INTRODUCTION

Intraoperative neurophysiological monitoring (IOM) has become indispensable for the safety in spine surgeries. Multimodality monitoring has recently been recommended for the optimal outcome. Among many monitoring modalities, CMAP is reported to have the highest sensitivity and specificity for intraoperative motor deficit. However, there are no consensus as to the criteria for interpretation of CMAP responses. This is mainly because the precise relationship between the degree of the wave changes and spinal motor function has not yet been clarified. The purpose of this study is to elucidate the relationship between the deterioration and improvement in the intraoperative CMAP and postoperative motor deficit and recovery.

METHODS

Three-hundred and fifty spine surgeries assisted by CMAP monitoring performed from 2002 to 2009 were reviewed. We defined “deterioration” of CMAP as an amplitude below 0.5μV, and “loss” of CMAP as an amplitude below 0.2μV. There were twenty-four cases of CMAP deterioration. These 24 cases were retrospectively reviewed. Multi-pulse stimulus technique was used to evoke the CMAP with short train of 5 stimuli with 2 ms ISI. Stimulus voltages were between 300-500V, and the filter bandwidth was set between 50-1000Hz. The CMAP were delivered from the limbs and the anal sphincters, 14 muscles at maximum. The CMAP were recorded and analyzed using Neuropack MEB-2200. Cases were classified as true positive (TP) when intraoperative CMAP deteriorated, and did not improve at the end of the operation, and the patient had postoperative motor deficits. There are cases in which intraoperative CMAP deteriorate, but improve by the end of the operation. Among them those who had postoperative motor deficits were classified as group A (A), and those who didn’t have postoperative motor deficits were classified as group B (B). The degree of postoperative motor loss and recovery rate were evaluated depending on the degree of the CMAP deterioration, whether there was the CMAP improvement or not, and the number of the muscles which showed deterioration.

RESULTS

350 surgical cases consisted of 74 cases of extramedullary tumors, 58 cases of intramedullary tumors, 55 cases of scoliosis, 38 cases of CSM, 25 case of OPLL and 19 cases of spinal tumors, and 81 others. There were eighteen cases with postoperative motor deficits. 14 cases were true positive. 4 cases were group A. 6 cases were group B. There were no cases of false negative. The most of these cases with monitoring changes were intramedullary tumors (TP;10, A;3 and B;4) (Figure 1). The complete loss of CMAP (<0.2μV) was associated with poor improvement of intraoperative CMAP (p<0.05) and higher rate of postoperative motor loss (p<0.01)(Figure 2). The cases with CMAP improvement by the end of the surgery (A and B) had milder postoperative MMT decrease (0.5) than TP cases (1.7), indicating that intraoperative improvement in CMAP is associated with milder postoperative motor loss (p<0.01)(Figure 3). 3 cases out of 4(75%) with the CMAP improvement by the end of the surgery, and only 8 cases out of 14 (57%) with no CMAP improvement by the end of the surgery had functional recovery from postoperative motor loss. Cases with CMAP deterioration of less than 4 muscles had better rate of functional recovery (89%) than the cases with CMAP deterioration of 4 or more muscles (33%), indicating that smaller number of muscles with CMAP deterioration was associated with better functional recovery from postoperative motor loss(p<0.05) (Figure 4).

DISCUSSION

50% or 20% of the control amplitude as a warning criteria result in too many false positives, so we set the criteria of 0.5μV. But now, there are higher risks of the false negatives. But by monitoring as many muscles as possible, we were able to avoid a false negative. In general, the amplitude of 0.5μV is very low, but this study revealed that there is a difference between complete wave loss (<0.2μV) and incomplete loss (<0.2V, < 0.5μV). Incomplete loss is associated with a better rate of CMAP improvement by the end of the surgery, and lower rate of postoperative motor loss. In this study, we emphasized on the importance of wave improvement after deterioration, because our hypothesis was that even after the wave deteriorated, whether it improves or not makes a difference in the neurological outcome. And this study has shown its difference. This means that monitoring should be continued until the end of the surgery in order to judge whether the damage to the nervous system is transient and reversible. There are few reports on warning criteria taking the number of muscles covered into consideration. The result of this study suggests that the number of muscles with CMAP deterioration can be a factor of the warning criteria.

CONCLUSION

It is suggested that the changes of intraoperative CMAP reflect postoperative motor function and its prognosis. In order to minimize postoperative motor deficit, it is important to monitor enough number of muscles covering relevant nerve roots, to give warning before the CMAP is completely lost.