The Histology and Electromyography of Primary Pharyngeal Flaps

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There have been many reports in the literature related to the use of pharyngeal flaps in improving palato-pharyngeal function. Pharyngofixation by means of a pharyngeal flap has had increasing usage, both as a primary and secondary procedure. The Plastic Surgery Clinic in Prague has been performing secondary pharyngeal flaps since World War I and primary flaps since 1924. Speech has been improved with pharyngofixation and our best results have been obtained through the use of superior-based primary flaps. For the past twenty years, we have used superior-based pharyngeal flaps in conjunction with the primary cleft palate repair whether the latter is done in one or two stages.

In order to assess the value of this operation, anatomical, histological and electromyographical studies have been carried out on the pharyngeal flaps at varying time intervals. Our study was limited to an evaluation of the primary pharyngeal flap. All operations were performed within the period from three to six years of age. Secondary flaps were eliminated from the study, since we were concerned that pre-existing scars in the palate may have had an unfavorable influence.

The Technique of Pharyngofixation

The pharyngeal flap was fairly wide in all cases being 15 mm. or more in a child of three years. The full thickness of the muscle was included in the flap. The base of a superior-based flap terminated several millimetres below the upper border of the pharyngeal constrictor in order to preserve blood and nerve supply which is so important to the function of the muscle layer. The donor site of the flap was closed with catgut sutures, and when possible, the muscle and mucous membrane layers were sutured separately. By closing the donor site, there is less risk of secondary hemorrhage and the posterior pharyngeal wall is restored.

The superior-based pharyngeal flap is sutured into the raw nasal surface on the anterior half of the velum created through a retropositioning operation on the palate (Figure 1a and 1b). The residual open portions of

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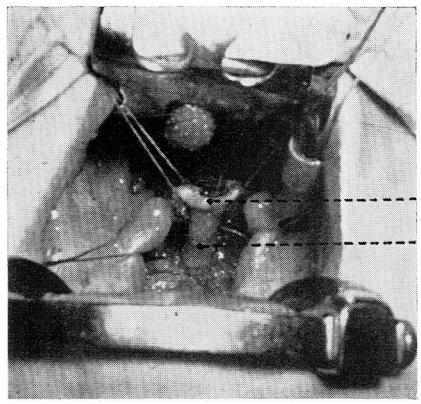

FIGURE 1a. Tubed superior based pharyngeal flap with a widely distended distal part to be sutured into the soft palate.

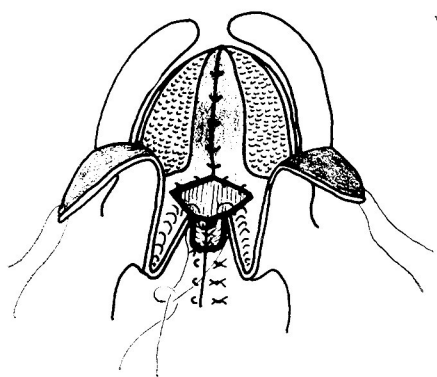

FIGURE 1b. Method of suturing the tubed superior pharyngeal flap to the soft palate.

the flap are closed insofar as possible with nasal mucous membrane. The proximal portion of the flap, which is not lined, is tubed using catgut sutures. It has been our feeling that should the pharyngeal flap separate from the soft palate that it would create a soft tissue prominence on the posterior wall which would assist in obtaining palatopharyngeal closure. The technique for the inferior based flap will not be given, since we have not used it for many years.

Anatomical and Histological Findings

An anatomical and histological investigation of the palatopharyngeal area was carried out on three of our patients. Two patients died several years after primary pharyngofixation and in the third, the pharyngeal flap had to be separated because of its effect on speech. All three of these flaps were superior based with two of the flaps having been open and one closed. In addition, we had an opportunity to biopsy and study five inferior based primary pharyngeal flaps.

