RESULTS OF FACIO-HYPOGLOSSAL ANASTOMOSIS IN THE TREATMENT OF FACIAL PARALYSIS*

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SURGERY of the facial nerve may be required for the restoration of function when the nerve is paralyzed from trauma or disease[1] and to reduce or abolish function when the muscles it supplies are involved in severe spasm. In a paper[2] before this Association in 1936, attention was called to the paroxysmal disturbance of function characteristic of surgical diseases of the cranial nerves. In addition to the facial, other cranial nerves showing explosive disturbance of function are the fifth and ninth in intractable neuralgia, the eighth in Ménière's disease, and the eleventh in spasmodic torticollis. Destructive operation upon the affected nerve is required for the relief of these conditions. Operation upon the facial nerve is resorted to in a large majority of cases to restore function, and in this respect surgery of the facial nerve differs from that of other cranial nerves in which the operation is always destructive.

The deformity caused by severe facial paralysis is too familiar to require description but an analysis of the components of this deformity may be of some interest. The most conspicuous and embarrassing feature of the deformity of unilateral facial paralysis arises from displacement of the mouth by unopposed contraction of the muscles of the healthy side, whereas the alteration of facial appearance caused by paralysis of other muscle groups, such as those of the upper lip, eyelids and brow, is not exaggerated by the activity of the muscles on the normal side (Fig. 1). From loss of function of the mandibular branch of the nerve there is not only sagging and deviation of the lips when the face is in repose but emotional expression on the healthy side draws the mouth out of alinement and suddenly produces a marked increase in the deformity. From observation of patients upon whom section of the upper branches of the nerve had been performed for the relief of facial spasm or in cases of accidental division of these branches, we have been greatly impressed with the slight facial deformity resulting from loss of action in the muscles of the upper part of the face when balance of the mouth is retained by action of the lower branch of the nerve (Figs. 2 and 3). There may be sagging of the lower eyelid from loss of innervation to the orbicularis oculi but this is not a conspicuous deformity and may be greatly improved by external canthoplasty.

Decompression of the nerve in the bony canal, direct suture and nerve

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graft have been enthusiastically advocated for lesions in or peripheral to the bony canal and these reconstructive operations will probably supersede anastomosis when the location of the lesion is favorable for such procedures.[3] In my observation of the results of suture and graft of the trunk of the facial nerve I have been impressed with the failure of these operations to restore emotional expression or to prevent mass movements of the face. The development of mass movements of the face and the permanent loss of normal emotional expression after nerve graft or suture are due to defective regeneration of the nerve. Following severe paralysis, regeneration of the facial nerve, whether spontaneous or aided by suture or graft, proceeds with some disorder of the regenerating fibers and with deflection of the new fibers from the course they normally follow. Ford and Woodhall,[4] in a very interesting paper, have discussed the effects of misdirection of regenerating nerve fibers upon the subsequent action of the facial muscles. After section or a severe degenerative lesion of the nerve, new fibers from that part of the nerve normally intended for one group of muscles may penetrate every muscle group within the facial domain, thus preventing the isolated action of individual muscle groups so essential to emotional expression. The result is that when the patient attempts to close the eye, the muscles about the mouth contract and efforts at expression by action of the muscles about the mouth are accompanied by associated contraction of the orbicularis oculi. While it is possible in operation for direct suture to preserve the nerve pattern in a gross way, straying and deflection of the new fibers cannot be prevented. This phenomenon of faulty regeneration fully explains the failure of any surgical procedure to restore normal movements of the face and emotional expression after severe lesions of the trunk of the nerve. The situation is altogether different after successful repair of one or more peripheral branches of the facial nerve. In such cases the misdirection of fibers of the regenerating nerve would affect only the group of muscles normally supplied by that branch of the nerve and would not mar facial ex-

