochondrial Effect
Propofol	At high concentrations, ↑ latency, ↓ amplitude	↓	Boluses OK. Prolonged infusions have risk of PRIS
Opioids	Minimal changes	No significant effect	Minimal
Volatile agent	Dose dependent, ↑ latency, ↓ amplitude	↓↓↓	Increased sensitivity
Dexmedetomidine	No significant effect	↓	None reported
Ketamine	↑ amplitude	↑	OK, but can increase energy consumption

Conclusions

- Patients with mitochondrial disease pose unique anesthetic challenges
- Surgery should be scheduled so as to minimize prolonged fasting
- Choice of anesthetic should take into account the metabolic disturbances associated with the disease
- Anesthetic doses should be titrated judiciously, as some of these patients are hypersensitive to volatile anesthetics
- Metabolic function should be closely followed intraoperatively, and corrected as needed
- Lactate-containing IVF should be avoided since lactate metabolism may be impaired, and exonenous lactate may interfere with monitoring of metabolic function

References

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