CASE NO. 1. This is a report on a patient who had a complete cleft on the left side and who died at twenty years of age of heart disease, sixteen years after hav-

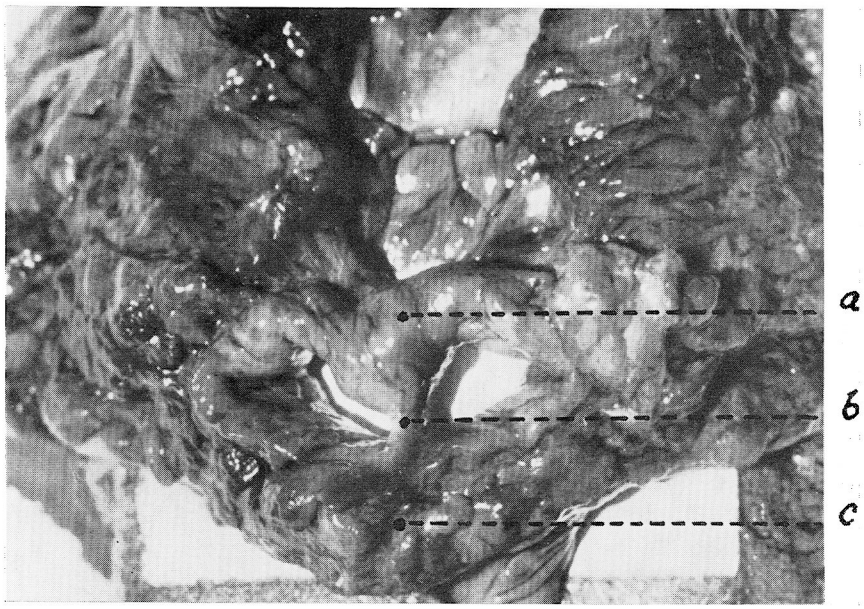

FIGURE 2. Autopsied material consisting of the superior-based flap with its origin and insertion. (a) posterior pharyngeal wall, (b) pharyngeal flap, (c) part of the soft palate situated posteriorly to the insertion of the flap.

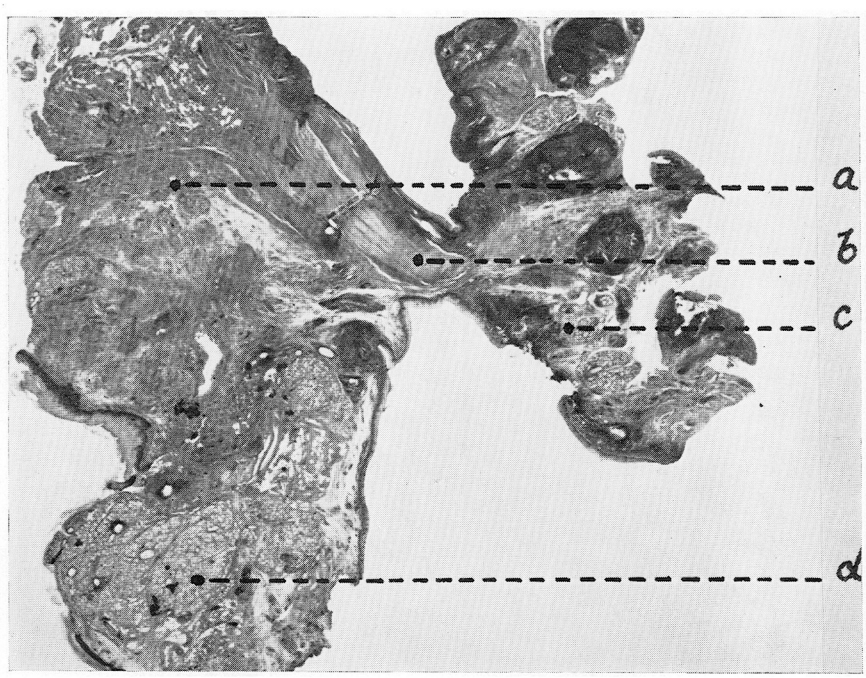

FIGURE 3. Lateral section from the same material. (a) velum, (b) pharyngeal flap, (c) posterior pharyngeal wall, (d) uvula.

