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Phonosurgery
(Combined Approach Palatopharyngoplasty—CAP)

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PHONOSURGERY has a wide application in otolaryngology, ranging from the correction of nasal speech to the offer of a reasonably good 'tracheo-oesophageal' alaryngeal speech (cf. conventional 'pharyngo-oesophageal' voice) following total laryngectomy (Ghosh *et al.*, 1972; Ghosh, 1973, 1974, 1976a, 1976b, 1977a, 1977b). The basic principles of Phonosurgery are (a) the construction of complete or partial static/dynamic stops in the phonetic passage and (b) the proper channelling of the phonetic stream. The present article deals with the correction of rhinolalia aperta by CAP (Combined Approach Palatopharyngoplasty).

In palatopharyngeal incompetence the spatial disposition of the components in the palatopharyngeal mechanism are disturbed in relation to one another, i.e. intrapalatally and palatopharyngeally. As a result, surgical correction which offers only a competent closing mechanism, viz. the palatopharyngeal isthmus, without simultaneous correction of the distorted spatial dispositions does not lead to the desired improvement in speech. In order to achieve the above a 'Combined Approach Palato-pharyngoplasty' (CAP) comprising (a) Levator palati transplantation and (b) Crossed palatopharyngoplasty (first stage), followed by a 'check-valve' palatopharyngoplasty (second stage) has been resorted to. The quality of speech following CAP is superior to that offered by other existing operations. In CAP three muscular tiers (which would offer the 'stops' referred to above), made of static and dynamic sphincters, are constructed by transplanting the levator palati, palatopharyngeus and superior constrictor muscles to prevent unwanted aspiration upwards of the phonetic stream into the nasal chambers, and to channel the phonetic stream out through the mouth, while uttering non-nasal pressure sounds. This is comparable to and identical with the three-tier protective mechanism of the larynx designed to prevent unwanted aspiration of food downwards into the airway during deglutition. In fact, it is the 'reverse' representation of the laryngeal protective mechanism.

A dynamic muscle transplant operation was devised for palato-pharyngeal incompetence, by Ghosh *et al.* (1972). Subsequently, a statico-dynamic palatopharyngoplasty was evolved for the correction of speech defects and nasal regurgitation in cases of palatopharyngeal incompetence (Ghosh, 1973). Static correction alone is not of any significant help and techniques are excluded from the present study after having unsatisfactory experience with them. Dynamism is quintessential in the speech mechanism

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as it is in any surgical correction for a speech defect. The dynamism is so precise and pre-planned that the articulators assume their respective expected positions a fraction of a second before the actual utterance of the sound. It is to be noted that in the dynamic corrections some amount of static correction does take place at the palatopharyngeal isthmus, thereby helping to bring about better competence. Both the above and Ortichochea's (1970) dynamic muscle sphincter operations bring about an effectively dynamic palatopharyngeal closure which serves the 'vegetative' aspect very efficiently; but more often than not the 'speech' aspect is not rectified to a comparable extent.

The principal types of operations available for the correction of rhinolalia aperta are set out in Table I.

Most of the existing operations are concerned with the palatopharyngeus, salpingopharyngeus and superior constrictor muscles. Often the levator palati is not given the functional importance it deserves. One action of the palatopharyngeus is to pull the palate downwards, virtually opposing the levators. In the statico-dynamic palatopharyngoplasty (Ghosh, 1973) this opposing action has been eliminated to a great extent

TABLE I

PRINCIPAL TYPES OF OPERATION AVAILABLE FOR THE CORRECTION OF RHINOLALIA APERTA

Static corrections

(a) Lengthening of the palate (Dorrance, 1925)
(b) Retropharyngeal implantation of autogenous and exogenous materials (Blocksma, 1962)
(c) Pharyngoplasty (Wardill, 1927).
(d) Pharyngeal flap operations:
  (i) Inferiorly based (Schoenborn, 1872; Rosenthal, 1924)
  (ii) Superiorly based (Sanvenero and Rosselli, 1934)
  (iii) Superiorly based bilateral flaps (Rethi, 1932) and lateral pharyngoplasty (Moore, 1960)
  (iv) Double posterior flaps, one superiorly based and the other inferiorly based (Millard, 1962)
  (v) Palmaris longus transplantation (Inchul and Bomberg, 1974)

Dynamic corrections

(a) Pharyngoplasty by muscle transplantation (Hynes, 1950)
(b) Dynamic muscle transplant operation (Ghosh *et al.*, 1972)

