Suprascapular nerve as a donor for extracranial facial nerve reanimation procedures: a cadaveric feasibility study

Laboratory investigation

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Object. Facial nerve injury with resultant facial muscle paralysis is disfiguring and disabling. To the authors’ knowledge, neurorization of the facial nerve using a branch of the brachial plexus has not been previously performed.

Methods. In an attempt to identify an additional nerve donor candidate for facial nerve neurorization, 5 fresh adult human cadavers (10 sides) underwent dissection of the suprascapular nerve distal to the suprascapular notch where it was transected. The facial nerve was localized from the stylomastoid foramen onto the face, and the cut end of the suprascapular nerve was tunneled to this location. Measurements were made of the length and diameter of the suprascapular nerve. In 2 of these specimens prior to transection of the nerve, a nerve-splitting technique was used.

Results. All specimens were found to have a suprascapular nerve with enough length to be tunneled, tension free, superiorly to the extracranial facial nerve. Connections remained tensionless with left and right head rotation of up to 45°. The mean length of this part of the suprascapular nerve was 12.5 cm (range 11.5–14 cm). The mean diameter of this nerve was 3 mm. A nerve-splitting technique was also easily performed. No gross evidence of injury to surrounding neurovascular structures was identified.

Conclusions. To the authors’ knowledge, the suprascapular nerve has not been previously explored as a donor nerve for facial nerve reanimation procedures. Based on the results of this cadaveric study, the authors believe that use of the suprascapular nerve may be considered for surgical maneuvers. (DOI: 10.3171/JNS/2008/108/01/0145)

Key Words • facial nerve injury • neurorization • suprascapular nerve

The human facial muscles, in addition to conveying various expressions and thus playing a communicative role, have also evolved to play a functional role for the visual, respiratory, olfactory, and digestive systems. Transection of the facial nerve or its branches can be the result of traumatic or iatrogenic injuries and often results in disabling and disfiguring consequences for the patient. These consequences can include speech difficulty, drooling, lagophthalmos, dysfunctional lacrimation, corneal ulcerations, and even blindness. The aim of reconstruction of the paralyzed face is to provide facial symmetry at rest and in active expression. This goal may be accomplished via muscle transpositions, alloplastic implantation, or neurorization procedures. Reanimation of the facial nerve has been performed using various regional nerves. When the facial nerve is transected or severely compromised and primary end–to-end repair is not possible, hypoglossal–facial nerve anastomosis remains the most popular method for accomplishing 3 main goals: restoring facial tone, restoring facial symmetry, and facilitating return of voluntary facial movement. Some authors have reported unsatisfactory results, however, when using such standard nerves as the hypoglossal and spinal accessory nerves. The majority of authors have agreed that the most important prognostic factor in facial reanimation is a tensionless anastomosis. Considering the mediocre results demonstrated in association with currently available techniques, a search for alternative donor sites seemed plausible. To our knowledge, the suprascapular nerve and, for that matter, branches of the brachial plexus have not been previously explored as a donor nerve for facial nerve reanimation procedures (Fig. 1).

The suprascapular nerve is a large branch of the upper trunk of the brachial plexus and, as such, usually receives input from the C-5 and C-6 spinal nerves. It runs laterally, deep to the trapezius and omohyoid muscles, and enters the supraspinous fossa through the suprascapular notch, inferior or to the superior transverse scapular ligament. It then runs deep to the supraspinous muscle and curves around the lateral border of the spine of the scapula (spinoglenoid notch) with the suprascapular artery to reach the infraspinous fossa. The present study was performed to test the hypothesis that this branch of the brachial plexus might be used when planning restorative nerve procedures of the face.
Materials and Methods

Five fresh adult human cadavers (10 sides; obtained in 3 female and 2 male cadavers) were used for this study. The specimens were obtained in individuals who were a mean of 71 years (range 55–94 years) at the time of death.

