Tendon Transfers for the Drop Foot

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KEYWORDS

• Tendon transfers • Drop foot • Posterior tibial tendon transfer • Bridle procedure

KEY POINTS

- The paralytic drop foot represents a challenging problem for even the most experienced orthopedic surgeon.
- Careful patient selection, thorough preoperative examination and planning, and application of tendon transfer biomechanical and physiologic principles outlined here can lead to successful results, either through a PT tendon transfer, Bridle transfer, or variations on these procedures.
- Achilles lengthening or gastrocnemius recession may also be needed at the time of tendon transfer.

INTRODUCTION

Tendon transfers are used around the ankle to recreate a balanced foot that is plantigrade and functional.[1,2] Historically, patients with poliomyelitis benefitted from the development and application of tendon transfers throughout the lower extremity, particularly within the foot and ankle to restore strength, balance, and function to a paralytic foot. Although this disease has been essentially eradicated through vaccination, foot and ankle surgeons commonly use tendon transfers for the paralytic foot for other etiologies. The indications are generally divided into four categories: (1) cavovarus, (2) equinovarus, (3) flail, and (4) the topic of this article, drop foot.[3]

In its most basic form, drop foot is defined as the failure of active foot dorsiflexion, which is the end result of a variety of processes. The cause may be neurologic, systemic, or traumatic.[3,4] The neurologic causes are categorized as either central or peripheral. Central neurologic causes include lumbar spinal pathology, closed head injuries, stroke, and multiple sclerosis. Peripheral processes to consider include peroneal nerve palsy; compartment syndrome; and neuropathies, such as Charcot-Marie-Tooth disease.[3]

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Depending on the cause and severity of the drop foot, the initial recommended conservative treatments consist of Achilles stretching, muscular rehabilitation, and bracing. The most effective brace to address drop foot is an ankle-foot orthosis (AFO). Surgery may be the best initial care if there is an identifiable and treatable central or peripheral nerve problem that could result in motor recovery (ie, lumbar nerve root decompression). For cases of drop foot that are at least a year old with little chance of motor improvement, a tendon transfer may be considered to provide active dorsiflexion.[1–4]

Drop foot is not necessarily just a result of dorsiflexion weakness. There may be associated soft tissue contractures and arthrofibrosis.[4] Failure to recognize all of the contributing factors can lead to inadequate correction and failure of treatment. Patient-specific factors that are also important to consider include expectations and their mental and physical abilities to participate in the crucial postoperative period. In some cases, treatment of a drop foot with an AFO may be the more reasonable option.[3,4]

Goldner's[5] approach to the paralytic foot involved identification of the primary cause or lesion, assessment of the mobility of the foot, vascular examination, sensory evaluation, strength testing of all relevant musculotendinous units, and patient-specific factors. This basic algorithm is essential to assembling a comprehensive, realistic, and effective treatment plan for each patient.

TENDON TRANSFER BASICS

Reports of tendon transfers are found in the literature as early as 1881. Mayer[6] outlined five fundamental tenets of tendon transfer in 1937. These included restoration of the anatomic relationship between a tendon and its sheath, tendon routing through tissue that allows for proper gliding, restoration of normal tendon tension, recreating the anatomic tendon insertion, and establishing proper line of tendon pull.

Musculotendinous units are defined by the gait cycle phase in which they are active. In general, in-phase transfers function most efficiently and effectively.[1,7,8] Although at the time the only option available, out-of-phase transfers are less ideal because of greater muscle strength loss and the need for greater muscle retraining.[2] Out-of-phase transfers are thought to function as static restraints to deformity (ie, tenodesis), not truly undergoing phase conversion, as previously suspected.[1,8,9]

Jeng and Myerson[2] outline several essential points to consider when planning tendon transfers. The function of a tendon is determined by its position relative to the joint under consideration (ie, tendons that run posterior to the ankle and medial to the subtalar joint function as plantarflexors and invertors) and the distance from the tendon to the joint axis, because this determines the effective lever arm for force application across a joint. Musculotendinous units form antagonist force couples (ie, posterior tibialis [PT] and peroneus brevis tendons). Loss of one component of this force couple leads to deformity dictated by its antagonist.

The relative strengths of the tendons involved determine the magnitude of this force differential. Silver and colleagues[10] determined these relative strength values for muscles acting on the foot and ankle and demonstrated a greater degree of complexity than previously suspected. The sum of the relative strength units for the dorsiflexors did not equal that for the plantarflexors (9.4 vs 69 strength units, respectively), and similarly for the evertors and invertors (11.9 and 60.9 strength units, respectively), suggesting a complex level of modulation through the central nervous system (CNS) in balancing these antagonistic forces.[1] These large differentials are realized in CNS injuries (ie, stroke, traumatic brain injury, cerebral palsy), for example, with the development of an equinovarus deformity caused by relative overpull by the plantarflexors and invertors of the ankle and hindfoot.