Fluctuations in Spinal Cord Perfusion during Adult Spinal Deformity Correction Identify Neurological Changes: Proof of Concept

Jay D. Turner MD, PhD; Robert Eastlack MD; Zaman Mirzadeh MD PhD; Stacie Nguyen BS MPH; Jeff B. Pawelek BS; Gregory Mundis MD

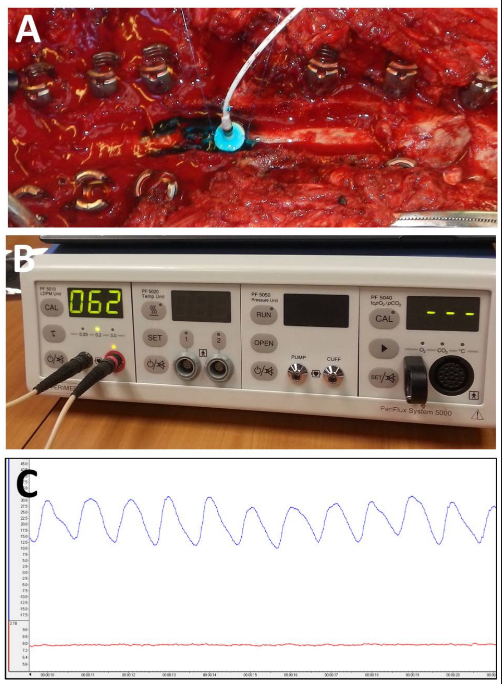
Barrow Neurological Institute and San Diego Spine Foundation

Introduction: Adult spinal deformity (ASD) surgery carries risk of spinal cord injury. Spinal cord ischemia is often implicated but has not been directly investigated. Here we present our index case as a proof of concept study for evaluating the role of spinal cord perfusion (SCP) in ASD correction.

Methods: ASD surgery was performed in the usual fashion with the addition of: 1) SCP monitoring, using laser Doppler probe fixated to the dura (Figure 1) at the level of the pedicle subtraction osteotomy (PSO), 2) intrathecal pressure monitoring with lumbar drain. Somatosensory evoked- (SSEP) and motor evoked potentials (MEP) were monitored throughout the case.

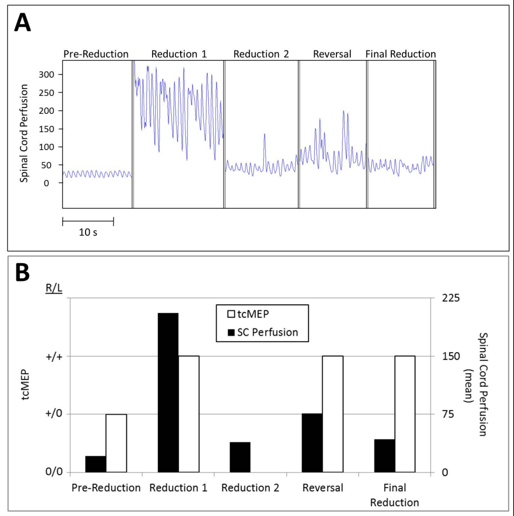
Results: An 84-year-old male with kyphoscoliosis and progressive myelopathy causing diminished motor and sensory function was treated with T4 PSO and long segment reconstruction. At baseline, SSEP signals were detectable in all four extremities, MEP signals were present in the right foot only, intrathecal pressure was 4 mmHg, and mean SCP was 21.2 perfusion (arbitrary) units (Figure 2, Table 1). The osteotomy was performed and reduced in two steps. After the first step of reduction, MEP signals appeared in the left leg and increased in amplitude in the right leg, and SCP simultaneously increased to 205.6. Further reduction lead to MEP signal loss in both legs and decrease in SCP to 39.2. With partial reversal of the reduction, MEP signals returned in both legs and SCP improved to 76.0. Final reduction maneuvers were then performed in a delayed fashion prior to closure, with stable MEP signals and final SCP of 42.9. SSEP signals, vital signs, and intrathecal pressure were stable throughout the case. Post-operatively the patient was neurologically stable and imaging showed good correction of deformity (Figure 3).

Figure 1. Laser doppler setup.



A. Intraoperative photo demonstrating fixation of probe to dura at level of PSO. B. Laser Doppler monitor. C. Baseline trace of spinal cord perfusion demonstrating normal oscillations (blue), synchronized with the heartrate, & stable backscatter (red) indicating minimal noise.

Figure 2. Spinal cord perfusion and MEP changes during each phase of osteotomy reduction.



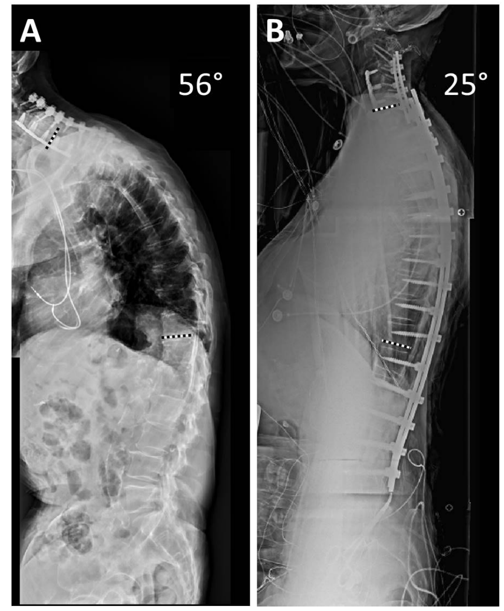
A. Spinal cord perfusion oscillations as measured with laser Doppler flowmetry. B. Temporal correlation of mean spinal cord perfusion with MEP changes.

Table 1. Intraoperative hemodynamics and other results.

	HR	SBP	DBP	MAP	IT Pressure	Vasopressors	Hgb	PaO2	O2Sat	PaCO2
Pre-Reduction	117	122	65	84	4	None	9.6	313	97.1	36
Reduction 1	104	136	62	87	3	None	9.2	323	96.6	39
Reduction 2	112	137	68	91	6	None	8.4	305	95.8	39
Reversal	128	141	71	94	3	DA	8.3	318	97.0	44
Final Reduction	91	127	69	88	5	None	10.1*	337	96.9	36
Mean	110	133	67	89	4	-	8.9	319	96.7	39

*After transfusion of packed red blood cells

Figure 3. Imaging before and after reconstruction.



A. Pre-operative lateral radiograph. B. Post-operative lateral radiograph.

Conclusions: The present case provides the first direct evidence that fluctuations in SCP may contribute to neurologic changes during ASD surgery. Further investigation is under way to further elucidate the underlying mechanisms, with the ultimate goal of developing targeted strategies for spinal cord protection during these high-risk cases.