



US DEPARTMENT OF DEFENSE

# BLAST INJURY RESEARCH PROGRAM COORDINATING OFFICE

## Neuroimaging Biomarker Studies

### Magnetic Resonance Imaging and Motor Evoked Potentials as Prognostic Tools in Spinal Cord Injury

Using multivariate analytics on large clinical databases, researchers at the University of California, San Francisco (San Francisco, California) assessed Magnetic Resonance Imaging (MRI) grading systems, MRI biomarkers, and intraoperative motor evoked potentials (MEPs) as prognostic tools in acute spinal cord injury (SCI).

The application of various MRI grading systems in predicting early impairment was examined using retrospective data from 25 acute thoracic SCI patients. The results showed that all variables of signal abnormality were negatively correlated with American Spinal Injury Association Impairment Scale at discharge. Of the MRI metrics examined, a multiple variable model identifies the Brain and Spinal Injury Center (BASIC) score, an MRI-based grading system for the axial plane, as the only statistically significant predictor of AIS at discharge. These results provide validation for multidimensional MRI measures as predictor of outcome and suggest that multidimensional MRI measures of the thoracic spinal cord may be a valuable parameter for patient stratification for diagnosis, intervention planning, and clinical trial criteria (*Dhall et al. 2017*; Figure 1).

In another retrospective study of 32 patients with acute cervical SCI, MEPs predicted neurological improvement and correlated with axial MRI grade. Specifically, the presence of MEPs significantly predicted AIS at discharge ( $p < 0.001$ ). In addition, patients without MEPs had a significantly higher axial MRI grade in comparison to the patients with MEPs ( $p < 0.001$ ). These findings provide clinical validation for the value of MEP as a prognostic tool and support the utilization of intraoperative MEP in surgery for traumatic spine fractures and SCI (*Mabray et al. 2016*).

Finally, a retrospective cohort study of 95 patients with acute cervical SCI identified two clusters of MRI biomarkers related to (1) measures of intrinsic cord signal abnormality and (2) measures of extrinsic cord compression. Of note, neurologic impairment was best accounted for by MRI biomarkers of intrinsic cord signal abnormality, with axial grade representing the most accurate predictor of short-term impairment, even when correcting for surgical decompression and degree of cord compression (*Haefeli et al. 2017*).

All three studies were conducted using retrospective analysis of clinical databases from the Zuckerberg San Francisco General Hospital (San Francisco, California).

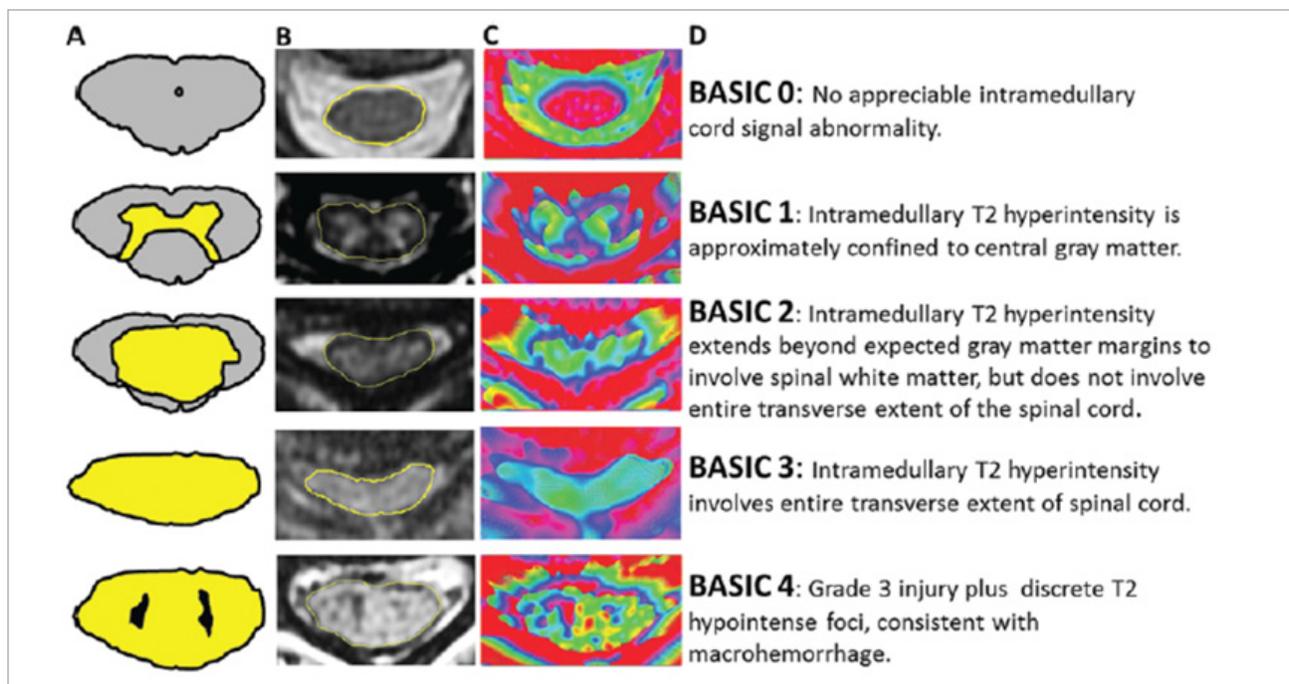
In conclusion, by validating the prognostic value of multidimensional MRI measures, MRI biomarkers, and intraoperative MEP, these results have significant impacts on the optimization of acute management of SCI and long-term recovery.





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**FIGURE 1:** the BASIC score of SCIs. Cartoon schematics (A), representative axial T2-weighted MRI scans (B), 3D-color surface plots based on the axial T2 image (C), and brief definitions (D) for each of the five BASIC scores (ranging from zero to four). In the representative MRI scans (B), the external contour of the spinal cord is outlined in yellow for better delineation. Figure is available in color online only. (Figure from Dhall et al. (2017) used with permission from the authors)

**REFERENCES:**

Dhall, S. S., Haefeli, J., Talbott, J. F., Ferguson, A. R., Readdy, W. J., Bresnahan, J. C., Beattie, M. S., Pan, J. Z., Manley, G. T., and Whetstone, W. D. 2017. "Motor Evoked Potentials Correlate with Magnetic Resonance Imaging and Early Recovery after Acute Spinal Cord Injury." *Neurosurgery*. doi: 10.1093/neuros/nyx320.

