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The Role of Extraocular Muscle Monitoring in Brainstem Surgeries

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INTRODUCTION

Intraoperative neurophysiological monitoring (IONM) is valuable in various surgical procedures. In cases where the brainstem is the target, monitoring the extraocular muscles can assist in reducing the risk of injury and preserving neural function. Delicate cranial nerves are frequently encountered during cranial base surgeries, and their lack of epineurium makes them highly vulnerable to damage. IONM provides continuous feedback on the integrity of cranial nerves, enabling surgeons to operate on offending lesions while minimizing the risk of injury. The selection of neuromonitoring techniques used depends on the location of the lesion being operated on [1].

Before performing a surgical procedure that involves the brainstem, it's critical to identify any potential risks to the nervous system. Brainstem-based surgeries can potentially harm the function of extraocular muscles. However, using IONM during the procedure can help mitigate the risk of damage. On the other hand, if IONM is not utilized, there is an increased risk of injuring an extraocular muscle, which could result in diplopia. Left untreated, diplopia can cause a patient to experience monocular vision and harm their peripheral and stereoscopic visual fields, significantly reducing their quality of life. Therefore, it's essential to preserve the normal function of extraocular muscles by using IONM.

During endoscopic endonasal skull base surgery, the extraocular muscles prove to be a valuable monitoring tool, as three distinct nerves innervate them: the oculomotor nerve (CN III), the trochlear nerve (CN IV), and the abducens nerve (CN VI) [3]. The specific innervations correspond to the individual muscles that make up the extraocular group. Electromyography (EMG) is the most utilized neuromonitoring technique in this type of surgery.

Electromyography (EMG) can be classified into two distinct types: free running or spontaneous EMG (sEMG) and triggered EMG (tEMG). Free running EMG provides continuous recording of motor unit potentials in muscle fibers and has a higher level of specificity and negative predictive value when it comes to postoperative cranial nerve deficits [4]. This gives surgeons greater confidence when operating on cranial

nerves. On the other hand, triggered EMG activity is observed when an electrical stimulus is applied to the cranial nerve, recording compound muscle action potentials from muscle fibers (Figure 1) [4].

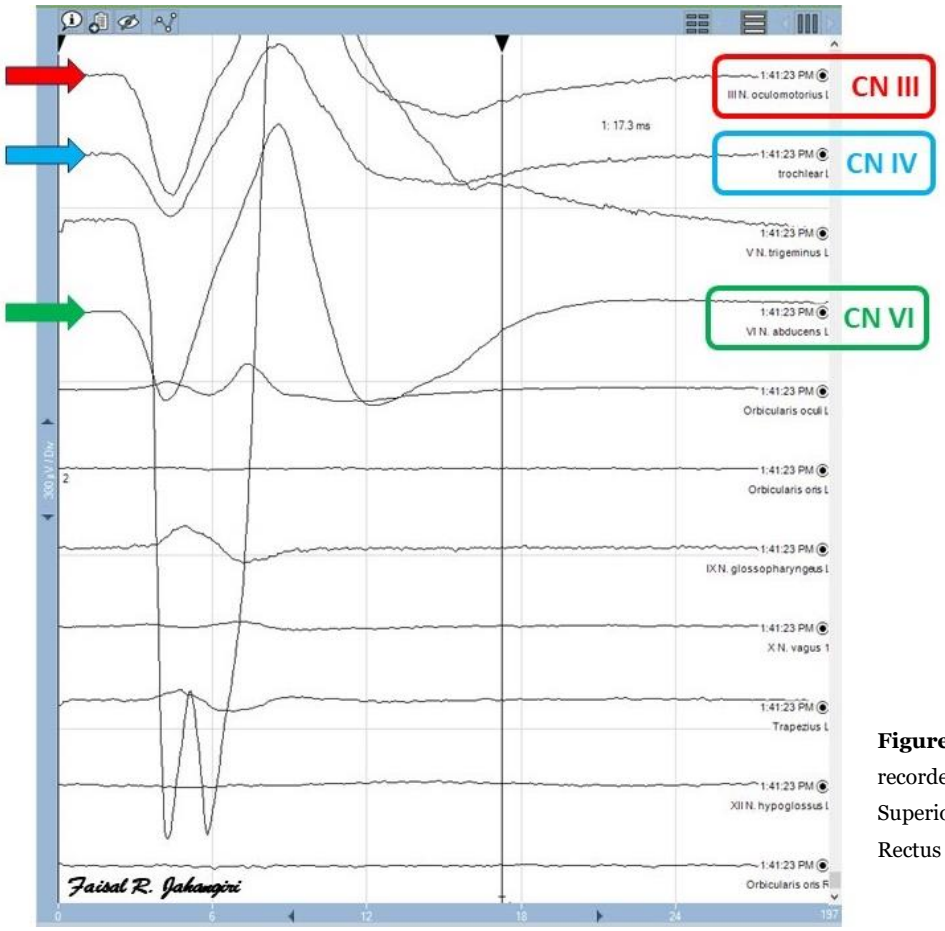

Figure 1. Triggered EMG responses were recorded from the Inferior Rectus (CN III – Red), Superior Oblique (CN IV – Blue), and Lateral Rectus (CN VI- Green) muscles.

Skull base tumors frequently invade surrounding structures, like the cavernous sinus, and can cause damage to the extraocular nerves responsible for eye movement [5]. When detected, these tumors are typically quite large, and the surrounding anatomy may already be compromised. Therefore, surgeons can use intraoperative monitoring of extraocular nerves to identify precise locations and avoid inadvertent injury. The preservation of extraocular monitor nerves during skull base tumor surgeries has been thoroughly researched, and some studies have reported using EMG to help with the monitoring process. It is worth noting, however, that EMG requires the placement of electrodes by a skilled and trained professional. While less widely researched than other methods, Electrooculography (EOG) is a simple and effective way to track extraocular muscle movement [6]. Researchers are exploring using EOG monitoring in skull base surgeries, particularly preventing extraocular motor nerve function issues during tumor removal [7-11]. EOG measures the electrical signals generated by eye movements, which can indicate abnormal oculomotor function [4,5]. These signals are easy to track and provide insight into eye movement abnormalities.

Disclaimer:

To prevent injury, these extraocular electrodes must be placed by experienced neurophysiologists or under their direct supervision.

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