

Perfusion Assessment with Near Infrared Spectroscopy (NIRS) in Pediatric Supracondylar Humeral Fractures: Can NIRS Detect the Poorly Perfused Extremity?

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Purpose: Near infrared spectroscopy (NIRS) measures the percentage of hemoglobin oxygen saturation in microcirculation. It has been used to identify poor perfusion in adults. The purpose was to determine baseline perfusion values with NIRS in pediatric forearms distal to a supracondylar humeral fracture (SCHF) and compare this to uninjured forearms. Additionally, we wanted to determine whether NIRS detected differences in perfusion between extremities presenting with a normal pulse and those without a palpable pulse ("perfused, pulseless").

Methods: Over a 10-month period, consecutive patients with an SCHF needing operative fixation were approached for consent. Participants had NIRS pads placed on the injured and uninjured volar forearm. Data were continuously collected but blinded to the surgeon. Monitoring was performed pre- and postoperatively on each forearm. Distal pulses, Doppler signal, pulse oximetry measurements, and motor/neurological function were recorded pre-/postoperatively. Data were also collected on 20 controls without injuries.

Results: 71 patients with mean age of 6 years (range, 2-10) had complete data collected. There were 55 type III fractures, 10 type II fractures, and 6 type IV fracture. 8 patients with type III fractures did not have a palpable pulse at presentation (perfused, pulseless). 20 controls were slightly older, with a mean age of 7.2 years (range, 3-11). Controls had a mean tissue oxygenation of 80% (range, 61-94). In the SCHFd with a pulse (n = 63), the mean tissue oxygenation during the entire study period was significantly higher in the injured forearm, 89.6%, compared to the uninjured forearm, 82.6% ($P < 0.001$). Preoperatively there was no difference between the injured (83.8%) and uninjured (82.7%) forearms. Postoperatively, the mean tissue oxygenation was significantly higher in the injured forearm, 89.2% versus 81.7% ($P < 0.01$). In the injured side forearms, there was a significant increase in mean tissue oxygenation from pre- to postoperative ($P = 0.004$). We found no correlation between oxygen saturation measured by pulse oximetry and NIRS monitoring of the volar forearm. Data were collected on 8 "perfused, pulseless" patients. There was a decreased mean tissue oxygenation seen in the injured side forearms (72.4%) compared to the uninjured forearms (86.8%). The injured forearms preoperatively had a mean tissue oxygenation of only 71.7%, but did improve to 82.4% postoperatively.

Conclusion: Children presenting with an SCHF and a palpable pulse had a significant increase in tissue oxygenation of the ipsilateral forearm measured by NIRS, as compared to the contralateral uninjured forearm. In children without a pulse, NIRS values were lower than controls preoperatively and did not reach the hyperemia levels seen in the palpable pulse group. NIRS is an objective measurement of distal perfusion and can assess/monitor perfusion after SCHF in "perfused, pulseless" patients.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.