Anatomical Variability of the Greater Occipital Nerve and an Alternative Method for Stimulation Lead Placement.

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INTRODUCTION

Occipital nerve stimulation (ONS) has been proposed as a surgical solution for patients with medically refractory headache conditions, including chronic migraine and chronic cluster headache. The therapy is thought to exert its effect by inducing neuroplastic changes in the trigeminal cervical complex and central pain processing nuclei, which can alter pain perception and response. However, ONS outcomes can vary, potentially due to factors such as patient selection criteria, choice of unilateral versus bilateral electrode placement, and differences in waveforms and stimulation settings.[1,2] Lead location also plays a crucial role in the success of the procedure, with accurate anatomical placement improving the predictability of treatment outcomes and therapy cost-effectiveness.[3–5]

METHODS

Traditionally, ONS lead placement is based on the mean exit point of the greater occipital nerve (GON) through the trapezius muscle. Although the craniocervical junction and C1 are often used as anatomic landmarks,[6] another suggested approach involves placing the lead 3 cm below the external occipital protuberance (EOP).[7] We performed an anatomical dissection of 10 formaldehyde-fixed human cadaver heads to evaluate the anatomical variability in the exit point of the GON and the bifurcation of its branches, aiming to propose a more informed ONS lead placement that considers anatomical variability. During data pooling, we accounted for skull shape differences by creating a parallel ring through the EOP, at the same level as the orbitomeatal line, referenced as FL (see Figure 1).

CONCLUSION

In summary, the observed large variation in the GON anatomy indicates that the EOP is a more reliable anatomical landmark than C1 for ONS lead placement. We recommend placing the leads just below or slightly above the EOP to increase the chance of covering the occipital nerve branches with the electrode area, thereby improving the predictability of ONS outcomes. To effectively cover the left and right medial branches of the GON in the majority of patients, we recommend an electrode array that spans 10 cm.

