THE NEW TONGUE

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Rehabilitation of major resections of the tongue has always posed a serious problem. This paper presents the feasibility and rationale of rehabilitating partial glossectomies by the use of the pectoralis major myocutaneous flap and the fabrication of a "new tongue" by the use of this flap.The criteria for these techniques in benign and malignant tumors of the tongue are outlined. The segmental innervation of the pectoralis major muscle from a variety of three to five nerve branches permits the development of a skin-muscle flap that may be transposed with its nerve supply intact or totally denervated, depending upon the status of the hypoglossal nerves and tongue in the operative field. This presents the possibility of transposing a skin-muscle flap into a glossal wound with a completely intact nerve supply where the new flap is under constant instruction in its new physiologic environment. It also presents the possibility of neurotization of the denervated section of the muscle flap by axones from the intact segment of tongue. A third possibility is the fabrication of a "new tongue" by the transfer of the hypo glossal nerves into the denervated segment of the peripheral aspect of the myocutaneous flap. This variety and combi-nation of rehabilitative techniques introduces a new phase into the rehabilitation of the tongue

The tounge is the most essential organ in the oral cavity. It is responsible for moving the blous for food or liquid through the oral cavity into the mesopharynx. It assists in molding and beautifying the human voice. It is essentially a mass of highly specialized muscle, covered with epithelium, nourished by a rich blood suplly through the lingual arteries, and contains the sensibilities of taste and contact. Although the tounge has an astounding capacity for adaption after injury or resection, there are well-recognized circumstances that may cause severe crippling. Its physiologic essentiality is matched by a strong emotional interest on the part of the surgeon in preserving its integrity. There are criteria that support the operationg of partial nd total glossectomy, and this paper will deal with this problem and propose a new method of rehabilitation.

Submitted for publication Sept 22, 1981.

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Presented at the 1981 Annual Meeting of the American Academy of Otolaryngology - Head and Neck Surgery, New Orleans, Sept 20-24.

CRITERIA FOR SURGICAL TREATMENT

The surgical treatment of advanced malignant tumors of the tongue requires combined management, often including gross subtotal or total glossectomy. Deeply infiltrative T3 and T4 neoplasms fall into this category. The majority of the large tumors of the tongue, however, also involve adjacent tissue such as the mandible, larynx, tonsillar area, pharynx (Fig 1), and sometimes the skin of the neck orchin. This understandably adds to the complexity of the surgical management and the deficit. Many tumors that would fall into this category have been treated with irradiation or minor surgical procedures without success. The seriousness of proceeding on any patient with this problem is well recognized.

There are also certain benign tumors that may satisfy the criteria for gross subtotal or total glossectomy. These occur primarily in children and appear as massive hemangiomas, lymphangiomas, and cystic hygromas. These tumors often extend into the mandible, neck, face, and lips. They interfere with swallowing, speaking, and aesthetic appearance. Many of these children have gastrostomies and tracheostomies at an early age. It is recognized that a large percentage of these tumors will partially or totally resolve spon-

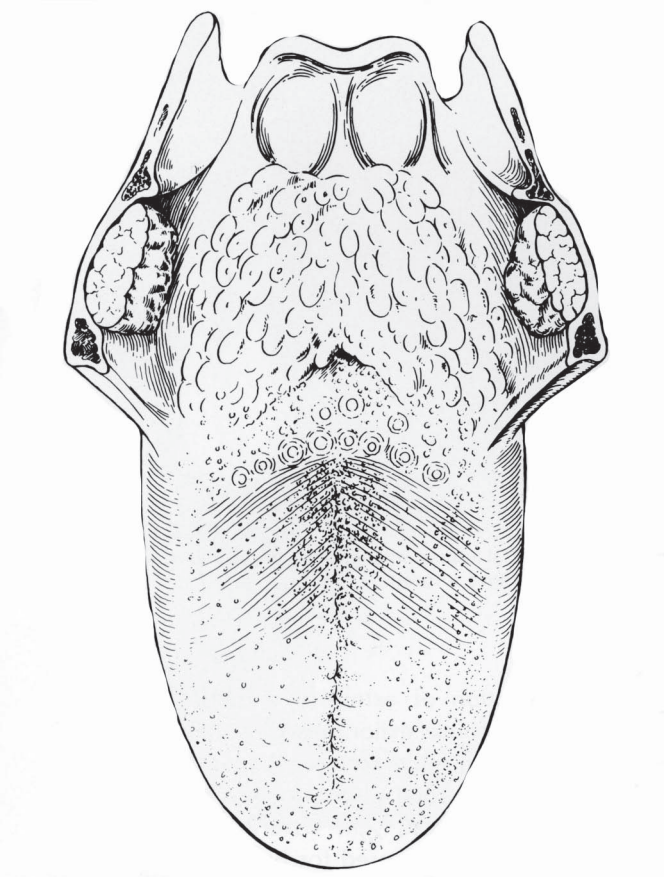

Figure 1. Anatomy of tongue is contingent with floor of mouth, mandible, tonsil, pharnx, and larynx

taneously over a period of two or three years. Some of these tumors will respond to conservative medical management, and some will respond to multiple minor surgical interventions. Some become asymptomatic and require no treatment. A small percentage of tumors in the tongue, however, will continue to grow, bleed, become ulcerated, distort the face and mandible, and establish the constant need for tracheostomy and gastrostomy. It is this latter group that may qualify for the operation of subtotal or total glossectomy with immediate rehabilitation