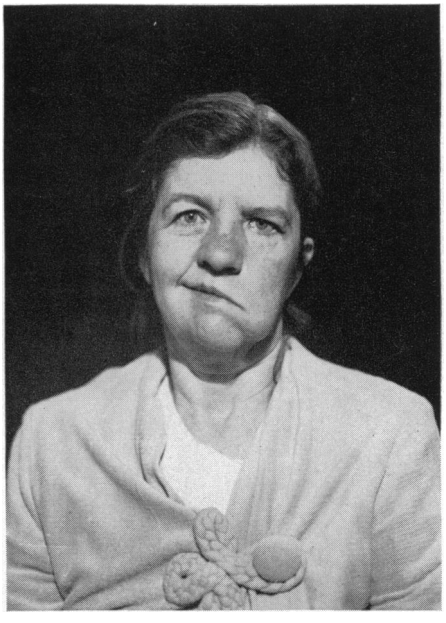

FIG. 1.—Facial paralysis with marked atrophy and deformity following complete removal of a left acoustic neuroma two years previously. Patient's general and neurologic condition excellent with exception of facial paralysis. Typical deformity of complete facial paralysis when atrophy of the muscles has taken place. No response to galvanic stimulation on affected side. Anastomosis not indicated. Operation for support of the face by fascial strips after Brown's method, November 9, 1939, with immediate improvement in patient's appearance. Operation too recent for postoperative photographs. Photograph used to illustrate severe progressive deformity when innervation of facial muscles is permanently destroyed.

pression. The results of suture of important branches of the nerve are highly successful from every standpoint.

While several surgical procedures are in common use for the relief of deformity resulting from severe facial paralysis, anastomosis of the facial with another motor cranial nerve is the only procedure which will restore innervation to the paralyzed facial muscles following an intracranial lesion of

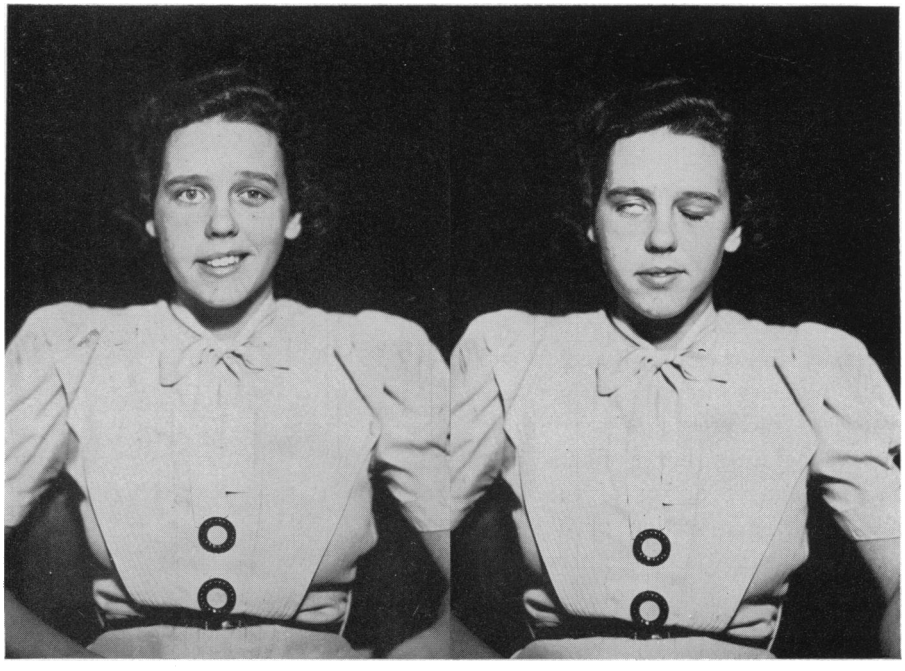

FIG. 2.—Paralysis of the upper branches of the facial nerve caused by a glass wound in the parotid region. As is usual in such cases, the mandibular branch of the nerve escaped injury. Photograph illustrates the important part played by the mandibular branch of the nerve in the preservation of facial symmetry. Even in smiling, the mouth is fairly well balanced although there is slight droop of the upper lip. Some widening of the palpebral fissure is shown. Suture of the individual branches of the nerve, November 2, 1939, two months after injury. Evidence of returning function expected in about three and one-half months after operation.

