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Case Reports & Case Series

Deep brain stimulation and bowstringing: Case report and pathological correlation

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ABSTRACT

Deep Brain Stimulation (DBS) is an established surgical therapy for movement disorders, epilepsy and more recently certain psychiatric disorders. The procedure is safe and complications fortunately few. Bowstringing as a complication has not been well documented and is most probably underreported. Bowstringing describes an entity where the subcutaneous electrode extensions running from head to chest cause a sensation of unpleasant tension, pulling and tightness. Patients may even complain of difficulty with turning their head to the contralateral side. This unpleasant feeling may continue to occur even after the removal of DBS extension leads as the cord like scar still remains. The underlying pathological process and why this occurs in a subset of patients is poorly understood. As such, to date in the literature, there are but a few proposed methods to manage bowstringing in DBS patients and certainly no consensus. We present an illustrative case report with histopathological correlation and suggestions for how this complication might be prevented and managed.

1. Introduction

Deep brain stimulation (DBS) surgery has revolutionized the management of advanced movement disorders, intractable epilepsy and even psychiatric diseases. Surgery has an excellent safety profile and adverse events are, for the most part minor. Most complications listed in published large series focus primarily on infection, hardware malfunction or fracture, lead migration, and stimulation side effects.

Bowstringing is a distinct complication of DBS surgery that is sparsely reported in the literature [1–5] and likely underreported, and its underlying pathology is only hypothesized. The clinical presentation is with neck pain on the side of the tunneled extension leads, pronounced cordlike protrusion of the tunneled tract, tension or a pulling sensation in the neck or chest and restriction of head and neck movements. Incidence is somewhat difficult to determine and may be between 0.6 and 2.6% of operated patients [1,3,4]. Bowstringing was also seen in 4% of patients in the BROADEN study [6], possibly even causing some patients to request removal of their systems and leave follow up. Typically, patients present with this complaint months to years after initial surgery.

2. Case report

A 68-year-old woman had undergone successful bilateral subthalamic nucleus DBS for tremor dominant Parkinson's disease four years previously. The dual channel implanted pulse generator (IPG) had been implanted in the right abdominal wall as per the patient's request. The patient underwent IPG replacement six months prior to the current episode, and returned with skin erosion and exposed hardware at the abdominal incision.

The patient was brought to surgery to remove the exposed hardware and attempt to salvage the DBS leads. First, the extension leads were disconnected through an incision below the connectors over the calvarium. The hardware was removed via the abdominal incision. Only cultures from the abdominal incision were positive for *Staphylococcus epidermidis*. The patient was discharged and on three weeks of oral antibiotics.

One month later she returned for reimplantation of a new IPG and extension leads on the left. On admission she pointed out the tight band in the right side of her neck that was distressing and uncomfortable. Under general anesthetic she was positioned on her back with her head

Abbreviations: DBS, Deep Brain Stimulation; IPG, Implanted Pulse Generator

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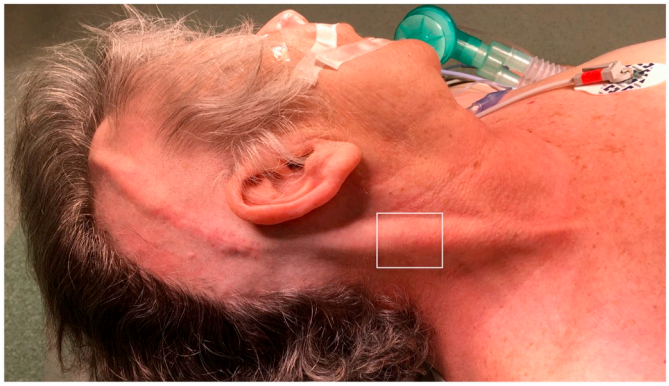

Fig. 1. Patient under general anesthetic prepared for implantation of a new IPG and extension leads. Thick fibrous scar that had developed around the tract of the original tunneled leads, which had been previously explanted. The rectangle outlines Fig. 2.

turned to the left (Fig. 1).

In addition to implantation of new extensions and IPG (on the left) an incision was made in the neck over the "bowstring" (Fig. 2). This showed a thick fibrous band through which the previous extensions had passed. This pseudocapsule was resected over several centimeters and sent for pathological analysis (Fig. 3). The patient made an uncomplicated recovery. The "bowstring" in her neck resolved and has not returned more than one year later.

3. Discussion

A few publications have reported "bowstringing" as a consequence of DBS [1–5]. Bowstringing has been attributed to scar tissue formation around the DBS extension leads, which over time may contract and become tight. This phenomenon has been associated with the trajectory used for passing the electrode extensions [1], the use of dual channel IPGs (where both extension leads traverse the same side of the neck) [4], superficial placement of the extensions [5], seroma or infection [3], and possibly after further surgery to replace the IPG [2,3]. Scar tissue does not have a predilection for gender or for the disease entity for which DBS was performed.

