SCIENTIFIC ARTICLE

A Comparative Outcome Study of Hamstring Versus Tibialis Anterior and Synthetic Grafts for Deltoid to Triceps Transfers

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Purpose To assess elbow extension strength and complications after deltoid-triceps transfers using hamstring tendon graft compared with tibialis anterior and synthetic tendon grafts.

Methods A retrospective review of deltoid-triceps transfers in patients with tetraplegia performed between 1983 and 2014.

Results Seventy-five people (136 arms) had surgery performed, with the majority undergoing simultaneous bilateral surgery (n = 61; 81%). Tibialis anterior tendon grafts were used in 68 arms, synthetic grafts in 23 arms, and hamstring tendon grafts in 45 arms. The average age at surgery was 31 years. Sixty-three arms (46%) were assessed between 12 and 24 months after surgery. Seventy percent of the group (n = 54) were able to extend their elbow against gravity (grade 3 of 5 or greater) following surgery. Seventy-nine percent of those with hamstring grafts achieved grade 3 of 5 or more compared with 77% with tibialis anterior and 33% with synthetic grafts. There was a statistically significant difference in postsurgery elbow extension between the tibialis anterior group and the synthetic graft group and the hamstring and the synthetic graft group but not between the tibialis anterior and the hamstring group. Complications occurred in 19 arms (14%), the majority occurring immediately after surgery and associated with the wounds. The remaining complications were with the synthetic graft group in which dehiscence of the proximal attachment occurred in 30% of the arms.

Conclusions Autologous tendon grafting is associated with achievement of antigravity elbow extension in a greater proportion of individuals than with prosthetic grafting. *(J Hand Surg Am. 2017;■(■):1.e1-e9. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic IV.

Key words Tetraplegia, tendon transfer, elbow extension, upper limb.

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THE SURGICAL RESTORATION OF elbow extension in people with tetraplegia was first described by Moberg[1] using the deltoid-triceps transfer. Since that time, both posterior deltoid-triceps and biceps-triceps transfers have been used to restore active elbow extension.[2–4] In a systematic review of the literature on reconstructive operations on the upper limb in tetraplegia, Hamou and colleagues[5] identified 14 studies reporting outcomes following reconstruction of elbow extension in 201 operated

arms between 1977 and 2003. Adverse events associated with elbow extension reconstructions reported in this review included: rupture or stretching of the repair (the majority), elbow contracture, local infection, inflammatory reaction, heterotrophic ossification in the triceps, hematoma, and donor site toe contracture. The adverse-event rate for these procedures was 1 complication for every 4 arms.

Provision of elbow extension stabilizes the elbow and provides greater range of movement in the horizontal plane. The ability to extend the hand in space by an additional 12 inches results in an additional 800% of space that the hand can reach, thus increasing the functional workspace of the individual.[6,7] Commonly identified goals following deltoid-triceps surgery include propelling a wheelchair and transfers.[8–10] Goals directly related to self-care and dressing, driving a vehicle, and positioning the arms when lying down have demonstrated the greatest level of satisfaction following deltoid-triceps surgery.[8]

Restoration of elbow extension after spinal cord injury (SCI) can be performed by transferring the posterior third of the deltoid muscle into the insertion of the triceps tendon via a tendon graft. A variety of tendons have been used to bridge the gap between the deltoid and the triceps, including the extensor digitorum longus, the tibialis anterior, the fascia lata, the central third of the triceps tendon, and synthetic material.[1,2,4] For those patients who require restoration of active extension of both elbows, simultaneous bilateral surgery is performed, ideally prior to hand surgery. Providing elbow extension prior to surgical restoration of the hand ensures there is an antagonist to elbow flexion that can counteract the flexion moment that is produced after a tendon transfer using the brachioradialis.[11]

Between 1983 and 2000, the tibialis anterior was used as the graft for deltoid-triceps transfer in 68 arms.[12] Rehabilitation of bilateral deltoid to triceps transfer using tibialis anterior grafts involved an initial 6-week period of bedrest with the arms immobilized in a crucifix position, followed by a further 8 weeks of gradual mobilization of elbow flexion increasing 15° each week until full flexion was reached. Patients remained inpatients for the period of their rehabilitation. This was due to the burden of care required for patients following bilateral surgery and the specialized nature of the rehabilitation. The increasing international use of synthetic grafts enabling decreased immobilization time, earlier rehabilitation,[13] and the increasing number of incomplete SCI were the reasons for changing to a synthetic graft between 2000 and 2004 in 23 arms. This decreased the postoperative bedrest time to 10 days, prior to the 8-week gradual mobilization of elbow flexion, ultimately decreasing the length of hospital stay by 4 weeks. In addition, the use of a synthetic graft enabled people with incomplete SCI to have elbow extension reconstructed without compromising their lower limb function. A number of complications and poor outcomes following use of the synthetic graft necessitated an abandonment of this surgical technique. From 2005, deltoid-triceps transfers have been performed using hamstring grafts (45 arms) because they have been proven to be a graft donor with minimal donor site morbidity in other orthopedic procedures such as anterior cruciate ligament reconstructions.[14,15] The purpose of this paper is to describe the surgical technique and rehabilitation of this procedure and to assess the outcomes in terms of elbow extension strength and complications compared with historical data on tibialis anterior and synthetic grafts.

METHODS

Patient population

All patients with tetraplegia assessed for surgery are enrolled in a secure International Upper Limb Surgery Registry, approved by a regional ethics committee.[16] Patients were included in the study if they had deltoid-triceps surgery performed between January 1, 1983, and December 31, 2014, had been followed up by the upper limb surgery team between 12 and 24 months following surgery, and had elbow extension strength formally tested and recorded. Those excluded from the study were those who had died prior to the 12- to 24-month follow-up (n = 1), those without documented presurgery muscle strength scores, and those who had been followed up at an earlier or later time (n = 38).

Surgical prerequisites

A Medical Research Council (MRC) grade 4 of 5 or 5 of 5 posterior deltoid is required for transfer.[17] However, because we routinely perform bilateral simultaneous surgery, transfers of posterior deltoid with strength less than grade 4 of 5 were performed on 3 arms (2 synthetic, 1 hamstring).

Surgical technique

Transfer using hamstring tendon grafts: In the prone patient and via a 4-cm longitudinal incision over the anteromedial tibia at the level of the tibial tubercle, the gracilis and semitendinosis tendons are identified,