Statico-dynamic concentrations

(a) Dynamic muscle sphincter operation (Ortichochea, 1970)
(b) Statico-dynamic palatopharyngoplasty (Ghosh, 1973)
(c) Transverse palatopharyngoplasty (Ghosh, 1976a)
(d) Levator palati transplantation (Edgerton and Dellon, 1971; Ghosh, 1977a)
(e) Combined Approach Palatopharyngoplasty (CAP) (Ghosh, 1978)

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by dextrous rerouting of the palatopharyngeus and salpingopharyngeus muscle complex. But in Ortichochea's dynamic muscle sphincter operation (1970) this action appears to be accentuated to the extent of producing a sort of restraint band, as mentioned by Weber *et al.* (1970) in connection with Rosenthal's operation. Nevertheless, since it is a dynamic mechanism, it effectively closes the palatopharyngeal sphincter by pulling down the palate and apposing the lateral margins of the new palatopharyngeal isthmus to each other, thus leading to improvement in rhinolalic speech. Closure of the palatopharyngeal sphincter alone is, perhaps, not the answer to the acquisition of ideal speech following corrective procedures. It appears essential to bring the different component parts of the palatopharyngeal mechanism into ideally desirable positions, relative to one another (i.e. intrapalatally and palatopharyngeally), in order to offer a normal or near-normal speech function.

Normally, palatopharyngeal contact during the production of non-nasal pressure sounds is at or above the level of the anterior arch of the atlas, involving the area around the midline. Resonators with different dimensions, capable of constant change, are necessary for the ideal production of different sounds. It appears also that this level of contact helps to create a resonator of particular dimensions, almost specific for the production of non-nasal sounds. It follows therefore that one should strive to obtain contact (or at least elevation) of the palate at about this level, thus bringing about a dynamic constriction of the nasopharyngeal isthmus. This is not fully achieved in existing operations and it may explain the relatively unsatisfactory speech quality often acquired following corrective surgery, even though the palatopharyngeal sphincter closes satisfactorily and effectively prevents nasal regurgitation, if it was present before surgery. This is as though vegetative competence is achieved more than speech competence.

In a series of thirty-five patients who underwent Ortichochea's operation or statico-dynamic palatopharyngoplasty, the speech improved in more than half the cases but some phonetic deficiency remained. The quality of speech was not of the high order that one would expect. With this in mind I resorted to the CAP operation comprising 'levator palati transplantation' (Edgerton and Dellon, 1971; Ghosh, 1977), with 'crossed palatopharyngoplasty', followed after about three months by 'check-valve palatopharyngoplasty' as a second-stage procedure.

The Operative Technique

Stage 1

(a) *Levator palati transplantation:* The patient is induced with a general anaesthesic through a guarded cuffed endotracheal tube and is placed in Rose's position. A Dingman's gag is applied to the mouth. The levator palati muscles are isolated and transplanted posteriorly in the

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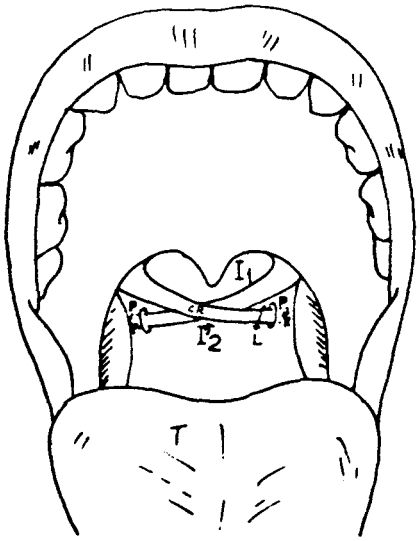


FIG. 1

P = Horizontal retropharyngeal musculofascial pockets. I_1 = Dynamic isthmus. I_2 = Potential isthmus (also dynamic). CR = Crossing. L = Lateral areas (lateral to the crossing). T = Tongue.

region of the uvula and secured with 3/0-chromic catgut, as reported earlier (Ghosh, 1977a).