FIG. 3.—Patient shown in Fig. 2, showing inability to close eye on the affected side. If it is impossible to repair the branches of the nerve to the muscles about the eye, considerable improvement may be obtained from canthoplasty.

the nerve. There can be no adequate substitute for anastomosis in such cases. Intracranial injuries of the facial nerve formerly were rare but now are frequently seen due to the increasing number of operations for cerebellopontine angle tumor, with destruction of the facial nerve by complete removal of the tumor and its capsule (Figs. 4, 5 and 6).

When anastomosis is required for innervation of the paralyzed facial musculature we have preferred the hypoglossal to the spinal accessory because of its functional similarity to the facial. Facio-hypoglossal anastomosis will restore movement to the paralyzed muscles in practically every case, will

balance the face in repose and prevent atrophy of the muscles on the affected side. These results fully justify this type of surgical procedure for the improvement of a deformity which without operation becomes progressively worse (Figs. 7, 8, 9 and 10). Function of the muscle groups cannot be individualized after facio-hypoglossal anastomosis, and when the patient responds to emotional stimuli the expression of emotion is registered only on the healthy side. Smiling is accompanied by slight deviation of the mouth to the normal side due to delayed action and weakness of the muscles about the mouth on the affected side. Frontalis action has been recovered in only one case in our series after hypoglossal anastomosis. The loquacious patient is the most unfavorable type for facio-hypoglossal anastomosis, and in such patients the spinal accessory might be used. There is a marked difference in the activity of patients' tongues, not only with respect to talking but also when swallowing. Associated movements of the face are produced by action of the tongue after hypoglossal anastomosis. In some patients in whom the movements of the tongue during swallowing or talking are very active, there are exaggerated contractions of the muscles about the eye and lips, giving the patient in an extreme case a grotesque expression. Success of anastomosis operations depends to a great extent upon the patient himself.

FIG. 4.—Complete left facial paralysis following total removal of an acoustic neuroma. There was also injury to the left trigeminal nerve. The lids have been sutured to protect the eye. Left facio-hypoglossal anastomosis, March 8, 1937, to relieve the paralysis.

Results of facio-hypoglossal anastomosis compare favorably with those of suture or graft of the nerve trunk, but anastomosis requires the sacrifice of another cranial nerve and if the hypoglossal is used it necessitates control of the movements of the tongue to minimize associated movements. Atrophy of the tongue caused by section of the hypoglossal appears to be of no important significance and causes no appreciable interference with speech or deglutition (Figs. 11, 12 and 13).

Much has been said about reeducation of the patient who recovers function of the muscles following operation for facial paralysis. It is difficult to understand how such reeducation could be very successful when directed only to improvement of action of the previously paralyzed muscles. Accepting the experimental evidence of regeneration of the nerve and the phenomena of deflection of axis cylinders from normal pathways, one can readily appreciate

the obstacles to reeducation. With misdirection and deflection of regenerating axis cylinders the entire facial musculature on the affected side is made a single functional unit and the facial muscles move *en masse*. It seems impossible for reeducation, under such circumstances, to effect materially a dissociation of action of various muscle groups. In some cases efforts at reeducation may result in increasing the patient's deformity by bringing about overactivity of the affected side, causing grimaces which may become habitual. We believe that much more can be accomplished in improving the results of operation by instructing the patient to suppress facial movements and

FIG. 5.—Photograph of the patient in Figure 4, 21 months after anastomosis. Recovery of motion in all muscle groups except the frontalis and platysma. No deformity is evident when the face is in repose.

FIG. 6.—Photograph of the patient shown in Figures 4 and 5, shown closing the eyes with little associated movement. Atrophy of the muscles of mastication caused by injury to the trigeminal nerve when the tumor was removed.

emotional expression on the normal side. Suppression of facial movements should become a fixed habit.

