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Practice Pearls

When to Consider Amputation Post Severe Brachial Plexus Injury

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Physicians involved in the diagnosis and management of traumatic nerve injuries will occasionally see patients with devastating complete pan-plexus injuries. Not infrequently, after it becomes clear that function is unlikely to recover, patients will ask about the option of amputation of the involved limb. At times, patients may wish to explore this option but are hesitant to ask the treating physician and would benefit from a discussion. The treating physician may lack a framework to consider how to respond to these inquiries from patients.

Many years ago, amputation served as first-line treatment for severe brachial plexus injury (BPI), especially in the case of root avulsions. In 1974, Parry reported "In the case of preganglionic lesions, amputation and provision of an artificial limb can lead to return to work within six to nine months of injury and in appropriate cases retention in the Service."[1]

With advances in electrodiagnostic, imaging, and surgical techniques, many of these patients now are treated with nerve grafts / transfers and sometimes free functioning muscle grafts, such as gracilis.[2] There are also important new approaches to providing a functional hand, such as bionic hand reconstruction.[3,4] Nevertheless due to scarcity of extra-plexus donors, difficulty with restoring distal limb function, pain, limb weight, or recurrent insensate limb injury, some patients still request consideration of limb amputation. Physicians treating such patients will want to be able to discuss these requests knowledgeably.

Brachial plexus avulsion and/or neuroma-related neuropathic pain is a common reason for patients to consider amputation. Patients should be educated that an amputation will not improve this pain. BPI patients may also be at higher risk of chronic phantom limb pain as it is due to central pain mechanisms. Amputation will not resolve pain resulting from post-ganglionic neuroma formation at the site of the BPI but an option for neuroma pain is targeted muscle reinnervation or regenerative peripheral nerve interfaces[5]; however, this is usually not an option in very proximal BPIs. In contrast to neuropathic pain, musculoskeletal pain related to chronic traction on the shoulder joint, from the weight of the flail arm, might be helped by amputation.[6] While some studies report reduction in overall pain since amputation,[7,8] many do not, and the level of expectation around pain reduction should be carefully managed.[2]

Patients might be considered for amputations when they meet three criteria[7]: 1) pan-plexus injury, 2) no meaningful functional recovery 18–24 months or more after surgical intervention, and 3) at least one chronic complication. Complications are related to lack of sensation and weight of the limb and might include shoulder pain and/or chronic neck pain due to the arm weight, chronic infection, fractures, or burn injuries. Of these, shoulder and neck pain due to traction may be the most common reason for amputation. Other criteria that have been advocated include[9] 1) flail upper extremity; 2) no prognosis for additional recovery; 3) failure of all possible surgical treatments; 4) patient dissatisfaction with lack of useful function and/or discomfort of the flail limb; 5) willingness to attempt prosthetic use, and 6) pain or discomfort secondary to inferior gleno-humeral subluxation.

If the patient meets these criteria, an in-depth discussion can be had with the patient around several pros and cons of an amputation vs. maintaining a flail limb.[9] These discussions may include the following areas: impact on pain, change in function, body image changes post limb loss, and if there is a potential for prosthetic fitting (both cosmetic and functional). At times gleno-humeral arthrodesis will be combined with amputation to reduced shoulder instability and pain.

Unfortunately, there is limited research on the outcomes of amputation after BPI, and it is challenging to make evidence-based decisions. Maldonado reported no significant change in the Disabilities of the Arm, Shoulder, and Hand (DASH) score after amputation. Although pain in these patients was reduced from visual analogue scale (VAS) of 7.8 to a VAS of 3.9, this was not statistically significant, which could be related to the study's small sample size ($n = 9$).[7] Similarly, Cantwell and colleagues reported a nonsignificant improvement in DASH scores, although many of their patients expressed satisfaction after surgery and none of the 32 patients expressed regret.[8]

Prosthetic use is variable after amputation, and in general there are high rates of upper extremity prosthetic abandonment for transhumeral amputations.[10] Cosmetic prostheses are rarely used and body-powered prostheses are rarely used long term, especially given the time between original BPI and amputation. Furthermore, such patients lack proximal shoulder stability and motor control (especially if the rhomboids and serratus anterior are nonfunctional) and have challenges supporting the weight of a prosthetic device. Gleno-humeral fusion is also usually required in these patients. Myoelectric prostheses may be an option for those with less severe BPIs, but are heavy, expensive, and require using electromyographic signals from "nonintuitive" muscles, such as unaffected shoulder muscles or contralateral limb muscles.[8]

