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Invited review article

Primary facial reanimation in head and neck cancer

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ABSTRACT

Facial Paralysis (FP) profoundly impairs the life of individuals, both functionally and psychosocially. Surgical approaches to treat this condition are myriad, but the ultimate goal is to restore symmetry and movement. Ablative surgery for tumors of the head and neck region are amongst the most common etiologies causing FP and this group of patients represents unique challenges. Surgical defects may have multiple competing reconstructive requirements and addressing the FP must be considered in this context. Furthermore, extent of disease, patient age, duration of preceding paralysis, adjuvant treatment, as well as the various different type of facial nerve defects are factors that may influence the type of reconstructive technique selected to address the FP.

The complexity of FP especially following head and neck ablation can lead to results that are inconsistent and humbling. FP defects can be broadly described as having the potential for facial muscle recovery versus irreversible paralysis. Literature that specifically focuses on primary facial reanimation procedures in the oncological setting is scarce. We present a comprehensive review of primary facial reanimation after ablative surgery including the descriptions of a wide array of surgical techniques such as reinnervation, dynamic muscle transposition, static suspension, and free tissue transfer. Understanding the advantages and limitations of the different options will enable the surgeon to offer treatment for the paralyzed face for most clinical scenarios.

Introduction

Facial paralysis (FP) carries profound implications for those afflicted. Apart from the devastating functional impairments, facial nerve paralysis disrupts the innate connection between mimetic muscles and emotions. This can create a barrier to social interactions leading to a decline in quality of life [1].

Ablative surgery of the parotid gland, temporal bone and lateral face are amongst the most common etiologies of facial nerve injury [2]. Post-surgical deficits causing FP range from simple transection of the main trunk or peripheral branches to resection of the entire facial nerve or distal muscle units.

There are several goals for reconstruction of the paralyzed face including restoration of brow position, eyelid function, nasal valve patency and voluntary smile [3], all while trying to reduce synkinesis. Ultimately, restoring facial symmetry with spontaneous movement is the overarching endpoint that the reconstructive surgeon aims to achieve.

In this article, we will focus mainly on primary reconstruction to address the paralyzed face immediately following ablative surgery. The most common options and insights on the underlying physiology will be discussed, with a comment of our preferred approach. To conclude, pictorial examples of clinical cases will help to illustrate the key aspects of the manuscript.

The surgical management of the paralyzed face is extremely heterogeneous and often individual surgeon dependent. A multitude of different surgical techniques have been described and studies attempting to compare techniques have been problematic. Describing a common systematic approach remains elusive perhaps due to the vast number of options, non-standardized rehabilitation methods, variable or conflicting results reported, and the absence of prospective comparative clinical trials. Furthermore, the application of several different grading scales has made comparisons difficult. A recent systematic review determined the Sunnybrook Facial Grading Scale [4] to be most useful as it met several criteria including less inter and intra-observer variability, reproducibility, symmetry assessment, and sensitivity to track changes after interventions.

For this present review, a MEDLINE (Pubmed) search was conducted using the following MeSH terms: [“Facial Paralysis” AND (“Diagnosis” OR “Treatment” OR “Therapy” OR “Physiology”)], [“Facial Nerve” AND (“Regeneration” OR “Transfer” OR “Transplantation”)]. The authors identified articles that predominantly

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focused on primary facial reanimation in the oncologic setting and comparative studies between different surgical techniques. Certain publications regarding non-post ablative FP were considered for inclusion if a thorough explanation of a novel technique or a technique that would be applicable for immediate reanimation after an ablative defect were outlined. The literature search identified no prospective randomized clinical studies. Excluding a few systematic reviews, the highest level of evidence reached were retrospective comparative studies (Level III). The majority of the articles included in this present review were retrospective case series (Level IV). Relevant animal studies exploring physiologic aspects of nerve regeneration were also considered.

Discussion

Primary reconstruction of FP following ablative surgery may be categorized into the following clinical situations:

(1) Immediate management of the eye
(2) Potential for facial muscle recovery
  a. Direct facial nerve repair techniques
  b. Distal facial nerve powered by another motor nerve
(3) Irreversible facial paralysis
  a. Procedures to address the eye
  b. Procedures to address the midface and smile

(1) Immediate management of the eye

It is of utmost importance to ensure that the eye is protected from dryness and corneal exposure when the upper face is paralyzed. This is imperative in both patients who have irreversible FP and during the course of facial nerve recovery. FP can lead to progressive lagophthalmos, ectropion, corneal exposure and abrasion, and blindness in rare circumstances [5]. Therefore, corneal protection should be a primary initial goal of FP treatment. Judicious use of lubrication, artificial tears, and tarsorraphies are essential in the immediate post-operative period even if facial recovery is anticipated [6] or to delay the definitive reconstruction to a later date in cases of irreversible FP [7,8].