The residual effects of facial paralysis after maximum recovery of function following anastomosis operations, obviously, will vary in importance according to the patient's occupation, age, sex and social position. One must give serious consideration to the unavoidable destruction of the facial nerve in operations for the complete removal of acoustic tumors. The patient should be fully informed before operation is undertaken that complete removal of an angle tumor is almost inevitably followed by facial paralysis and he is entitled to know in detail the features of such paralysis. In only one case have we been able to completely remove an acoustic neuroma without destroying the facial nerve (Figs. 14 and 15). Facial paralysis is a small sacrifice to make

for the assurance of permanent eradication of an acoustic neuroma as a primary procedure especially when one reflects that operations for recurrence of these tumors following incomplete removal are highly dangerous and may be impossible. The argument for a more conservative type of operation for acoustic neuroma is strengthened in certain cases by the fact that the tumor is a benign one, and after complete enucleation of the tumor with almost complete removal of the capsule, recurrence probably would not take place for a great many years.

FIG. 7.—Results of facio-hypoglossal anastomosis for relief of facial paralysis following complete removal of a left acoustic neuroma. Tumor symptoms completely relieved by operation and the patient is actively engaged in his work. Photograph shows the face in repose. The mouth is well balanced, there is little difference in the width of the palpebral fissures and very slight alteration of the patient's facial appearance. Photograph two years after anastomosis.

FIG. 8.—Photograph of the patient in Figure 7, showing limitation of emotional expression with some weakness of the left side of the mouth. The functional results of the operation in this case were highly satisfactory.

When there is residual paralysis or incomplete recovery of important muscle groups the patient's appearance may be improved by supporting the face with fascial strips, as described by Brown,[5] in 1938; and stabilizing the paralyzed side in this manner is the only operation that will improve the deformity when the facial muscles have lost galvanic response or when there is extensive destruction of peripheral branches of the nerve. In many cases the combination of nerve anastomosis and fascial support gives the best results, and we believe this combination of surgical procedures should be employed more frequently.

Facio-hypoglossal anastomosis is an operation of little difficulty and negligible risk. An incision is made extending from the tip of the mastoid process downward, following a crease in the neck about 2 cm. beneath the mandible, extending in the direction of the thyroid cartilage (Fig. 16). The hypoglossal nerve is first isolated at the level of the cornu of the hyoid bone and traced backward to where it curves around the occipital artery, but it is not sectioned until the facial trunk has been identified and divided. Exposure of the facial nerve in the digastric fossa is accomplished very easily by retracting

FIG. 9.—Photograph of the patient in Figures 7 and 8, showing mass movements of the face on the left side when efforts are made to forcibly retract the angle of the mouth on that side. No evidence of frontalis function.

FIG. 10.—Photograph of the patient in Figures 7, 8 and 9, showing closing of the eyes, which is accompanied by movements of the muscles about the mouth. Photograph one year after anastomosis.

the digastric muscle downward and following the digastric branch of the facial upward to the trunk. Section of the facial trunk is made as close as possible to the stylomastoid foramen. The branches to both the stylohyoid and the digastric muscles are sacrificed but the resulting paralysis is apparently not of great importance, although it may account for some difficulty in swallowing. After division of the facial the peripheral stump is pulled downward and placed in a suitable position for suture. The hypoglossal is then sectioned sufficiently close to the tongue to permit the central segment to be approximated with the trunk of the facial without tension (Fig. 17). This requires section of the thyrohyoid branch of the hypoglossal and in some cases it is impossible to approximate the ends of the two nerves satisfactorily without freeing the descendens hypoglossi from the main trunk of the nerve. Anas-

FIG. 11.—Marked facial paralysis produced by section of the nerve for the cure of left facial spasm. Section with immediate suture of the upper branches of the nerve had produced temporary relief of the spasm with recurrence. Facio-hypoglossal anastomosis for relief of the paralysis.

FIG. 12.—Photograph of the patient shown in Figure 11, two and one-half years after facio-hypoglossal anastomosis. Very little deformity with face in repose. There was no return of function of the frontalis muscle but the corrugator on the affected side is active.