(b) *Crossed palatopharyngoplasty:* The posterior pillars (palatopharyngeus) are isolated from below, as low as is deemed necessary, to give them adequate length to reach the retropharyngeal musculofascial pocket on the opposite side (vide infra), with their bases situated superiorly at the apex of the tonsillar fossae (Fig. 1). The raw areas resulting from the transplantation of the palatopharyngeus muscles are closed with 3/0 chromic catgut sutures. Two vertical incisions about one centimetre in length are made on each side, in the posterior pharyngeal wall as deep as the prevertebral fascia, half a centimetre medial to the posterior pillars, at the level of the upper third of the tonsillar fossae. Two horizontal retropharyngeal pockets are then constructed (Fig. 1, P) through these incisions, working laterally but not communicating with the raw areas left after isolation of the posterior pillars. These musculofascial pockets are made in front of the prevertebral fascia (i.e. between the fascia and the superior constrictor muscles). The muscular tissue should be handled cautiously lest excessive fibrosis and contracture should result from too much trauma, developing in the wake of healing and thereby reducing the contractility (dynamism) of the transplanted muscle flaps. Hence the flaps are handled with anchoring silk sutures, as mentioned earlier (Ghosh, 1973). Each lower cut end of the pillars is now inserted into the pocket on the opposite side, thus crossing each other (hence the name 'crossed').

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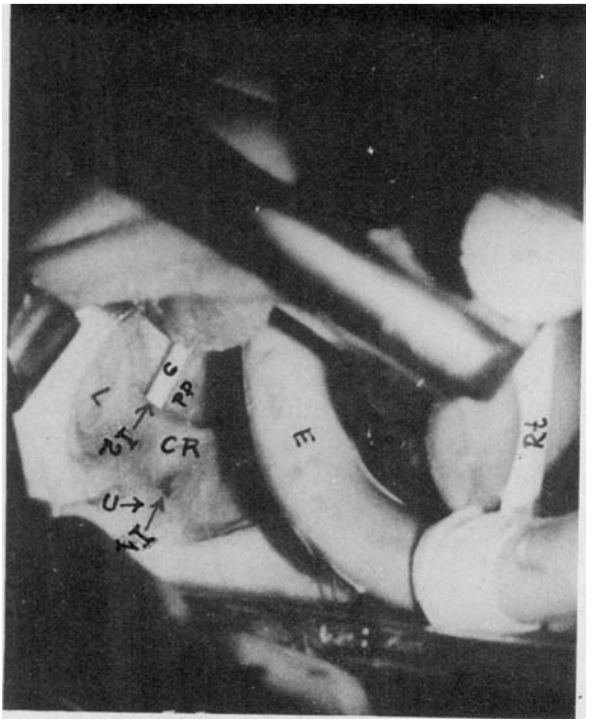
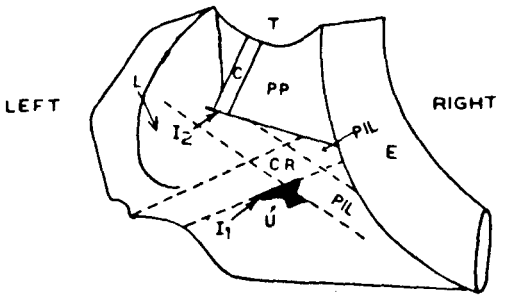


FIG. 2

E = Endotracheal tube, pushed to the right. CR = Crossing. L = Lateral areas, obliterated by fibrosis. P.P. = Posterior pharyngeal wall. U = Uvula. I_1 = Dynamic isthmus. I_2 = Potential isthmus. C = Catheter in I_2. (The photograph taken one month after operation; in Rose's position).



LEGENDS — E = ENDOTRACHEAL TUBE
C = CATHETER I_2 (ISTHMUS$_2$)
CR = CROSSING OF POSTERIOR PILLARS
U = UVULA PIL = POSTERIOR PILLAR
I_1 = ISTHMUS$_1$
L = LATERAL TRIANGULAR AREA
T = TONGUE
PP = POSTERIOR PHARYNGEAL WALL

FIG. 2

(Inset). Diagrammatic representation of Fig. 2.

