Selective Neurectomy for the Spastic Upper Extremity

Caroline Leclercq, MD

KEYWORDS

• Spasticity • Motor nerves • Neurectomy • Hyperselective neurectomy

KEY POINTS

- Hyperselective neurectomy is effective in reducing the severity of upper limb spasticity.
- The procedure requires a thorough knowledge of the anatomy of upper extremity motor nerves and their branches to each individual muscle.
- Neurectomy should involve at least two-thirds of each motor ramus entering the target muscles.
- Magnifying loupes and microsurgical instruments are recommended for this procedure.

INTRODUCTION

Spasticity occurs as a consequence of many conditions, including cerebral palsy (CP), stroke, and traumatic brain injury. The initial treatment for spasticity is nonsurgical, including a wide range of physical and occupational therapy techniques. Pharmacologic agents may be used as an adjunct, whether orally, intrathecal, or locally administered. In select cases, surgery may be indicated following proper conservative treatment.

The goals of surgical treatment can vary greatly, depending on the extent of functional impairment. Whenever possible, surgery aims to improve function. In some cases, however, it will be limited to improving hygiene and comfort, reducing pain, or correcting a severe deformity. The goal of functional surgery is to correct the deformities by rebalancing existing forces.[1] Multiple surgical techniques are used to address different components of the upper extremity deformity, such as spasticity, muscle contracture, joint contracture, and paralysis; this goal-specific surgical plan underscores the need for a preliminary thorough physical examination. Surgical options aimed at spasticity reduction include root procedures (eg, selective radicotomy and dorsal root entry zone lesioning) as well as peripheral procedures (eg, partial neurectomy).

Partial neurectomy was described by Stoffel[2] in 1913, and expanded by Brunelli and Brunelli[3] in 1983. The conceptual basis of this technique is to decrease the spastic component of the deformity, while retaining some active control of the involved muscles. Satisfactory outcomes of this technique have been reported,[4–14] but the results are difficult to interpret because of a lack of standardized use of postoperative outcomes instruments. Further, there is a general perception that recurrence is frequent. In light of our recent anatomic studies,[15–17] new guidelines for a "hyperselective" neurectomy (HSN) have been described and we have conducted a prospective study to reevaluate the results of this treatment. In this article, we discuss the essential components of a preoperative examination, indications for HSN, technical details, and outcomes of treatment.

PREOPERATIVE EXAMINATION

Selective neurectomy is effective only for the spastic component of the deformity. Therefore, it must be distinguished from other potential

Disclosure: The author does not have any commercial or financial conflicts of interest or funding sources to disclose.
Institut de la Main, Clinique Bizet, 21 rue Georges Bizet, Paris 75116, France
E-mail address: caroline.leclercq@free.fr

Hand Clin 34 (2018) 537–545
https://doi.org/10.1016/j.hcl.2018.06.010

deforming factors, namely muscle contracture, joint deformities, and paralysis. The clinical picture may vary greatly from one individual to another, depending on the amount and location of the initial brain insult. Further, clinical manifestations within the same patient may vary, depending on ambient temperature, emotional state, and stress, for example, Clinical examination is a critical part of the assessment. It is best performed as a multidisciplinary team, including the physiatrist, neurologist, physical and occupational therapist, and surgeon. This should ideally be done in a warm, quiet, and friendly environment to limit spasticity. For the same reason, it is unwise to decide on surgery after a single session, and assessment should be repeated before any decision-making. Physical examination findings are recorded on standardized charts, and video recording of each patient is performed before and after every step of treatment. A thorough examination of the upper limb is essential to rule out any other associated neurologic disorders and/or potential contraindications to surgery.

Evaluation of Spasticity

Spasticity is usually easy to diagnose based on clinical characteristics, but can be difficult to quantify.[4] The Ashworth scale was developed to assess the efficacy of antispasticity treatment in patients with multiple sclerosis. It is descriptive and, despite subsequent modification, remains subject to personal interpretation, with suboptimal interobserver reliability.[18] There is evidence that the Tardieu scale[19] is currently the most reliable tool for evaluating spasticity.[20–24]

Muscle Contracture

Unlike spasticity, muscle contracture is permanent and cannot be overcome. However, the distinction between contracture and spasticity may be difficult to establish clinically. Despite this challenge, it is critical to discern contracture from spasticity to formulate the best treatment plan. In such cases, nerve blocks or botulinum toxin (Botox) are very helpful; spasticity yields completely, whereas contracture persists.[25,26]

Joint Deformity

Passive motion of the involved joints may be difficult to assess because of muscle contractures. In this setting, motor blocks are not very helpful because they cannot alleviate muscle contracture. Sometimes it is not until surgical release of the muscle contracture that the actual range of passive motion can be evaluated. Joint contracture is rare in patients with CP, who present more frequently with joint instability, especially at the thumb metacarpophalangeal (MCP) joint (eg, hyperextension), and at the finger proximal interphalangeal (PIP) joints (eg, swan-neck deformity).

Motor Impairment

Motor examination of the upper limb may be difficult, especially when severe contractures are present. Rather than individual muscles, it is easier to evaluate muscle groups contributing to a particular function. The palsy usually predominates in the distal part of the upper limb and involves the extensor and supinator muscles, whereas the spastic flexor, adductor, and pronator muscles usually retain some voluntary control. Assessment of the weak extensor and supinator muscles may be difficult when the antagonist flexors and pronators are severely spastic. Botox serves as a diagnostic aid in this regard; when injected in the spastic antagonist muscles, it allows one to more accurately evaluate the function of the seemingly paralyzed muscles. In many cases, these muscles may end up demonstrating satisfactory voluntary control.

We have not found electromyographic studies to be helpful in quantifying the motor function of either the pseudo-paralytic or the spastic muscles. Although promising, 3-dimensional movement analysis is complex in the upper limb, and not routinely used.[27,28] Involuntary movements, whether spontaneous (eg, chorea, athetosis) or during use (eg, dystonia) are recorded; they may be contraindications to surgery.

Sensory Impairment

Sensory examination is essentially impossible before the ages of 4 or 5. Light touch and 2-point discrimination are generally intact in children with CP, whereas complex sensations (eg, fine sensibility, proprioception, stereognosis) are more readily affected. In patients with stroke, all types of sensations may be severely impaired. Pain may be present, but is difficult to evaluate and discern causation. It may be linked to severe contractures, a deformed joint, or, rarely, Kienböck's disease secondary to a severe wrist flexion deformity.[29]

Functional Assessment

The International Classification of Functioning, Disability and Health (ICF) provides a standard language and framework for assessing function and disability.[30] The ICF is unique in its ability to distinguish capacity and performance. Capacity is the ability to execute a task at the highest possible level of functioning. Performance is the spontaneous use of the hand during activities or play. In