ASSESSMENT

It is well recognized that the chance for cure of an extensive cancer of the tongue and its associated regional tissues is very small. Even with a well organized combined therapeutic program of surgery, irradiation, and chemotherapy, one should not expect a success rate of more than 10% or 20%.

It may be possible, however, to effectively palliate many of these advanced cases of cancer of the tongue. The burden of their cancer is usually associated with severe pain, bleeding, foul ulceration, coughing, aspiration, and trismus. Most of these symptoms can be reduced or eliminated by a well planned massive palliative procedure with immediate rehabilitation. The decision to go ahead under these circumstances is indeed a profound and soul searching experience on the part of the responsible surgeon and the patient. It is essential to have a clear understanding with the patient and the family group as to what is to be attempted, how it will be carried out, what may hopefully be accomplished, and the serious risks entailed.

The assessment of massive benign tumors in children must be initiated with a trial period of several years of so called conservative types of treatment. The surgeon should certainly wait for the possibility of spontaneous regression. He should also wait until such measures as the use of steroids, sclerosing agents, compression, embolization, and even irradiation have been evaluated. In certain instances it is more appropriate to plan a series of limited small operations, attempting to perform a gross subtotal resection of the neoplasm and still maintain a degree of functional activity of the organ. This may require five separate operations, which can certainly accomplish the removal of a portion of the gross tumor. Whether it will resolve the problem would remain to be seen.

It is well recognized that benign tumors of this nature in children usually involve adjacent organs such as the mandible, face, lips, and neck, and the treatment of the neoplasm in the surrounding tissue is often a more delicate and unsatisfactory experience than the treatment of the neoplasm in the tongue itself. There is an axiom for the treatment of massive benign tumors in children that the surgical intervention should not cause more deficiency or inconvenience than the tumor itself. This axiom has led, rationally, to a strong position of conservatism. There are tumors, however, that do not behave in a rational way, and conservatism under these circumstances may be harmful. These criteria would identify an exception to this rule and support a more adequate operation with immediate rehabilitation. If however, a definite chance of improvement by radical surgical treatment is not well recognized, then extreme caution must be observed. It is essential that all of the details relating to the surgical enterprise in children be revealed to the parents and their complete cooperation and endorsement he strongly expressed.

HISTORICAL DEVELOPMENT

Operations on the tongue were first carried out as a method of punishment for prisoners, religious martyrs, and for certain crimes. The majority of early surgical interventions for lesions of the tongue ended in disaster. Severe bleeding, asphyxiation, and functional disability in speaking and swallowing understandably made operations on the tongue unpopular. There was a stigma attached to this type of operation creating a negative emotional attitude among patients and physicians, which delayed the proper organization and development of formalized surgical intervention. Over the past century, however, a variety of successful techniques have evolved for the resection of all or part of the tongue.

It has become evident through experience that operations on the anterior surface of the tongue can cause serious functional disability when the residuum of the tongue is immobilized by suturing it directly to the rim of the mandible or the lower lip. It also became obvious that resection of the lateral portion of the tongue created serious dysfunction when the residuum of the tongue was immobilized by suturing it to the lateral horizontal ramus of the mandible, thus restricting its movement. The patient who had this portion of the mandible removed in the ablative technique and had the residuum of the tongue sutured to the soft and supple portion of the cheek had much less disability. It was also recognized that there was a serious impediment created when a large portion of the base of the tongue was resected, thus eliminating the pushing action of the tongue. This was, of course, compounded when there was a lysis of the ipsilateral or bilateral hypoglossal nerves. When these operations on the tongue were combined with adjacent soft tissue, including the anterior portion of the mandible, the lateral neck larynx, and pharynx, the serious functional and aesthetic effects were compounded.

The rehabilitative techniques in operations on the tongue consist primarily of direct approximation (Fig 2). There are circumstances where tongue flaps and skin flaps may facilitate residual activity of that organ. Larger defects in the tongue have been rehabilitated by regional cutaneous flaps from the cervical area, upper chest, and forehead (Fig 3).[1-3] The use of these regional flaps was a significant advance in the management of the rehabilitation of extensive wounds in the oral cavity. The pectoralis major musculocutaneous flap has proved to be an additional rehabilitative advance in gross subtotal or total glossectomy (Fig 4). This flap creates augmentation, skin covering, and muscular movement; it may be used for hypoglossal crossover and can be fabricated to resemble a tongue. There are no reports on the previous use of this flap for this type of rehabilitation.