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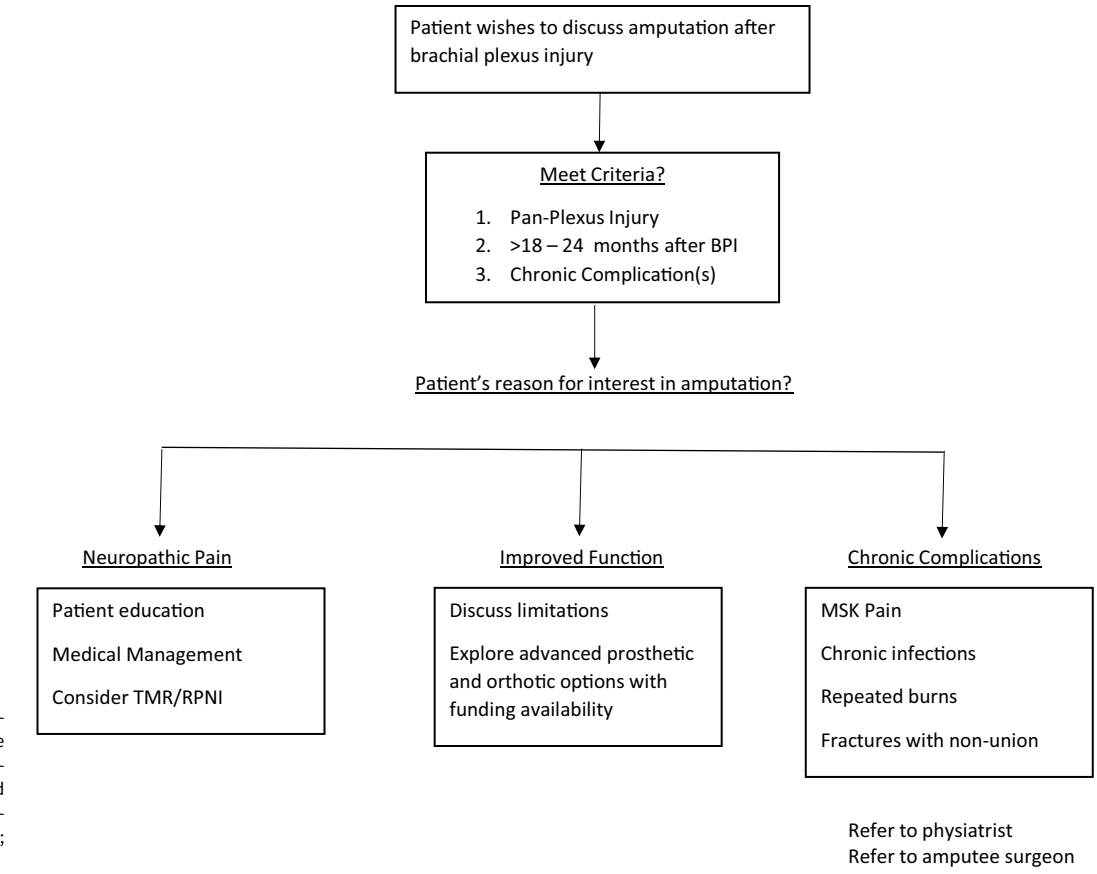


Figure 1: Flowchart for guiding discussion of amputation after severe brachial plexus injury. (BPI = brachial plexus injury; TMR = targeted muscle reinnervation; RPNI = regenerative peripheral nerve interface; MSK = musculoskeletal).

There have been some advancements for transhumeral amputations such as osseointegration prostheses, implantable myoelectric sensors, and implantable nerve cuffs to eliminate device weight, enhance control, and/or proprioception, but these have yet to become mainstream and are still under study.

In summary, there are clearly marked improvements of treatments available to patients with a severe and devastating proximal pan-plexus injury. Nevertheless there will be some patients for whom these treatments are unsuccessful, and they will be asking treating physicians about amputation as an option. We should not dismiss this option and should consider amputation clinic referral for those who have complete BPI, with failed surgical interventions, and have chronic complications due to the weight or lack of sensation in their limb (Figure 1). An in-depth discussion should be had with these patients regarding pain and that procedures would likely help only mechanical pain, but not neuroma or phantom limb pain. Moreover, prosthetic use is very challenging in these patients, although some might be able to use myoelectric prostheses and there is ongoing research to improve prosthetic technology. Most importantly, a physiatrist well-versed in treating patients with limb loss and a surgeon familiar with the variety surgical options for BPI should be consulted for a more in-depth amputation discussion.

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