FIG. 13.—Photograph of the patient in Figures 11 and 12, shown attempting to smile. There is some lagging of the angle of the mouth on the left side and slight widening of the palpebral fissure. The patient's facial expression was normally vivacious and good effects of the operation were somewhat marred by associated movements, particularly those about the eye.

tomosis should be performed carefully, with accurate approximation of the nerve sheath and without projection of nerve fibers between the sutures. Three arterial sutures are sufficient to unite the nerves. In some cases we have sutured the proximal end of the descendens hypoglossi to the peripheral end of the hypoglossal trunk. Atrophy of the tongue following this procedure has developed in every case except one, showing that attempts to preserve the

FIG. 14. FIG. 15.

FIGS. 14 and 15.—Photographs of the patient after recovery from facial paralysis caused by removal of a large left acoustic tumor and its capsule. The intracranial portion of the nerve was greatly lengthened and it was protected during the operation. There was a temporary facial paralysis lasting about six months. The patient was bedridden for some time before operation and was unconscious when admitted to the hospital. She made a complete recovery from tumor symptoms with the resumption of full duties as a school teacher. Photograph three years after removal of tumor. No evidence of impaired facial expression.

trophic supply to the tongue are generally futile. The junction of the anastomosed nerves should be covered by the digastric muscle which is retracted downward during the operation.

The first evidence of returning function of the nerve following anastomosis is improved tone in the paralyzed muscles and the restoration of balance of the mouth. In about three and one-half months feeble movements appear about the angle of the mouth and spread upward to the eye muscles which show definite contraction in about six months. During the stage of paralysis the sagging face should be supported by adhesive strips and the muscle tone preserved as much as possible by facial massage. The maximum improvement is reached after about two years.

Regardless of the type of surgical procedure employed for the relief of complete facial paralysis, one must be impressed with the fact that the maximum recovery following all operations leaves much to be desired, and that the patient's facial appearance is never restored to normal. Facio-hypoglossal anastomosis for the relief of paralysis following intracranial lesions of the nerve will balance the face in repose, restore movement of the paralyzed muscles, and prevent further disfigurement resulting from atrophy of the muscles.

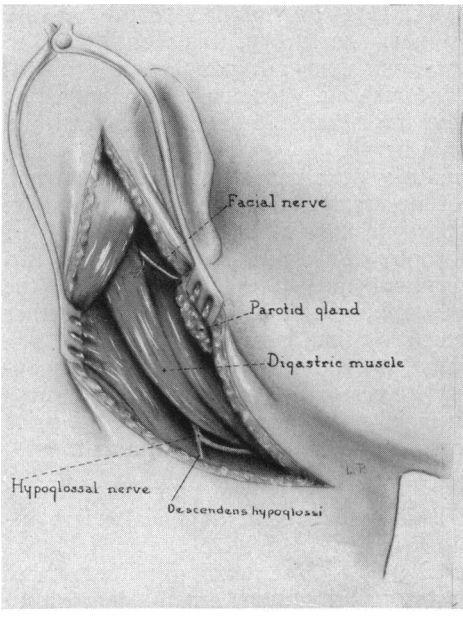

FIG. 16.—Drawing showing exposure for right facio-hypoglossal anastomosis. The sternomastoid muscle is retracted backward. The hypoglossal and the facial nerves are shown. By retracting the digastric muscle downward and backward, a small branch of the facial nerve to this muscle can usually be found. Tracing this branch backward leads to the trunk of the nerve.

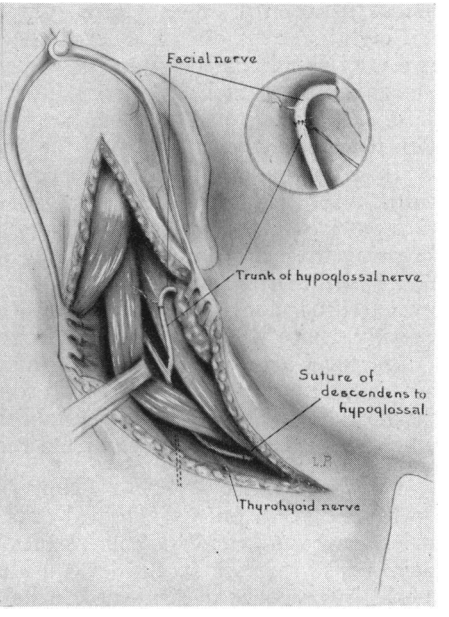

FIG. 17.—Drawing showing the hypoglossal trunk divided and anastomosed to the peripheral trunk of the facial. The thyrohyoid branch is sacrificed in mobilizing the nerve for suture. The dotted lines show the course of the descendens hypoglossi which has been sutured into the peripheral segment of the hypoglossal nerve. (Redrawn from Facial Spasm. ANNALS OF SURGERY, May, 1937.)