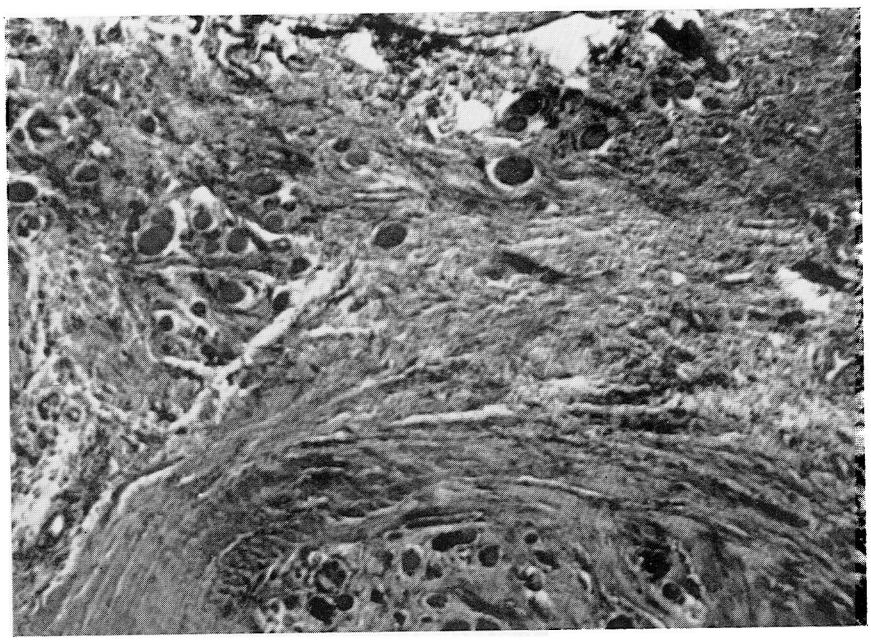

FIGURE 4. Cross section of the scarred anterior part of the pharyngeal flap 2 years after the operation. The individual muscle fibers are atrophied and separated from one another by a large amount of fibrous collagenous connective tissue. Masson's trichromatic method. ×20.

ing a superior-based primary pharyngeal flap at the time of his cleft palate repair. His speech had been quite acceptable. At autopsy, the entire soft palate, pharyngeal flap and adjacent posterior pharyngeal wall were obtained (Figures 2 and 3). It was found that the muscle and the flap had been entirely replaced by scar tissue with only a few muscle fibers remaining at the borders (Figure 4).

CASE No. 2. This is a report on a female, age six, who had a complete bilateral cleft lip and palate and who died from complications from other anomalies two years after having had a primary pharyngeal flap performed at the time of the palate repair. An examination two months before the patient's death revealed the patient to have slight nasality. Cross-sectional examinations of the flap revealed muscle fibers in various quantities. There was evidence of atrophy of the muscles and replacement by fibrous tissue and this was more evident toward the distal flap (Figure 5).

CASE No. 3. This is a report on a boy, age six, who had had a primary pharyngeal flap in which the proximal aspect of the flap had been tubed. Because of denasality, the flap was excised and then examined histologically (Figure 6). The covering of the flap was that of normal pharyngeal mucous membrane. Muscle fibers were present throughout the sections and in the periphery of the submucosal layers, the muscle fibers appeared to be in fairly good condition (Figure 7). Towards the center of the flap there was increasing evidence of atrophy and replacement with fibrous tissue.

Five inferior based flaps were biopsied at varying times from ten to fifteen years following surgery, and in each case muscle fibers were present but showing some signs of atrophy.

