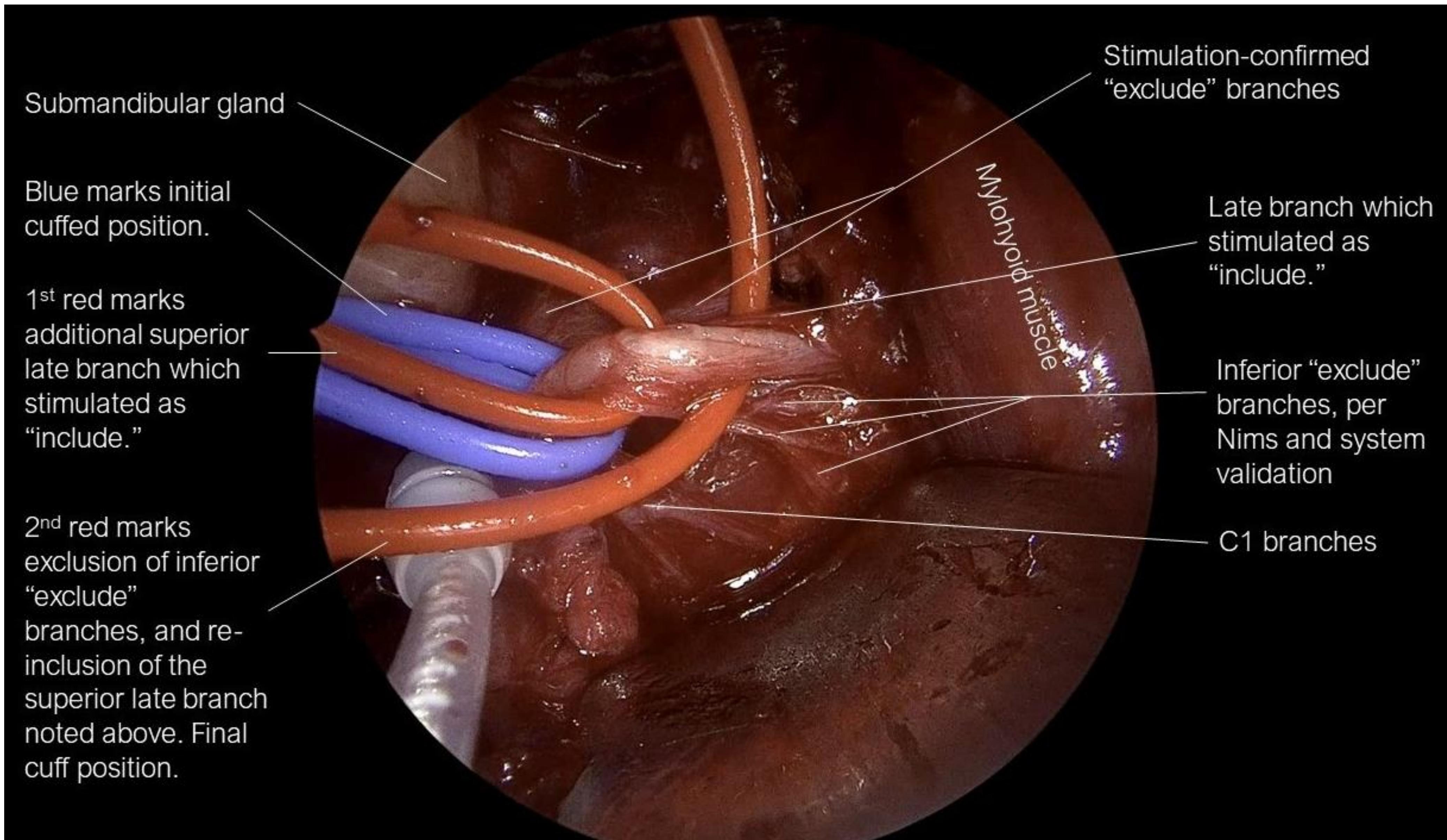


# Unusual Anatomy of the Hypoglossal Nerve During Upper Airway Stimulation Surgery

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## Introduction

- Upper airway stimulation (UAS) is a surgical option for treatment of obstructive sleep apnea (OSA) in select patients
- The Inspire UAS system was FDA approved for treatment of OSA in 2014 in patients with moderate to severe OSA who have failed or do not tolerate continuous positive airway pressure (CPAP) therapy.
- Electrode cuff placement on proper distal branches is essential and requires identification of the breakpoint between medial and lateral branches of the hypoglossal nerve (CNXII) to produce unhindered tongue protrusion
- Exclusion branches are typically found on the superior aspect of CNXII during dissection
- We present a case of abnormal branching patterns where nerves associated with “exclusion” signals emerged from the **inferior** aspect of the hypoglossal nerve (CNXII).



**Figure 1.** Dissection of the distal branches of CNXII are shown. Vessel loops placed to show our “include” and “exclusion branches” verified by NIMS testing.

## Case Report

A 65-year-old female with pre-op apnea-hypopnea index (AHI) of 15.5 and no known anatomic abnormality or neck surgeries underwent UAS. The dissection was performed in standard fashion and CNXII was identified in normal anatomic position. Distal branches of CNXII were identified and skeletonized to identify our initial breakpoint.