ANATOMY

The anatomy of the pectoralis major muscle has been well described [4-9] It is a triangular shaped muscle covering the anterior superior thorax. It is composed of a clavicular portion arising from the medial half of the clavicle. This section blends with the sternocostal component originating from the anterior sternal surface, the first through the seventh costal cartilages, and the aponeurosis of the external abdominis oblique. Both segments insert into the inter tubercular sulcus of the humerus in such a fashion that the sternocostal fibers he posteriorly to those originating from the clavicle.

The dominant vascular supply is via the pectoral branch of the thoracoacromial artery which, in turn, arises from the second division of the axillary artery. Adjunctive supply is from the lateral thoracic and the pectoral branches of the intercostals. Freeman et all' utilized contrast media cannulated into cadaver specimens to document a rich vascular anastomosis between all the above mentioned arteries that course within the fascial envelope of the muscle on its deep surface.

The medial (C8, T1) and lateral (C5, 6, 7) pectoral nerves innervate the pectoralis major muscle. The lateral pectoral nerve arises from the lateral cord of the brachial plexus, pierces the clavipectoral fascia, and is distributed on the deep surface of the muscle. The medial pectoral nerve, designated such from its origin on the medial cord of the brachial plexus and not from its topography on the pectoralis muscle, first pierces the pectoralis minor muscle, sending eventually two to three branches to the pectoralis major, either directly or coursing inferiorly or laterally. [4-9] There is considerable variation in the nerve supply, ranging from three to five nerves, and these should be identified by electrical testing to determine the branches that supply the tip of the muscle, as this is the section that will be used to augment or form the new tongue (Fig 5).

TONGUE REHABILITATION

Because of the neuromuscular anatomy of the pectoralis major flap, the surgeon has three options for rehabilitation of the tongue (Fig 6). The segmental innervation of the pectoralis major muscle from a variety of three to five nerve branches permits the development of a totally denervated skin muscle flap or one that is partially or regionally denervated. These variations have specific advantages in rehabilitating a wound or muscular organ structure.

In the total reconstruction of the tongue, the ideal situation is the anastomosis of the proximal segment of the hypoglossal nerve to the distal neuromuscular segment of the skin-muscle flap. There are obvious variations and limitations to this technique. The hypoglossal nerve may not be available, or it's stump may be foreshortened. The nerve to the muscle segment in the tip of the flap usually accompanies the principal vascular bundle, but there are variations. The optimal nerve segment is selected by electrical testing. No single nerve segment entering the pectoralis major muscle matches the hypoglossal nerve in volume, number of fascicles, or axones. The nerves in the pectoralis major muscle are always long and thin. This discrepancy in size understandably detracts from the efficiency of the neural anastomosis. This can be compensated for to a slight degree by implanting the extra fascicles of the hypoglossal nerve directly into the muscular substance at the tip of the flap (Fig 7 through 9).

Neurotization of this muscular flap by an intact segment of tongue in gross subtotal glossectomy is another method of tongue rehabilitation. This physiologic facility is the principle of reinnervation of a well nourished denervated muscle by a well-nourished muscle with a functional neural system. For this technique to have maximum effectiveness, both muscles should have an adequate and independent blood supply, the donor or living muscle should be effectively interdigitated into the host or denervated muscle, and the process should be preferably carried out at the time of the primary ablative technique. This neurotization of the pectoralis major muscle requires that it be denervated at the time of transfer by the lysis of its multiple nerve supply, thus making it receptive for the budding axones in the residuum of the tongue. The carrying out of these principles creates a maximum opportunity for neurotization to occur. Its functional result is, obviously, limited (Fig 10)

A third option for the rehabilitation of either partial or total glossectomy is to transfer the pectoralis major muscle flap into the glossal wound with its principal nerve supply to the tip intact. The introduction of this autonomous muscle segment will produce some movement of this portion of the flap in its new implanted bed. Although this movement is controlled by the nerves from the cervical and thoracic segments, there is a perpetual instruction from any remaining elements of the tongue in partial glossectomy, and from the pharyngeal sphincters in total glossectomy, in the physiology of swallowing. This creates an adaptation of this portion of the flap to participate as efficiently as it can in the swallowing act. The mechanism of these adaptations eventually becomes subliminal as it is integrated into the conscious and unconscious physiology program with a synergistic effect (Fig 11). These techniques are certainly preferable to an inert flap. The movement in the tongue and flap can be documented by electromyographic tests, and that is the subject of a subsequent paper.

SUMMARY

The development of rehabilitation of the tongue is detailed, from direct approximation to the use of a kinetically activated myocutaneous flap. This flap has been used (1) by hypoglossal cross over, (2) by on lay technique, and (3) with its nerve supply intact. There is improvement of function in all gross subtotal and total resections of the tongue.

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