Assessing Pain Under General Anesthesia with Functional Near Infrared Spectroscopy

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Abstract content: Establishing an objective evaluation of pain perception with a low-cost, portable device will dramatically improve current medical care for pain patients, including those undergoing surgical procedures. Functional near infrared spectroscopy (fNIRS) is a robust neuroimaging technique that is able to provide non-invasive, long-term measure of cortical hemodynamic changes. In this study, we applied fNIRS in both healthy, awake volunteers and anesthetized surgical patients to monitor the brain activities during induced ongoing pain (awake case) and during surgical procedures (anesthetized case).

Methods: Eleven healthy, male volunteers and ten pediatric patients undergoing knee surgery participated in this study. We recorded fNIRS signals mainly from the medial prefrontal cortex (mPFC), an area that has recently been highlighted to play an important role in the processing of pain. Each healthy volunteer had two scanning sessions: an ongoing heat pain session in which the subject received a continuous heat pain for 5 minutes and a warm session in which the subject received a 5-min nonpainful warm stimulus. For surgical patients, their mPFC signals were recorded during the entire surgery. The timings of major invasive surgical events, such as incisions, injections, soft tissue removal and suture were marked in the data. Support for this work was provided by NIH R01GM122405.

Results: With fNIRS, we observed significant alterations in the low frequency component of the mPFC signal during induced pain (in healthy volunteers) and major surgical procedures (in anesthetized surgical patient, see **Fig.1**).

Conclusion: These results suggest that nociceptive/pain pathways may not be fully blocked by general anesthesia. This work also reveals the potential of using fNIRS as a useful tool to evaluate pain in surgical conditions.

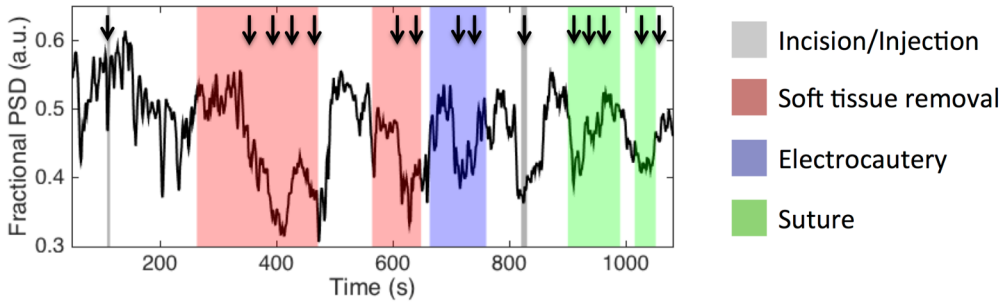

Figure 1. Case study: fractional power spectral density timecourse of mPFC low frequency (0.02-0.08Hz) hemodynamic signals during a knee arthroscopic surgery of a 14-year old female under general anesthesia. Significant power shifts were observed during or shortly after major surgical events, which potentially indicate ongoing pain processing in the brain.