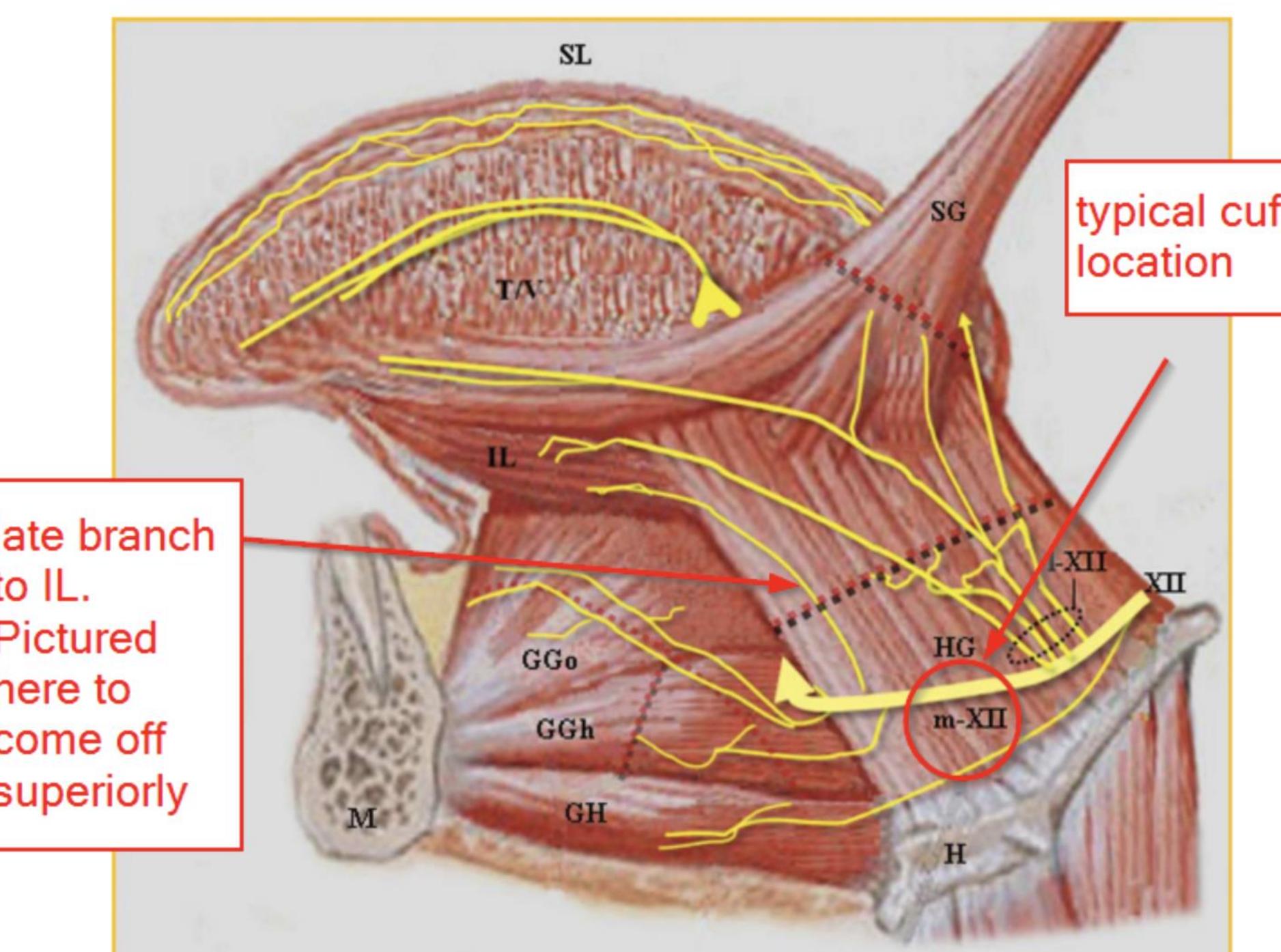
After neurophysiologic intraoperative monitoring stimulation (NIMS) testing and initial cuff placement, system validation showed poor tongue protrusion and retraction. Reevaluation of CNXII demonstrated several distal branches along its inferior aspect producing exclusion signals. No further distal late branches along its superior surface produced exclusion signal. CNXII was reinspected and did not appear twisted. Cuff placement was revised to a more anterior location, excluding C1 and the collection of late inferior CNXII branches. Final system validation demonstrated good protrusion on configurations A, B, and C, without retraction. Cuff was placed distally with a very vertical orientation on post-op neck film.

Postoperatively, the patient did not have any complications and underwent device activation. She had resolution of her sleep apnea a postoperative AHI of 2.6 demonstrated on polysomnogram.

## Discussion

Literature review demonstrates variations in terminal CNXII branching are typically related to proximity and takeoff angle to CNXII. Superior branches of CNXII typically produce exclusion signals and inferior branches produce inclusion signals during surgery. The medial belly of the inferior longitudinal muscle is innervated by the medial (distal) aspect of CNXII and could be responsible for retraction by distal branches (Figure 2). A more vertically oriented distal course of CNXII may change branching patterns. However, this branch is likely included in the cuff in the majority of UAS surgeries.

NIMS testing and visual inspection is relied upon during UAS surgery to determine which branches are to be excluded or included in the electrode cuff. The accuracy of EMG is subject to placement of the stimulation probe as well as conduction challenges that could both mask and/or over transmit the electrical pulse. Careful dissection of the distal branches of CNXII is essential and correct placement of the electrode cuff should always be confirmed with system validation to ensure the best possible outcome. This case demonstrates the possibility of distal nerves branches from the inferior aspect that may be responsible for tongue retraction. Exclusion of unusual anatomic variations is required to ensure good outcomes.



**Figure 2.** Branches of the hypoglossal nerve and corresponding muscle innervation

## Conclusions

Variations in the branching patterns of CNXII exist and can make UAS surgery more challenging. We demonstrate a case where distal exclusion branches were found branching along the inferior aspect of the hypoglossal nerve. Recognition of this anatomic variation is important to recognize to ensure proper cuff placement.

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