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DISCUSSION.—DR. CHARLES BAGLEY, JR. (Baltimore, Md.): Doctor Coleman has presented to us, under the title of "Facial Nerve Surgery," a very interesting group of patients after removal of acoustic nerve tumors. He has done this in his usual modest fashion, with no effort to call attention to the difficulties encountered in the removal of this type of tumor further than to mention the necessary destruction of the facial nerve in the majority of cases. Any tumor in the cerebellar pontine angle is rather inaccessible, so that the operation presents many mechanical difficulties. The actual incorporation of the seventh and eighth nerves in the tumor mass forces one to choose between a subtotal removal or total loss of function of the seventh and eighth nerves on the side of the tumor. In theory, this would seem to be a very simple choice. On the contrary, one always dreads to face a patient whose complete facial paralysis is of his making. Doctor Coleman has, in these cases, attempted to give the patient the advantage of total removal and then to restore the function of the facial nerve.

In this type of paralysis, where one knows the nerve has been destroyed, waiting for spontaneous return is not necessary. Doctor Coleman's plan of repairing the nerve at the earliest possible moment has the advantage of restoring the nerve before damaging atrophy of tissue has advanced too far. The functional results shown by his patients are quite satisfactory at the present time, and, as some of these operations have been performed rather recently, there will be greater improvement as time goes on.

Doctor Coleman is to be congratulated on the very excellent results obtained in a number of patients with complete removal of acoustic nerve tumors in whom he has been able to reestablish facial nerve function so that the price which they have paid for complete removal will ultimately be minimal.

DR. JOSEPH E. J. KING (New York, N. Y.): I want to congratulate Doctor Coleman on his splendid paper, his management of facial nerve injuries in general, and his fine results in this series. I have always felt that facial nerve injuries should be considered under three headings: First, those in which the nerve is destroyed in its intracranial course; second, that group in which the nerve is injured or destroyed in its course through the temporal bone; and third, those where the injury has occurred in the peripheral portion of the nerve. Therefore, the operation of choice for restoration of the nerve will depend upon the level or point where the nerve is destroyed.

Most of the cases which have come under my observation were those in which the injury was associated with mastoid disease or following mastoidectomy. All of these I have referred to Dr. Thomas Tickle for nerve graft. I have done this for three reasons—he has obtained very good results with his cases, there is no scar on the neck, and there is no associated hemiparalysis and atrophy of the tongue.

In those cases in which intracranial destruction has taken place, a graft is out of the question, and in such cases the anastomosis described by Doctor Coleman is naturally the procedure of choice. In cases in which the damage to the nerve is in the peripheral portion, and suture cannot be accomplished, one must resort to fascial strips.

DR. FRANK H. LAHEY (Boston, Mass.): I am sure that this is no place for the general surgeon to enter into a discussion of nerve anastomosis—in our clinic this is the field of the neurosurgeon. On the other hand, I think if we have differences of opinion regarding choice of nerves, we should state them. I have had many opportunities of viewing end-results following injury to hypoglossal nerves, and I am impressed with this as an undesirable situation.