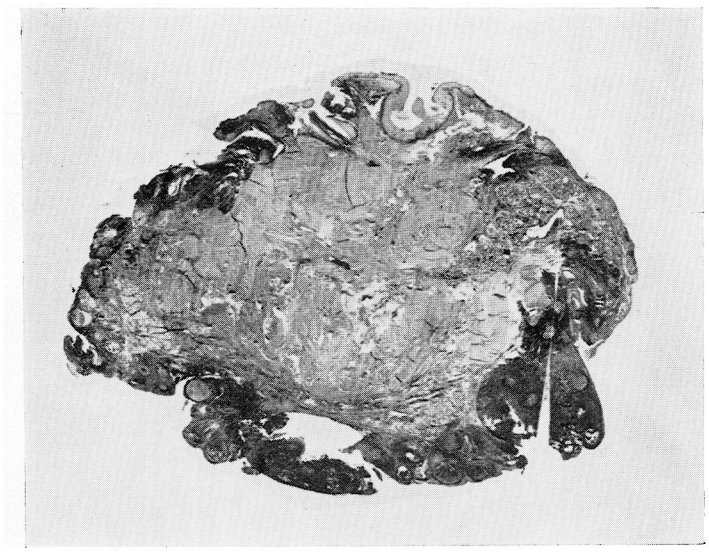

FIGURE 5. Cross section of superior based tubed pharyngeal flap, primarily implanted 2 years previously.

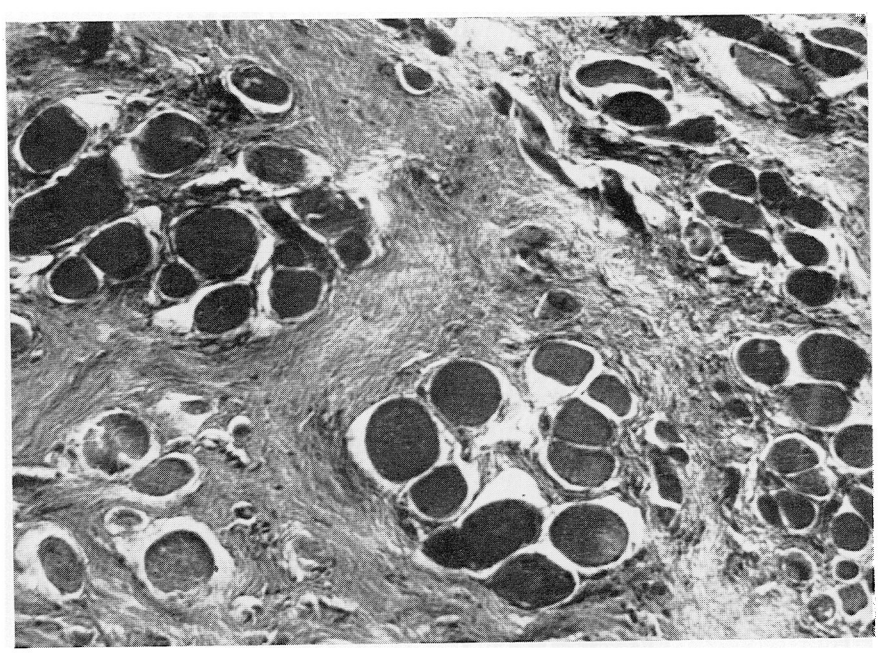

FIGURE 6. Cross-section of pharyngeal flap 2 years after being tubed. The cross-sectioned muscle fibres form small bundles. Some muscle fibres (especially on the right edge of the picture) show signs of atrophy. Masson's trichromatic method. ×35.