RESULTS

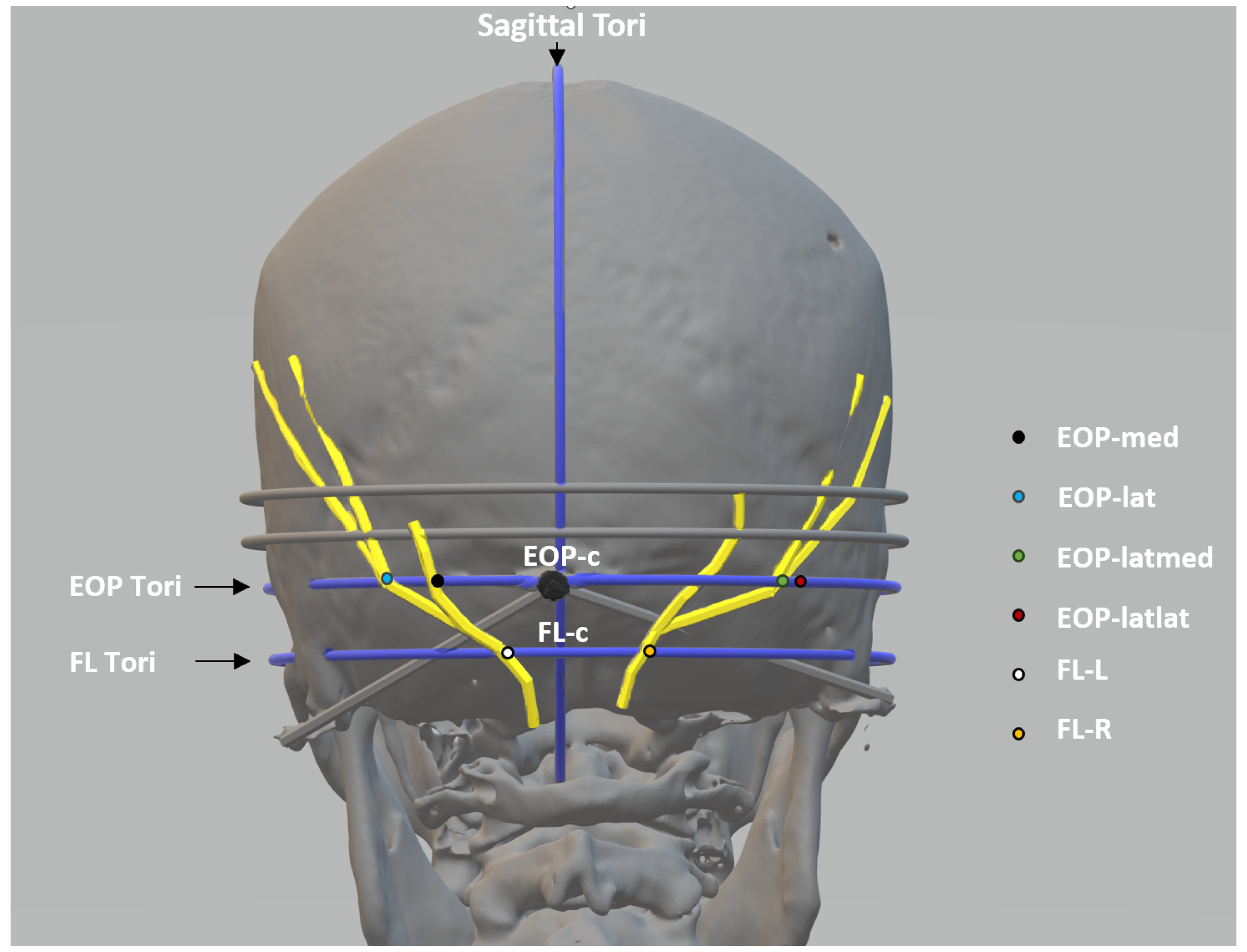

Figure 1 - 3D Rendering of a Cadaver Specimen, Showing Lines ofTori Relating to EOP and FL and Sagittal Plane. In Yellow, the Occipital Nerve Crossing Points on the Tori Where Measurements Were Taken.

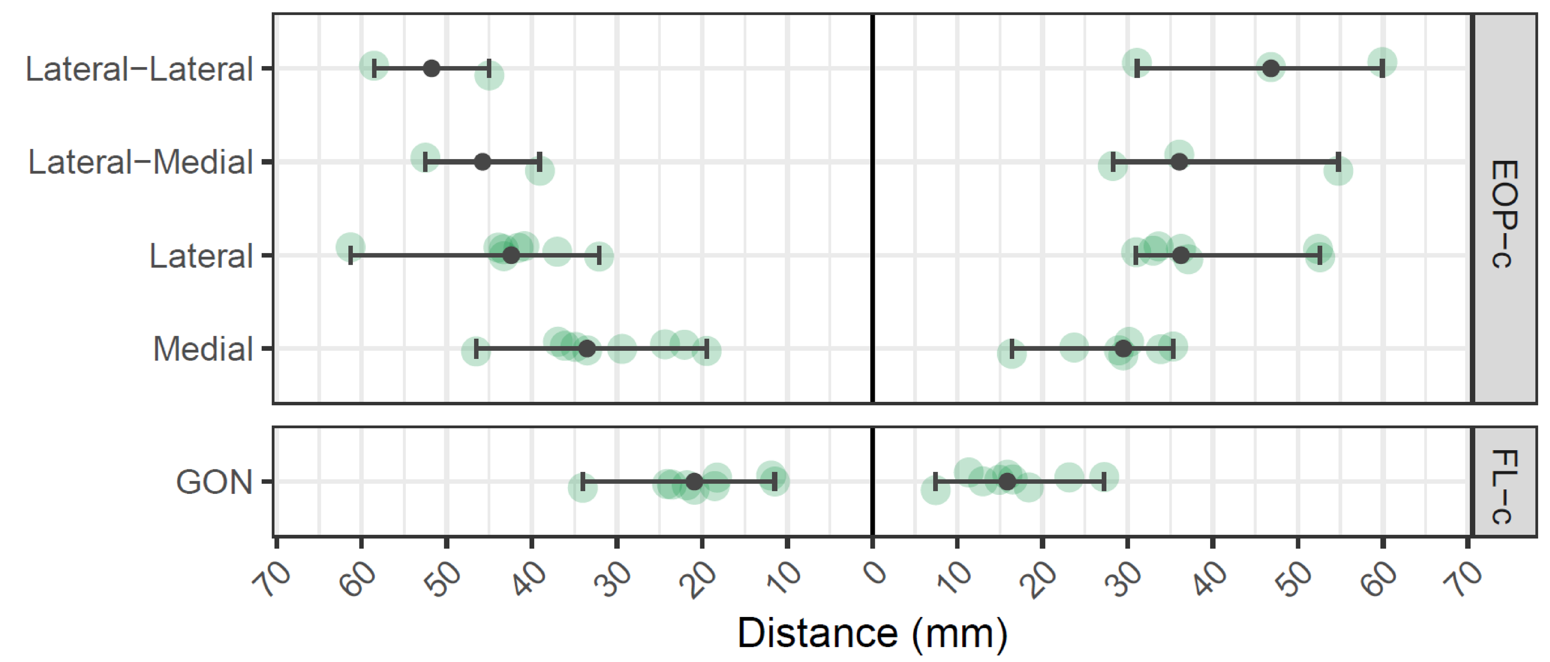

Figure 2 - Error bar Plot Showing Left and Right GON Distances from Central Points of EOP and FL for all Ten Cadaver Specimens, Including the Median Measurement.

Our measurements revealed large variations in the anatomy of the GON, specifically in the exit point through the aponeurosis of the musculus trapezius and differences in its trajectory, orientation, location, and number of bifurcations. These differences were observed within individuals (left to right) and between individuals as shown in Figure 1. Specifically, the GON exit point relative to the FL-c, which varied from 7.43 mm to 34.02 mm. The total distance between the left and right medial branch of the GON at the level of EOP was 81.9 mm and the distance between the most lateral branch from left to right was 121.21 mm as shown in Figure 2.

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