Doctors Poppen and Horrax feel the same way, and, therefore, I may say we prefer to use the spinal accessory nerve. Doctor Poppen has performed most of these operations and, although the functional result has been excellent, the spinal accessory nerve has been chosen in 19 cases and the hypoglossal in one. I have had several cases in which the hypoglossal nerve has been involved in malignancy and its sacrifice has been required. It must be that there is a variation in the degree of dysfunction following paralysis of the hypoglossal nerve. Certainly, in some of my surgical cases I have thought it undesirable to have patients talk with a thick speech and to have difficulty with mastication. You have to question yourself—will you choose to sacrifice the function which has to do with speech and swallowing, or the one which has to do with the last 90 degrees of abduction of the arm; which is the function taken away when the spinal accessory is used in the anastomosis? The last 90 degrees of motion is accomplished by scapular rotation through the accessory innervated trapezius. We have felt that it is better for the patient to lose this last 90 degrees of arm abduction than to have difficulty with speech and swallowing. That may be only a difference of opinion but it has been the conclusion of Doctors Horrax, Poppen and myself.

DR. VILRAY P. BLAIR (St. Louis, Mo.): The most striking feature of this contribution is Doctor Coleman's analysis of the functional results of nerve anastomosis—and that might have something to do with the choice of the repair method. Whether we like the fascial strips or not, most of ours are performed in that way because most of the cases we see are either too old to offer hope of restoring muscle action or the nerve injury has been of small filaments in the parotid gland, and it is practically impossible to make an anastomosis in these. If the fascial strip operation is performed carefully, an almost perfect restoration of the quiescent face will result. Many have tried to obtain muscular motion by turning down a piece of the masseter muscle, but I have never been sufficiently impressed with the procedure to try it. Brown's real contribution was not trying to turn down a piece of muscle which might slough or sclerose but his procedure is to extend the fascia far enough to allow attachment to the undisturbed muscle, which is, I think, the difference between success and probable failure.

DR. CLAUDE C. COLEMAN (Richmond, Va.) closing: I want to thank Doctors Bagley, King, Blair, and Lahey for their part in the discussion. I agree with Doctor King that nerve graft may be used as a substitute for anastomosis whenever the lesion is favorably situated. Nerve grafts for lesions in the facial canal will not be followed by associated movements but they do not prevent mass movements, and I have never seen a nerve graft restore emotional expression.

In facio-hypoglossal anastomosis, movements of the face are initiated by moving the tongue. Unless action of the tongue is repressed, associated movements of the muscles about the eye may be troublesome. Anastomosis operations, of course, are much simpler than nerve grafts in the facial canal. A thorough knowledge of the surgical anatomy of the temporal bone is essential to exposure of lesions of the facial nerve in the facial canal.

Doctor Lahey has expressed a preference for the spinal accessory nerve when a cranial nerve must be used to restore innervation to paralyzed muscles of the face. The choice of the nerve to be used has long been a subject of much controversy. As stated in my paper, we have used the hypoglossal because of its closer functional similarity to the facial. However, there are cases in which the spinal accessory may be preferred. We have used the

spinal accessory in only one case, that of an old lady with facial paralysis following complete removal of an acoustic neuroma, who objected to any operation which would affect the nerve of her tongue. The point not being of great importance in her case, we were willing to use the spinal accessory.

From a careful study of patients, both before and after facio-hypoglossal anastomosis, I have not been impressed with any loss of function from sacrifice of the hypoglossal nerve. Voice records have been made of these patients before and after operation, showing no noticeable interference with speech. In complete lesions of the nerve proximal to its exit from the facial canal, function of the digastric, stylohyoid and buccinator is lost. That of the digastric and stylohyoid would be permanently lost regardless of which nerve is used in the anastomosis. It may be that some impairment of the hyoid stabilization has something to do with the speech and it is very probable, too, that the buccinator, like the frontalis, does not recover as completely after nerve graft or anastomosis as other muscle groups. Impairment of function of speech or deglutition, attributed to section of the hypoglossal on one side, might be due in part at least to impairment of function in these three muscles and not to loss of the hypoglossal.

From my observation of section of the spinal accessory as a part of the surgical treatment of spasmodic torticollis, I am inclined to believe that the loss of the hypoglossal is of less importance than that of the spinal accessory. In view of the fact that section of either of these nerves carries no considerable penalty, it would seem that the choice between the hypoglossal and the spinal accessory nerves in anastomosis should not be determined by the loss of function incident to section of the substituting nerve but should depend upon which nerve would bring about better facial movement.