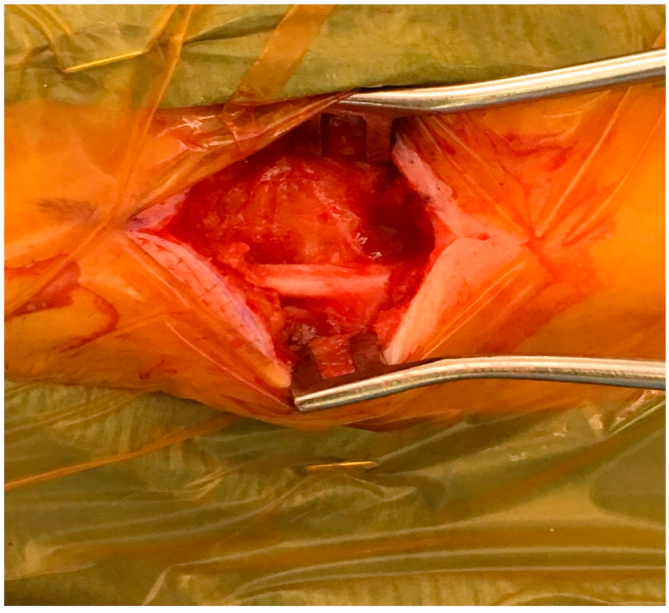

Fig. 2. Exposure of the fibrous band in the subcutaneous tissues.

It has indeed been pointed out that simple removal of extension leads is inadequate [4], as in our case, as the fibrous band remains. Thus, the introduction of "stretchy" extension leads, does not address this problem. The fibrous scar must be resected, sometimes through more than one incision [4] and remaining scar must be separated from the surrounding soft tissues.

Any implanted foreign body will have a pseudocapsule form around it [7–9]. Pseudocapsule formation involves a characteristic complex inflammatory response culminating in the migration of fibroblasts to the interface with the implant and the formation of a collagen capsule. As neurosurgeons, we are very familiar with this phenomenon when performing shunt revisions. Surprisingly, although reported [10], bowstringing in shunt patients is quite unusual even though the shunt does follow a similar trajectory in the subcutaneous tissues of the neck.

The question remains as to why some patients develop this problem while others do not. It is our conviction, that a more pronounced inflammatory reaction is more likely to result in "bowstringing". This might occur if there is bleeding along the tunneled track, or if the leads traverse tissue planes. Patient specific immunological reactions may play a role, although no hypersensitivity could be demonstrated in one patient who was patch tested [5]. Lower profile extension leads passed atraumatically through the subcutaneous fat may be the best way to minimize the incidence of this complication. We also refrain from pulling the extensions too taught toward the subcutaneous IPG pocket, with the rationale that a more tortuous trajectory is less likely to become a tight fibrous band. Future generation skull mounted IPGs will make this complication obsolete.

Patient consent

The patient herself has consented to the submission of this case report for submission to the journal.

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Conflict of interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

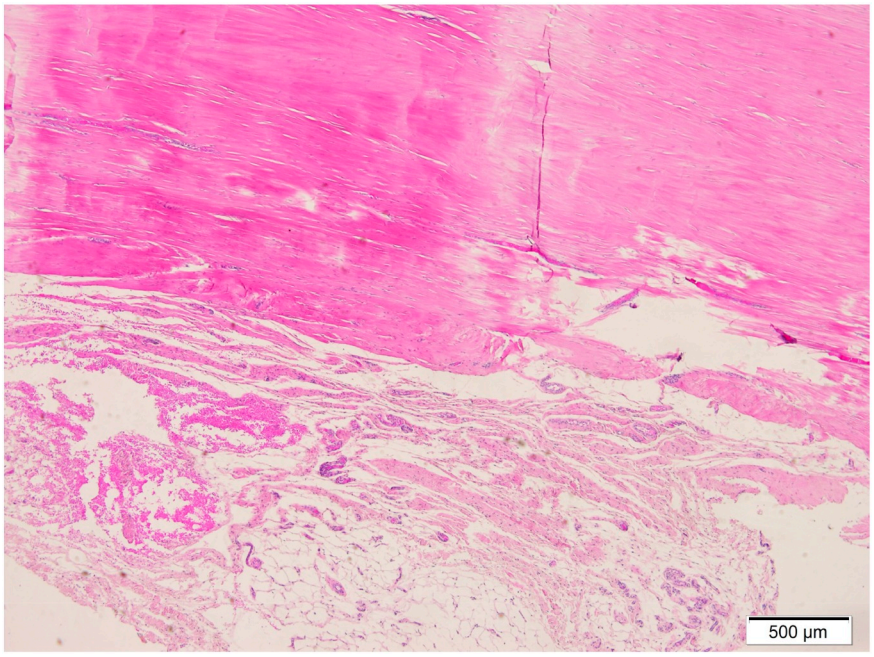

Fig. 3. Paraffin embedded section, stained with H&E. Seen is a dense collagenous tissue adjacent to vascularized fibro-fatty tissue. No significant inflammation is seen in the specimen. There are no microorganisms identified.

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