Intraoperative Neuromonitoring Facilitates Safe Fascicle Sparing Capsular Resection of Atypical Neurofibromas in NF1

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Disclosures

• The authors DO NOT have any financial or organizational relationships with commercial interests or other entities. We hereby certify that to the best of our knowledge, no aspect of our current personal or professional circumstances places us in the position of having a conflict of interest with our duties, responsibilities, and exercise of independent judgement as an Officer, Member of the Board of Directors, Nominee for Office, Educational Presenter and/or a representative of AANS/NREF/NPA.
Introduction

- Neurofibromatosis Type 1 (NF1) affects 1 in 2500-3000 live births
- Caused by mutation of neurofibromin protein (a tumor suppressor), which regulates the Ras/MAPK pathway
- Individuals are predisposed to nerve sheath tumors called neurofibromas (NF)
- Incomplete surgical excision of atypical NF before malignant transformation preserves nerve function but has allowed for local recurrence of tumors
- Aim: Determine if gross total resection of ANF via intraoperative monitoring can be achieved without long-term post-surgical complications
Methods

NF1 Natural History Study: Preoperative Imaging Surveillance and Physical Exams

~300 patients

Clinical indicators suggesting atypical transformation:
- Increased Growth Rates on MRI (≥ 20% per year)
- Increased $^{18}$F-FDG-PET avidity ($SUV_{\text{Max}} \geq 3.5$)
- Pain

5 Abnormal Preoperative EMG and NCV studies

16 Marginal Surgical Resections of NF with intraoperative monitoring

11 patients

Tumor Recurrence

Histopathological analysis and clinical outcome analysis

21 tumors

Post-operative follow-up with MRI scans every year

~300 patients
Fig. 1. NF resection surgery. (A) Initial approach. (B) Platysma cut and R brachial plexus exposed. (C) Fascicular dissection. (D) Nerve stimulation. (E) Surface mapping. (F) Fascicle splitting and circumferential dissection of ANF.
Results

Fig. 2. Histopathological images of tumors included in this study. (A) Benign plexiform NF. (B) ANF. (C) ANNUBP. (D) Low-grade MPNST. Smooth inked margins suggest a marginal resection (E), while a ragged margin with ink particles suggests a positive or unreliable margin.
Results

Fig. 3. The relationship between ordinal histopathological neurofibroma groups and imaging characteristics.
### Results

<table>
<thead>
<tr>
<th>Patient &amp; Surgery ID</th>
<th>Nerve-Related Complications</th>
<th>Other Complications</th>
<th>No. of NFs Resected</th>
<th>Histopathology</th>
<th>NF Type</th>
<th>Surgical Margins</th>
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<tbody>
<tr>
<td>1A</td>
<td>No</td>
<td>No</td>
<td>1</td>
<td>ANF</td>
<td>Nodular</td>
<td>Pos/unreliable</td>
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<tr>
<td>1B</td>
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<td>No</td>
<td>1</td>
<td>ANF</td>
<td>Plexiform</td>
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<td>2A</td>
<td>Small area of numbness (transient)</td>
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<td>Neg</td>
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<td>Slight weakness of biceps (transient)</td>
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<td>No</td>
<td>2</td>
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<tr>
<td>8B</td>
<td>Decreased light touch sensation (transient)</td>
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**Table 1. Postoperative outcomes and tumor histopathological classification**
Discussion

- Gross total resection of ANF with intraoperative monitoring can be achieved without long-term post-surgical complications ($n = 14, 88\%)$ likely due to the schwannoma-like growth patterns of ANF.
- Preoperative EMG and NCV studies yielded only 5 (31\%) abnormal studies.
- Detecting ANF has been traditionally difficult; here, we combine pre-operative MRI & PET imaging with post-operative histopathological analysis to successfully detect and resect ANF with minimal morbidity.
- $^{18}$F-FDG-PET may distinguish histopathology more reliably than MRI.
- We are continuing to follow patients for tumor recurrence.

Fig. 4. Schematic representation of neurofibromas in NF1 patients. We hypothesize that in NF1, occasional neurofibroma nodules may become dominant (asterisk) with rapid growth due to acquisition of cellular atypia (right). Such rapid growth may displace quiescent neurofibroma nodules and nerve fascicles to the margin on this nodule. This pattern may allow safe marginal dissection of the dominant nodule during surgery.
Summary Points

• Marginal resection of atypical neurofibromas can be achieved with minimal to no morbidity
• Atypical neurofibromas may have schwannoma-like eccentric growth patterns
• $^{18}$F-FDG-PET imaging may distinguish neurofibroma histopathology more reliably than MRI