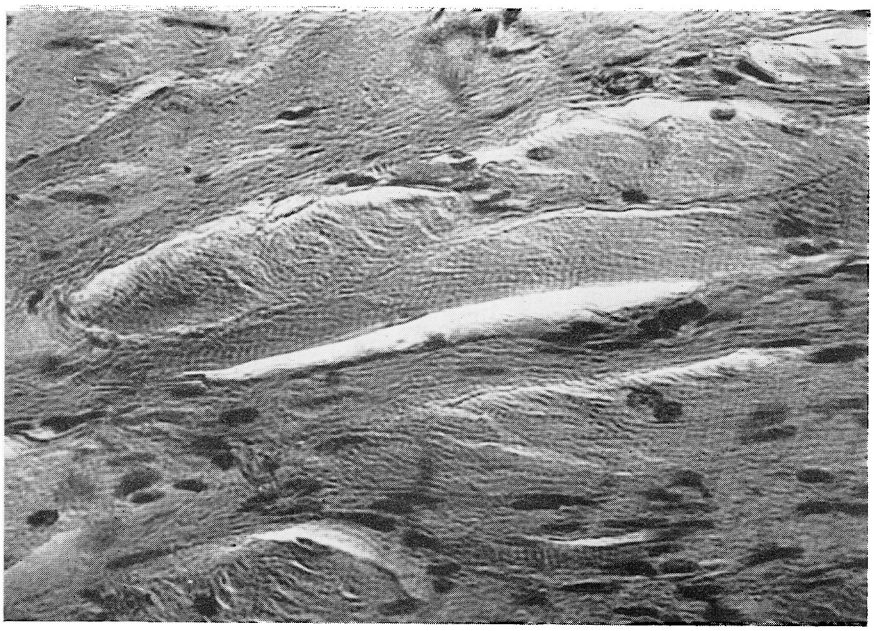

FIGURE 7. Pharyngeal flap 2 years after being tubed. In the peripheral parts close to the mucosa, there are well defined striated muscle fibres with loose collagenous tissue among them. Masson's trichromatic method. ×125.

Electromyography Material and Methods

One hundred fifty-four (154) patients between the ages of three and 47 years who had had primary pharyngeal flap from ten days to 42 years were examined. The EMG "DISA" apparatus was used. Coaxial needle electrodes were employed. The potentials obtained were read on a screen. The examination was tape-recorded. A topical anesthetic spray was used in each case. The electrode was inserted into the center of the flap, into the healed scar in the donor site and 0.5 cm. lateral to the healed scar in the donor site on the posterior pharyngeal wall. The recording was made during the vomiting reflex.

The duration of each individual's spike was assessed and two types were distinguished: a short spike from the immediate vicinity of the electrode and a longer one from a greater distance. The frequency of the spikes were judged according to the follow scale:

0. No activity (state of rest)
1. Only one action potential of equal amplitude
2. Several spikes of different amplitudes which did not interfere
3. Several spikes which interfered occasionally
4. Spikes that interfered frequently
5. All spikes interfered and the zero line disappeared

TABLE 1.

time interval	*activity (%)*			*no. of cases*	*type of flap*	
	strong	*weak*	*none*		*superior*	*inferior*
within 3 weeks.....	45	40	15	20	20	—
within 1 year.....	50	15	35	6	6	—
1–2 years.....	44	22	34	9	9	—
2–3 years.....	35	—	65	7	7	—
3–4 years.....	25	8	67	12	12	—
4–5 years.....	40	18	42	11	9	2
5–10 years.....	34	23	43	22	21	1
10–15 years.....	33	15	52	27	18	9
15–20 years.....	75	17	8	12	2	10
20–30 years.....	45	33	22	19	3	16
30–42 years.....	80	—	20	9	1	8

Results

Of the 154 patients examined, there were only 18 that demonstrated no activity in the pharyngeal flap. In others, the response or activity decreased as the distance from the electrode increased. Table 1 illustrates the response in the immediate vicinity of the electrode in the flap and relation of the time interval after surgery.

There was a strong electrical response during the first year after pharyngeal flap surgery and there was then a steady decrease in the following 15 years. This was felt to be due to atrophy of muscles and fibrous tissue replacement. There was a more persistent and better electrical response in the inferior-based than the superior-based flaps.

Table 2 illustrates the relationship between the electrical response in the flap to the type of flap and the degree of scarring.

There is a direct correlation between the amount of fibrous tissue and the electrical response. In general, superior-based flaps had a greater tendency to form fibrous tissue with a lesser electrical response (Figure 8).