First, in the supine position, the suprascapular nerve was dissected and identified above the clavicle (within the posterior cervical triangle) from its origin in the upper trunk of the brachial plexus distal to the suprascapular notch (Fig. 2). For 2 specimens (the mean age for this group was 72 years [range 65–78 years]), the nerve was first split into 2 equally sized fascicles from the notch proximally to the origin of the nerve from the upper trunk of the brachial plexus. This nerve-splitting technique was performed prior to transection of the suprascapular nerve to evaluate the efficacy of using only half of this nerve with the notion of maintaining some function of the spinati muscles. Next, the facial nerve was localized at its emergence onto the face from the stylomastoid foramen. The superficial lobe of the parotid gland was divided, and branches of the facial nerve were then dissected distally onto the face (Fig. 2). A subcutaneous tunnel was created with long hemostats, and the distally transected or split suprascapular nerve was brought superiorly to the ipsilateral extracranial facial nerve at its exit from the stylomastoid foramen and also to its facial branches (for example, the temporofacial and cervicofacial parts) (Fig. 3). Measurements were made of the length and diameter of the suprascapular nerve available for mobilization to the more proximally located facial nerve. Additionally, the length of the neck in all cadaveric specimens was measured from the angle of the mandible to the superior edge of the clavicle. Nerve connections remained tensionless with left and right head rotation of up to 45°. None of the cadavers exhibited any evidence of gross disease, previous surgical procedures, or traumatic lesions to the neck or face. All measurements were made with calipers. Statistical analysis was performed using the Student t-test (SPSS 8.0 for Windows), and significance was set at p < 0.05.

Results

All specimens were found to have a suprascapular nerve that, once transected at the suprascapular notch, easily reached superiorly to the extracranial facial nerve. The mean length of the suprascapular nerve available (from the origin at the upper trunk to the suprascapular notch) was 12.5 cm (range 11.5–14 cm). The mean diameter of the nerve was 3 mm (range 2–4 mm). The length of the necks for all cadavers ranged from 12–13.5 cm (mean 13 cm). Body habitus in these cadaveric specimens was not an issue regarding either the dissection or technical aspect of the study. In all specimens, the suprascapular nerve reached...
tension free to the facial nerve stem as it exited the stylomastoid foramen and the more distal temporofacial and cervicofacial trunks of this nerve (Figs. 2 and 3). For enough length to reach the facial nerve on the face, 2 specimens required teasing of the suprascapular nerve fascial attachment to the upper trunk, which provided an additional 2 cm of length. This additional 2 cm allowed the nerve anastomosis superiorly to remain tension free with head rotation. The nerve-splitting technique was easily performed in the 2 cadavers. No gross evidence of injury to surrounding neurovascular structures was identified. No statistical differences were noted between sides, ages, or sex of the cadaveric specimens (p > 0.05).

Discussion

With the exception of primary neurorrhaphy, currently used techniques for facial reanimation have produced less than optimum results. The most desirable repair is a tension-free primary reanastomosis, in which the injured facial nerve is reapproximated after traumatic injury. Unfortunately, this repair is not always possible, especially if the section of the destroyed facial nerve is of significant length to create a nerve gap, leaving a grafting neurorrhaphy as the only remaining option. Both sensory and motor nerves have been used to repair traumatic motor nerve injury, resulting in a give-and-take scenario. Intuitively, a motor nerve graft would be ideal for the reinnervation of a motor nerve, yet 1 motor deficit would simultaneously be created on the repair of another. On the other hand, the trade off of slight sensory dysfunction on restoration of motor function, as is the case when repairing a motor nerve using a sensory nerve, seems ideal. However, autologous nerve grafting has failed to produce impressive restoration of function, especially in the elderly and in individuals with a history of neck irradiation. For example, the great auricular nerve is the preferred sensory nerve used in facial nerve reconstruction. Experiments in histomorphometric rat models have demonstrated robust nerve regeneration through both motor and mixed nerve grafts. In contrast, poor nerve regeneration has been seen through sensory nerve grafts, with significantly decreased nerve fiber counts and nerve density compared with mixed and motor groups. These data suggest that the use of motor or mixed nerve grafts, rather than sensory nerve grafts, will optimize regeneration across mixed nerve defects.