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The ends are sutured with 3/0 chromic catgut, anchoring them inside the pockets (Fig. 1, P). At this crossing the two flaps are sutured loosely to each other. Two isthmuses are thus constructed (Fig. 1, I_1 and I_2). The triangular areas lateral to the crossing (Fig. 1, L) eventually close by adhesion and fibrosis. I_2 is a potential space and I_1, a dynamic opening, actively opens and closes; it is much smaller than the one present in the dynamic muscle sphincter operation. Fig. 2 (and inset) shows the palatopharyngeal region taken one month after crossed palatopharyngoplasty, showing the isthmuses with a catheter in I_2 and the lateral areas (L in Fig. 1). Postoperatively, intravenous fluids (without saline) are given for two days, followed by oral fluids (e.g. citrated milk) for the next two days. During the intravenous feeding the patient is given sips of sterile water every half to three quarters of an hour to prevent drying of, and crust formation on, the palatal and pharyngeal wounds. Subsequently, soft food is allowed for about a week. After each feed the patient washes his mouth with hydrogen peroxide solution. An antibiotic is administered for ten days, and the patient is discharged a week after the operation. Towards the end of the second week, speech therapy is started and continued for three months. The speech is recorded ten days after the operation, when the oedematous swelling of the palatopharyngeal isthmus has reduced considerably; the recording is repeated after about three months. There has been remarkable improvement in speech during the immediate postoperative period to the extent that the speech becomes denasal in most cases. Gradually the quality of speech deteriorates and the dynamic component starts to play its role (i.e., active contraction of the palatopharyngeal isthmus begins with the gradual disappearance of oedema), leading again to improvement in speech quality some time during the second week, when the first speech recording is made. At this time the denasality disappears.

Stage 2

Check-valve Palatopharyngoplasty: Patients who have undergone the stage 1 operation are evaluated after about three months, and if improvement in the quality of speech is not deemed to be adequate, the second stage procedure is undertaken. The criteria are that (a) the speech should be intelligible to a stranger and (b) its quality should be pleasant and acceptable to the listener.

Operative procedure: under general anaesthesia the patient is placed in Rose's position. A Dingman's gag is applied. Normal saline is infiltrated into the posterior pharyngeal wall below the level of the lateral musculofascial pockets constructed at the time of performing the crossed plasty. A superiorly based flap (Fig. 3, CVF) of the superior constrictor muscle with its pharyngeal aponeurosis, taking almost the whole breadth of the posterior pharyngeal wall, is elevated, its base being situated just below the level of the above-mentioned pockets. The length is adjusted in such a

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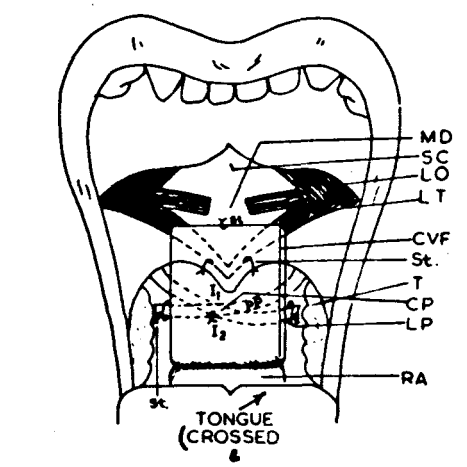


FIG. 3

Diagramatic representation of CAP (Combined Approach Palatopharyngoplasty).

way that the free margin of the flap can be sutured to the soft palate without any tension. The flap is then turned up and stitched to the soft palate after making its oral surface (uvula and surrounding areas) raw and after removing the mucosal lining on the anterior surface of the lower part of the flap (Fig. 3, St). Both the isthmuses (Fig. 3, I_1 and I_2) are well covered by this flap. Since the anterior mucosal surface of the flap is in contact with the mucosa-covered crossed flaps, no adhesions develop between the two; otherwise, the very purpose of constructing a 'check-valve' opening would be nullified as adhesions would lead to the development of a 'stop-valve' mechanism. This would produce a purely 'static' correction rather than a 'dynamic' one. The sole purpose of these procedures is to offer a 'statico-dynamic' palatopharyngeal mechanism which closely resembles the normal one functionally. The postoperative regimen is the same as in the stage 1 procedure. Speech therapy is imparted as after the previous stage.

Observations and Discussion

The combined approach palatopharyngoplasty has been performed in eight cases. In one case the right flap (posterior pillar) necrosed at its lower end and lay loose, floating in the pharynx. One month later a repair was done; but the result was not satisfactory with regard to improvement in speech, presumably due to repeated handling of the flap which resulted in

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FIG. 4
Palatography before operation (Levator palati transplantation).

excessive trauma and associated infection, with undesirable fibrosis and concomitant diminution of dynamism (contractility). There was no problem with the palatal component in this case or in others. In this operation, along with the dynamic closure of the palatopharyngeal isthmus (Fig. 3, I_1), there is shifting of the levator eminence posteriorly and elevation of the major portion of the passive part of the soft palate. The new eminence is situated posterior to the pre-operative one. The post-operative movements of the palate are close to those associated with the normal excursions which occur during the production of non-nasal pressure sounds, in regard both to the level of elevation and to the site of palatopharyngeal contact, viz. about the midline of the posterior pharyngeal wall (Fig. 4 and 4A; pre and postoperative palatograms). In other words, the inactive passive posterior part of the soft palate is exploited and put into action by increasing the effective length of the palate. This elevation reduces the nasopharyngeal cavity by decreasing the vertical dimension which is responsible for the augmentation of the higher overtones that are present in sounds like—sh—and other consonants, hence the clarity of speech is improved.