(2) Potential for facial muscle recovery
a. Direct facial nerve repair techniques

If the facial nerve is transected and the distal and proximal ends can be approximated, a direct tension-free repair of the transected nerve should be performed without delay [9,10]. Wallerian degeneration begins within 24–36 h of the injury in the axon stump distal to the site of the lesion. The axonal frame disintegrates, myelin sheath degrades and macrophages and Schwann Cells clear the degradation products. The regenerating axonal nerve sprouts from the proximal stump and can grow at a rate of approximately 1 mm per day. Direct repair enables the axonal growth across the site of injury to eventually reach the neuromuscular junction [11].

The complex vascular plexus that nourishes peripheral nerves is highly sensitive to excessive tension. One study demonstrated that an induced 8% elongation of the nerve caused a 46% decrease in perfusion [12]. Appreciating this physiology reinforces the concept that a tension-free repair must be achieved in order to obtain optimal results [13]. Epineural neurorrhaphy is widely applied as a coaptation technique. There is no clinical evidence demonstrating superiority between different techniques but animal studies have shown that epineural anastomosis caused fewer neuromas compared with interfascicular nerve repair [14]. Perhaps the most important technical consideration is to prevent epineural tissue from intruding between the endoneurium of the proximal and distal stumps [15–17].

An autologous interposition nerve graft is required when faced with a gap in nerve continuity [18]. Cadaveric studies have described numerous nerve donor sites and its features and selection may depend on the other reconstructive requirements of a given situation. The Sural Nerve has been used most often because of its generous length (grafts up to 40 cm) and an average of 8.1 fascicles in the distal portion [19]. Another popular option, depending on the length required, is the Great Auricular Nerve because of its proximity, low donor site morbidity, excellent size match with the Facial Nerve and an average of five nerve fascicles [20,21]. The Motor Nerve to the Vastus Lateralis has been used by some surgeons, especially when the anterolateral thigh free flap was required for large post ablative soft tissue defects. The multi-branching pattern (4.4 primary nerve branches with 2.3 subsequent secondary branches) may be useful where several branches may need to be grafted. It rivals the Sural Nerve length and avoids sensory deficits associated with a separate Sural or Medial Antebrachial Cutaneous Nerve harvest [22].

It seems reasonable to polarize the nerve graft in the same functional direction so that fewer axons are lost in branching. However a recent systematic review of animal studies showed that outcomes were not affected by nerve graft directionality [23]. It has been postulated that restoring motor nerve integrity using a donor motor nerve may have physiologic advantages over sensory nerve grafts. Animal studies observed more robust nerve regeneration with motor in comparison with sensory nerves [24,25]. However to our knowledge there have been no clinical studies favoring motor over sensory nerve grafts [26].

For most limited and even extensive defects of the facial nerve mobilization of the distal and proximal stumps may be possible to achieve a tension-free single neurorrhaphy [27]. A retrospective comparison between 56 autologous nerve grafts and 34 direct end-to-end anastomosis, showed that voluntary movement and facial reinnervation were better while synkinesis was less when a single neurorrhaphy after facial nerve mobilization was done as compared to nerve grafts [28].

Clinically, there are several parameters that have been shown to be predictive of outcome and may be considered when selecting a reconstructive option. The duration of pre-existing FP has been shown to impact outcomes. In a retrospective series of 155 patients, Ozmen et al. found that the duration of facial dysfunction and pre-operative paralysis were significant factors that affected nerve recovery. They reported that patients with a preoperative deficit lasting less than 6 months experienced more postoperative House-Brackmann grades III and IV than those with a preoperative deficit lasting more than 6 months after facial nerve graft procedures [10]. The same time line threshold has been defined in cases of post-operative facial dysfunction where the nerve was known to be intact. In another retrospective experience of 281 patients with facial dysfunction after Vestibular Schwannoma resections, better outcomes have been observed after performing dynamic reanimation procedures within 6 months post-operatively if no spontaneous improvements were detected [29]. Patient age has also been shown to predict successful nerve recovery. Negative correlations between age and nerve axonal load have been described in cadaveric studies [30]. Clinical studies have shown that patients younger than 60 years old were more likely to have better outcomes following interposition grafting than patients older than 60 [31–33]. Postoperative radiotherapy is often perceived as an important factor. However there is controversy whether radiotherapy affects nerve graft outcomes. Although time to recovery may be different, one study by Brown et al. demonstrated similar final results in radiated and non-radiated patients [32].

We acknowledge that nerve repair that enables activity of the existing normal facial musculature offers the best chance to achieve symmetry both at rest and with movement, and when feasible it is our preferred reconstructive method. Nevertheless, synkinesis is the anticipated consequence following any nerve repair technique and is a limitation even after direct facial nerve repair. The traditional explanation of synkinesis is the result of anarchic growth of axons and aberrant innervation across the site of injury, causing muscle hypertonicity and unwanted movement. Injuries that cause irreversible damage to both axons and supporting surrounding structures such as the