Discussion

There is a direct relationship between the degree of scarring and the electrical activity within the flap. Scar tissue which affects the functional

TABLE 2.

type of flap	*electrical activity (%)*			*amount of scar (%)*		
	strong	*weak*	*none*	*slight*	*medium*	*heavy*
superior based (108 cases).....	38	29	33	38	31	31
inferior based (46 cases).....	73	23	4	75	19	6

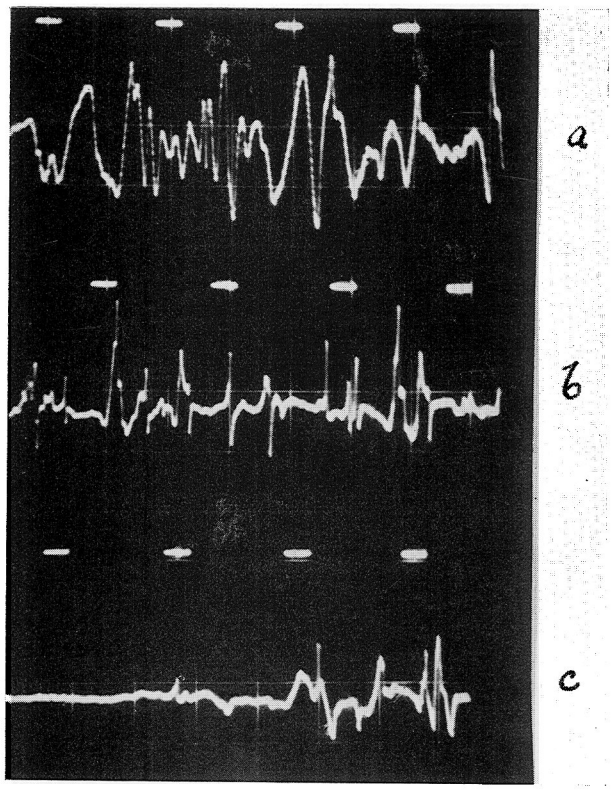

FIGURE 8. Electrical activity in superior-based flaps: (a) strong (L.M., 11 years following the operation); (b) (F.R., 24 years following the operation); (c) several spikes only (M.D., 19 years following the operation).

value of the flap is the result of two factors: first the interference with the nerve and blood supply of the muscle during the preparation of the flap and second, to the healing process, particularly when an open flap heals by second intention. The muscle fibers in an inferior-based flap suffer less injury to their blood and nerve supply and the raw surface is easier to close with mucosal flaps.

Muscle atrophy and the accompanying fibrous replacement with a decrease in the electrical response took place gradually over several years. This coincided with clinical examinations which revealed a heavily-scarred pedicle after several years. The end of the pharyngeal flap attached to the velum maintained better vitality than the pedicle and seemed to become part of the velum, both anatomically and perhaps functionally. The anatomical-histological observations correlated well with the EMG studies.

In our Case No. 1 report previously given, although there were few muscle fibers present after 16 years, the patient's speech remained quite

acceptable. In our Case No. 3, in which the proximal aspect of the flap was tubed, it was observed that there was better preservation of the muscle fibers than in our Case No. 2 where the pedicle was left open to heal by second intention.

It was our opinion that the functional state of the flap did not have a decisive influence on palatopharyngeal closure. The superior-based flap, despite its tendency to undergo fibrosis, provided for superior clinical results to the inferior-based flap. The superior-based flap, due to its position tends to elevate the velum. A speech analysis on 270 patients at five to 25 years interval following surgery has demonstrated that the functional affect of the superior-based flap has been far superior to the inferior-based flap.

Summary

Two autopsies, six biopsies and 154 electromyographies were the basis for a biological assessment of primary pharyngeal flaps, both superior and inferior based. It was determined that the inferior-based flap preserved its muscle content in a better state than did the superior-based flap, the latter demonstrating a greater degree of muscle atrophy and fibrosis. Nevertheless, the superior-based flap provided for far superior dynamic palatopharyngeal closure than did the inferior-based flap provided the patient has a functional nasopharyngeal musculature. Tubing or closing the proximal aspect of the superior-based flap assists somewhat in preservation of the muscle fibers.

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