Currently, the hypoglossal nerve is the most common motor nerve used in facial nerve reconstruction. In a retrospective study, Malik et al. compared the outcomes achieved using 3 procedures typically performed for reanimation of the paralyzed face. Of the 28 patients who underwent classic faciohypoglossal transposition, only 7 (25%) were described as having a favorable outcome (House–Brackmann grade of ≤ 3 at 24 months). Complete transection of the hypoglossal nerve produces ipsilateral paralysis and hemitongue atrophy, which interferes with mastication, speech, and deglutition. Lifchez et al. have mentioned their dissatisfaction with using the hypoglossal nerve as the primary donor nerve for facial reanimation because of uncontrolled facial movements that occur with tongue movement. Adour et al. have reported muscle spasms associated with eating or motion of the shoulder after using the hypoglossal and spinal accessory nerves, respectively, for facial nerve reanimation. The major disadvantage of these
techniques is that they require the sacrifice of an intact cranial nerve, which too often results in functional loss. The consequences of sacrificing cranial nerve XII can become exacerbated when the facial nerve does not recover function on that side, as well as with patients with other coexisting neuropathies. For example, in patients receiving treatment for a malignant parotid gland tumor with invasive metastases to Level II–V lymph nodes, a radical neck dissection may be warranted in which the vagus nerve is destroyed. In this scenario, if repair of an iatrogenic facial nerve injury with the hypoglossal nerve results in movement dysfunction of the tongue, coupled with partial loss of intrinsic muscles of swallowing due to sacrifice of the ipsilateral vagus and further complicated by infrahyoid strap muscle dysfunction due to sacrifice of the ansa cervicalis, then a significant swallowing deficit would be unavoidable. In elderly individuals and/or patients treated with adjuvant external-beam radiotherapy to the neck, this swallowing deficit would increase the risk of additional sequelae such as aspiration pneumonia.

The suprascapular nerve is an attractive substitute for such nerve graft procedures for several reasons. First, by splitting the suprascapular nerve longitudinally and performing a partial suprascapular–facial anastomosis, it may be possible to restore facial function without creating a new functionally significant deficit. Second, if a trade off of functionality is necessary, loss of rotator cuff musculature would be likely to produce fewer functional consequences than those seen with hypoglossal sacrifice, particularly as relates to speech and swallowing. Furthermore, the suprascapular nerve is a motor branch of the brachial plexus supplying the supra- and infraspinous muscles; it does not normally have a cutaneous distribution. The supraspinous muscle assists the deltoid muscle in raising the arm from the side of the trunk, and the infraspinous muscle aids the teres minor to externally rotate the head of the humerus.12 Thus, complete sacrifice of the suprascapular nerve would result in minor weakness on the first 10 degrees of arm abduction. This weakness would most likely be overcome by accessory muscle hypertrophy with physical rehabilitation, resulting in minimal dysfunction. The suprascapular nerve is easily accessible and of a comparable caliber to the extracranial parts of the facial nerve. According to Asaoka et al.,2 the number of myelinated axons in the facial nerve at its point of exit through the stylomastoid foramen was found to be 7228. Similarly, Pruksakorn et al.10 reported the mean number of myelinated axons of the suprascapular nerve at its origin off of the brachial plexus to be 6004. This comparable size allows the suprascapular nerve to be used in both a split-nerve anastomosis as well as a direct suprascapular–facial nerve anastomosis. The smaller split suprascapular nerve as also performed in our study would provide a good size match for the distal branches of the facial nerve on the face, such as the cervicofacial trunk.

Conclusions
To our knowledge, the use of the suprascapular nerve for facial nerve reanimation has not previously been explored. Based on the results of our cadaveric study, the use of the suprascapular nerve may be considered by the surgeon for facial nerve reanimation procedures. Of note, the nerve-splitting procedure used in some of our specimens was also easily performed and would decrease the morbidity associated with complete transection of the suprascapular nerve.

References

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