

Application Note 235

Zygomaticus Measures using Pressure Pad vs. EMG for MRI or fMRI *Proof of Concept*

Equipment

- MP150WSW data acquisition system with AcqKnowledge®
- Standard setup:
 - EMG100C electromyogram amplifier module
 - LEAD110S shielded leads (x2) and LEAD110 lead
 - EL254S 4 mm Ag-AgCl recording electrodes
 - *Optional* MEC110C module extension cable (C-series amplifier to Touchproof)
- MRI Setup:
 - DA100C general-purpose transducer amplifier
 - TSD110-MRI pressure pad transducer consists of TSD160A differential pressure transducer, RX110 sensor, and AFT30-XL tubing.

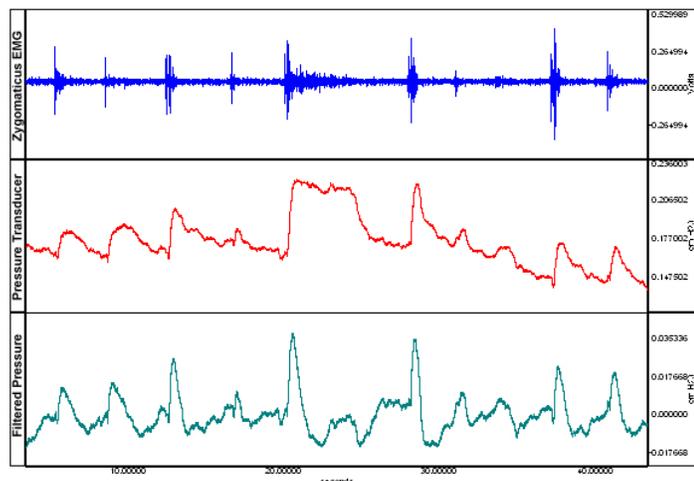
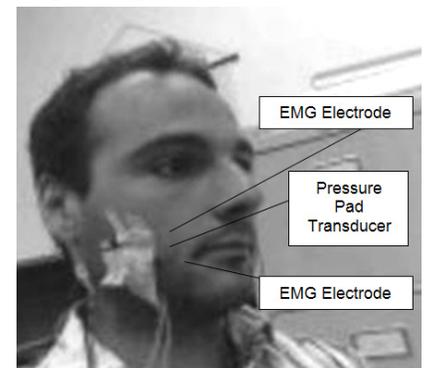
Generally considered, recording EMG in the MRI environment requires significant attention to a number of factors, including cabling construction, amplification and filtering methodology, and signal processing. Primary recording problems appear during periods of gradient pulsing and R/F stimulation. In particular, large artifacts will manifest with subjects with EMG recording leads. In most cases, it's relatively simple to remove the R/F components from the EMG recording leads with a common mode low pass filter (such as BIOPAC's MRIRFIF). However, gradient pulsing artifact is typically present from the EMG recording leads because the MRI-induced signal artifact has in-EMG-band frequency components.

The recording system used needs to accommodate the MRI-induced artifact with a sufficiently high dynamic range and bandwidth EMG amplifier and data recording system (such as the EMG100C and MP150 System from BIOPAC). After the EMG signal recording, the data can be processed to "look between" points of MRI gradient pulsing artifact to identify EMG signals of interest. A complete system dynamic range of at least 80 dB (1 part in 10,000) has proven sufficient to characterize both the MRI pulse and EMG signal in sufficient detail. A complete system bandwidth of at least 5 kHz, with preferably at least 4x over-sampling ability (20 kHz) is needed to ensure that the system can recover from points of artifact sufficiently rapidly. The EMG amplifier used should employ filtering methods that lend themselves to rapid settling without sacrificing roll-off characteristics to minimize aliasing and extraneous noise.

The AcqKnowledge processing software can be set up to trigger on periods of artifact and to isolate non-artifact-contaminated periods to measure the EMG activity present. This synchronization can occur using the artifact itself or, ideally, a digital trigger signal coming from the MRI that indicates points of gradient pulsing activity.

With some MRI protocols, especially those with extensive and rapid gradient switching cycles, it has proven helpful to employ indirect methods of recording facial EMG activity to better isolate periods of activity. BIOPAC has successfully employed a pressure pad transducer to record minute changes in muscle contraction simultaneously with EMG, such as on the Zygomaticus, to obtain a measure of smiling.

In the following example, the subject's right Zygomaticus EMG is measured with two EL254S 4 mm Ag-AgCl recording electrodes and one EMG100C amplifier. The ground lead was placed below the subject's right mastoid. The TSD110-MRI Pressure Pad Transducer was placed directly between the recording electrodes and simply taped into position using surgical tape. The pressure signal was routed through 10 m of semi-rigid 1.5 mm polyethylene tubing (AFT30-XL) to terminate in a 2.5 cm H₂O pressure transducer (TSD160A with DA100C general purpose transducer amplifier).



The data shows very good correlation between the recorded pressure signal (middle channel) and the associated EMG (top channel).

- In particular, the sustained Zygomaticus contraction is far better reflected in the pressure signal than in the EMG signal. The bottom channel is a 0.2 Hz high pass filtered version of the basic pressure signal to better illustrate the points of Zygomaticus contraction onset.

When performing an EMG measurement in the MRI, the top channel in the example will incorporate periods of significant artifact with levels as much as 40 dB over EMG activity levels. The pressure pad tracing in the middle channel will be completely unaffected by either MRI R/F pulsed energy or gradient switching due to completely pneumatic measurement methods.