

Tetraplegia Management Update

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Learning Objectives

- Provide information about the epidemiology of tetraplegia.
- Discuss the clinical manifestations of tetraplegia in the upper extremity.
- Describe surgical algorithms for treatment of tetraplegia of the upper extremity.
- Review the treatment outcomes of upper extremity in tetraplegia.
- Assess the rehabilitation methods of upper extremity in tetraplegia.

Deadline: Each examination purchased in 2015 must be completed by January 31, 2016, to be eligible for CME. A certificate will be issued upon completion of the activity. Estimated time to complete each JHS CME activity is up to one hour.

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Tetraplegia is a profound impairment of mobility manifesting as a paralysis of all 4 extremities owing to cervical spinal cord injury. The purpose of this article is to provide an update and analyze current management, treatment options, and outcomes of surgical reconstruction of arm and hand function. Surgical restoration of elbow and wrist extension or handgrip has tremendous potential to improve autonomy, mobility, and critical abilities, for example, eating, personal care, and self-catheterization and productive work in at least 70% of tetraplegic patients. Tendon and nerve transfers, tenodeses, and joint stabilizations reliably enable improved arm and hand usability, reduce muscle imbalance and pain in spasticity, and prevent joint contractures. One-stage combined procedures have proven considerable

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advantages over traditional multistage approaches. Immediate activation of transferred muscles reduces the risk of adhesions, facilitates relearning, avoids adverse effects of immobilization, and enhances functional recovery. Transfer of axillary, musculocutaneous, and radial nerve fascicles from above the spinal cord injury are effective and promising options to enhance motor outcome and sensory protection, especially in groups with limited resources. Improved communication between medical disciplines, therapists, patients, and their relatives should help that more individuals can benefit from these advances and could empower many thousands tetraplegic individuals “to take life into their own hands” and live more independently. (*J Hand Surg Am.* 2015;40(12):2489–2500. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)

Key words Combined procedures, early activation, nerve transfer, tendon transfer, tetraplegia.

GLOBAL INCIDENCE OF SPINAL CORD injury (SCI) has been estimated as 10–80 new cases per million annually, which means that approximately 12,000 in the USA alone and 250,000–500,000 people worldwide become paralyzed every year.¹ This population often represents otherwise healthy and active individuals aged between 20 and 40 years. In approximately 50%, SCI occurs at the cervical level, which leads to tetraplegia.²

The causes of SCI differ among countries but worldwide most commonly occur because of motor vehicle accidents, falls, violence (crime), sports, and leisure activities. Nontraumatic causes include tumors, infection, degenerative, or vascular disorders—it can happen to anyone of us any day.^{1–4}

Upper extremity functional surgery has an important role in the management of patients with SCI. As SCI remains incurable, upper extremity function, aside from the brain, is the most important functional resource of tetraplegic patients and judged to be most desirable to regain, before bowel, bladder, sexual function, or walking ability. Anderson reports that 49% of surveyed tetraplegic patients ranked rehabilitation of arm and hand function as first priority, with no other goal surpassing 13%.² Similarly, another study reports that 77% of 565 tetraplegic patients expected important or very important improvement in quality of life if their hand function improved.⁵

Surgical rehabilitation is a powerful tool to restore upper extremity function, for example, restored elbow extension improves reach and stabilizes the elbow, allowing further reconstruction of grasp, and the ability to swim and drive.^{3,6,7} Regaining grip by reconstructive surgery eliminates the need for adaptive equipment; allows patients to groom, self-feed, self-catheterize, manipulate objects, write, and perform productive work; and markedly improves autonomy and spontaneity, thus enhancing self-esteem for tetraplegic people.⁸ Regrettably, despite highly positive results,

tetraplegia surgery is profoundly underutilized. In the USA with more than 100,000 tetraplegic citizens, fewer than 400 receive upper extremity functional surgery annually—less than 10% of appropriate candidates. The reasons for explaining this paradox are complex, with inadequate information causing skepticism among patients, therapists, and rehabilitation physicians. Inadequate referral networks also play a role.⁹

The objective of this article is to provide an update on surgical management of tetraplegia upper extremity surgery from the experience of the authors.

CLINICAL PICTURE

Remaining upper extremity function in tetraplegia depends on the injury level. Patients with C2–4 tetraplegia generally have no arm and hand muscle function, except shoulder elevation (trapezius muscle innervated by the spinal accessory nerve), some neck muscle control, and may be ventilatory support dependent. Individuals with intact C5 myotome usually retain elbow flexion and shoulder abduction and may be able to perform simple activities such as eating, using devices attached to their wrists and hands. Wrist extension is the key function of the C6 level that usually produces only weak grip, as active thumb and finger flexion is paralyzed. At the C7 level, extension of the elbow is present that is crucial for transfer and may enable patients to live in an adapted environment with some caregiver assistance. Although this categorization is simplified, it clearly shows that any treatment improving the functional level, for example, from C5 to C6 or 7, produces a marked enhancement in both function and independence.

Muscle testing

Planning treatment depends on muscle strength testing of the upper extremity according to the Medical Research Council system and International Classification of Surgery of the Hand in Tetraplegia¹⁰

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