INTRODUCTION: The purpose of this study was to evaluate the efficacy of somatosensory-evoked potential (SSEP), spontaneous EMG and stimulus-evoked (S-E) EMG monitoring of neural function during the percutaneous placement of iliosacral implants.

METHODS: While simultaneously monitoring S1 nerve root function using SSEP, spontaneous EMG, and S-E EMG monitoring techniques in a canine animal model, a 2.0 mm stainless steel K-wire was progressively inserted using a percutaneous technique into the S1 body of each of 17 dog hemipelves guided by a GE high speed CT scanner capable of 1 mm slice thickness with a resolution of 0.45 mm. The K-wire was directed in an attempt to compromise the S1 nerve root. A minimum of 4 data points per hemipelvis was planned. The endpoint was contact with the nerve. It was expected that this endpoint would be heralded by a burst of spontaneous EMG activity and an abnormal SSEP signal (defined as a >50% decrease in amplitude or a 10% increase in latency). Current thresholds required to evoke an EMG response (S-E EMG) were continuously recorded. A current threshold of < 4 milliamperes (mA) was expected as indicative of nerve contact and < 6 mA indicating broaching of the neural canal. A GE Advantage Windows workstation running version 1.2 software was used with a configuration calculated to provide distance measurements to the nearest 0.1 mm. Actual K-wire final location was determined by anatomical dissection. A power study had been prospectively performed to determine the number of hemipelves required to provide 90% power assuming that measurements would be obtained from both sides of the same animal with a minimum of four data measurements per side.

ESSENTIAL RESULTS: A total of 113 data points were obtained (>6 per hemipelvis) for determination of the current threshold/distance S-E EMG relationship. The generalized estimating equation (GEE) was used in a regression analysis since independence cannot be assumed among the measurements obtained within each dog. The resulting GEE regression equation is Distance = -0.093 + (0.359)(Current). The corresponding correlation coefficient was found to be 0.801 with a root mean square error of 2.47 indicating a highly significant (p < 0.001) fit (Figure 1).

Anatomical dissection at completion of the study revealed that 16 of the 17 K-wires had actually contacted the nerve root. Four had penetrated the nerve root and 12 were compressing the S1 root but had not penetrated the S1 canal. This K-wire corresponded to the only final S-E EMG current threshold measured at > 6 mA (6.3 mA). Fourteen of the remaining 16 current thresholds were < 4 mA; an observed proportion not different from the expected 16/16 (Fisher exact test, p =0.48). A spontaneous burst of EMG activity was not obtained in a single case. This is significantly different from the expected (Fisher exact test, p< 0.001). SSEP’s could be obtained in only 12/16 due to technical problems and abnormal SSEP’s were obtained in only one of the 12. This, again, is significantly different from the expected (Fisher exact test, p< 0.001).

DISCUSSION: The incidence of nerve root injury from iliosacral screw malposition has been reported as being as high as 10%. SSEP, spontaneous EMG, and S-E EMG monitoring systems have been proposed as methods for decreasing this risk of iatrogenic nerve injury. This study further confirms the validity of the S-E EMG current threshold/distance relationship and its potential applicability for nerve monitoring. Additionally, and perhaps more importantly, it raises serious concern regarding the validity of SSEP and spontaneous EMG monitoring for the purpose of minimizing nerve root injury during the percutaneous insertion of iliosacral implants.

** Henry Ford Hospital, 2799 West Grand Boulevard, Detroit, MI 48202.