

Surgical Management of Spasticity of the Forearm and Wrist



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KEYWORDS

- Forearm spasticity • Wrist spasticity • Cerebral palsy • Traumatic brain injury • Stroke
- Upper extremity spasticity surgery • Tendon transfer

KEY POINTS

- Upper extremity spasticity manifestations can range from mild to profoundly debilitating and may result from cerebral palsy, traumatic brain injury, or stroke.
- Careful examination in a multidisciplinary setting is necessary to formulate the best treatment plan.
- Nonsurgical options for treatment include serial casting, orthotics, therapy, baclofen, valium, and botulinum toxin A.
- In specific cases, forearm and wrist deformities are addressed by surgery directed at the involved joints and tendons.
- The most commonly used procedures include FCU to ECRB transfer, PT release/rerouting, flexor tendon lengthening, and wrist arthrodesis.

INTRODUCTION

Upper extremity spasticity manifestations range from mild to profoundly debilitating. Spasticity is a frequent sequelae of cerebral palsy (CP),¹ traumatic brain injury, and stroke.² Taken together, these conditions comprise a substantial number of patients. The commonality among these diagnoses is that of an upper motor neuron syndrome, in which a supraspinal central nervous system lesion disrupts the balance of inhibitory and excitatory input into the spinal reflex arch.³

After the initial insult to the central nervous system, there is flaccid paralysis followed by the return of reflexes and the eventual development of spasticity.⁴ Physiologic and structural changes subsequently occur in an attempt to mitigate functional compromise resulting from the pathologic

insult.⁵ These rearrangements contribute to subcortical hyperexcitability, which leads to increased muscle activity and exaggerated spinal reflex responses to peripheral stimulation.⁶ Furthermore, there is a velocity-dependent increase in the resistance of a passively stretched muscle or muscle group.³ Joints become restricted in the direction of action of the strongest crossing muscle. Digital, wrist, and elbow flexors tend to overpower their antagonists because of a larger cross-sectional area (Fig. 1).⁷

Upper extremity spasticity can affect all ages and sociodemographics and is a complex clinical problem with a variety of treatment options depending on the patient, the underlying disease process, and postoperative expectations. The goal of this review is to discuss indications for surgery, preoperative work-up, surgical techniques,

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Fig. 1. Common examination findings in upper extremity spasticity. Note the flexed posture of the wrist and pronated forearm.

postoperative care, and outcomes for patients with forearm and wrist spasticity.

WORK-UP

Before surgical intervention, one should assess the patient's overall cognitive and functional status. After obtaining a relevant history from the patient or caregiver, the surgeon must complete a thorough upper extremity functional evaluation. The examination should focus on passive range of motion, active range of motion, degree of spasticity or joint contracture, and the presence of dystonia. Sensibility should be assessed using a two-point discriminator. Skin creases over contracted joints are examined for hygiene and skin breakdown. More than one preoperative functional evaluation is recommended to confirm any proposed surgical plan.

Further work-up may include plain radiographs of the involved extremity, dynamic electromyography, and motion analysis studies. Dynamic electromyography records muscle activity with certain movements, such as grasp, release, wrist flexion and extension, elbow flexion and extension, and forearm supination and pronation.⁸ Muscle recordings are obtained from the spastic muscles and their antagonists to guide decision making regarding tendon transfers.⁸

Three-dimensional motion analysis has become an increasingly used quantitative measurement of upper extremity function.⁹ Motion analysis records movements using reflective markers and specialized cameras while patients complete standardized tasks. Although labor- and time-intensive, this analysis is recommended in all but the most functional patients, because the results of motion analysis may change the surgical plan.

NONSURGICAL TREATMENT

Nonsurgical treatment of spasticity of the wrist and forearm ranges from serial casting, orthotics, and therapy, to oral drug therapy, intrathecal baclofen, and injection of phenol or botulinum toxin type A.¹⁰

Serial casting has been shown to have a positive short-term effect on the spasticity of the wrist in adults and children. By maintaining muscle fiber length, casting provides a static impediment to joint contracture. However, casts require frequent changes and adverse events, such as pain and skin breakdown, may occur.¹¹ Oral medications, such as baclofen, valium, and clonidine, are used to treat spasticity. However, effectiveness must be balanced against the side effects of drowsiness, dizziness, and generalized weakness.² Continuous infusion of intrathecal baclofen is effective in decreasing spasticity.² Because small concentrations of the medication are administered directly into the intrathecal space, systemic side effects are minimal. Phenol is a neurolytic agent that is useful for temporary treatment (3–5 months) of spasticity. It is injected into or adjacent to a nerve controlling the muscles of interest. Botulinum toxin type A inhibits the release of acetylcholine at the neuromuscular junction and is injected directly into spastic upper extremity musculature. A total of 400 units may be injected in one setting and this may be repeated every 12 weeks, as needed. The reduction in forearm, wrist, and finger spasticity with administration of botulinum toxin type A has been shown to increase upper extremity function,^{10,12} but like phenol results are temporary.

SURGICAL TREATMENT

Tendon transfers, releases, reroutings, and lengthenings are the mainstays of surgical treatment of the spastic forearm and wrist (Table 1).² Additional surgical treatments include selective peripheral neurotomy¹³ and adjunctive surgeries for secondary symptoms, such as carpal tunnel release in the

Table 1
Surgical options for the treatment of wrist and forearm spasticity

Forearm pronation deformity	PT release, PT rerouting
Forearm supination deformity	Biceps rerouting
Wrist flexion deformity	FCU to ECRB, PT to ECRB, BR to ECRB, wrist arthrodesis, flexor-pronator slide, tendon lengthening
Wrist extension deformity	Extensor lengthening or release

Abbreviations: BR, brachioradialis; ECRB, extensor carpi radialis brevis; FCU, flexor carpi ulnaris; PT, pronator teres.

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