The smaller the resonating cavity, the greater is the augmentation of the

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FIG. 4A
Palatography after operation (Levator palati transplantation).

higher overtones. Consequently, in this operation, closure of the palato-pharyngeal mechanism takes place at two levels, viz. (a) an upper one at the level of the atlas, brought about by contraction of the transplanted levators in their new positions, about the median palatopharyngeal area, the muscle ends having been stitched to each other in the midline (Figs. 4 and 4A); and (b) a lower one at the level of the upper parts of the posterior pillars, i.e. between the crossing of the pillars and the free margins of the uvula and soft palate (Fig. 3, I_1), which is situated anterior to the posterior pharyngeal wall. Between this dynamic sphincter (I_1) and the posterior pharyngeal wall the potential opening, the second dynamic isthmus (Fig. 3, I_2), intervenes. Though there is a sort of shelf, produced by the crossing of the palatopharyngeal muscle flaps, situated behind the I_1 (i.e. between I_1 and the posterior pharyngeal wall), patients do not complain of any stagnation of nasal secretion at this level, nor of difficulty in clearing the throat. In fact, the nasal secretions drain down through the posterior isthmus, viz. I_2 (Fig. 5, postoperative nasogram). The different specific positions of the component parts of a functional unit (viz. the nasopharyngeal chamber) relative to one another seem indispensable for

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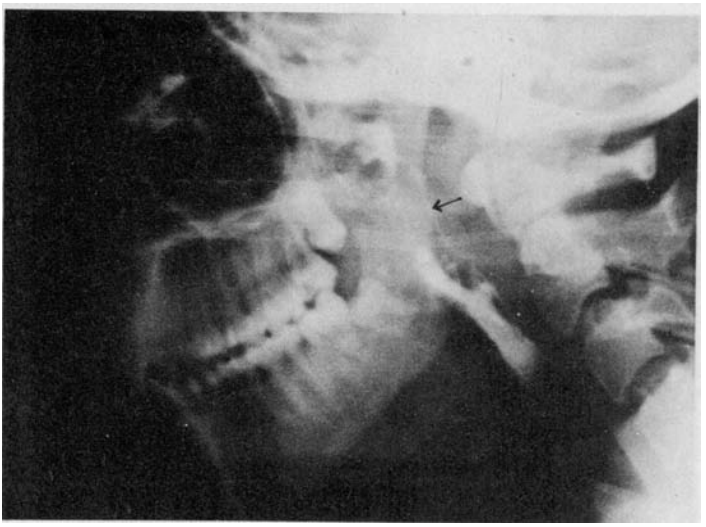


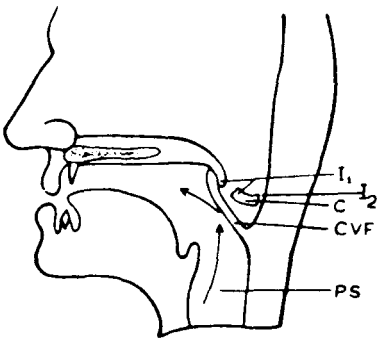
FIG. 5

Postoperative nasogram (same case as in Fig. 2) showing the passage of the dye through the posterior isthmus (I_2).

the production of appropriate sounds. This is achieved almost perfectly in the present operation since the upper closure takes place at the level of the atlas, about the midline, as in physiologic speech. This type of realignment of the componènt parts, bringing about 'intrapalatal' and 'palatopharyngeal' correction of defective dispositions, is not so well achieved in other operations. The muscle diastasis is also adequately corrected (Fig. 3). The 'check-valve' procedure further prevents leakage of the phonetic stream through the newly created palatopharyngeal isthmus (I_1), during the utterance of non-nasal/pressure sounds, without obstructing the flow of respiratory air and nasal secretions (Fig. 6). So, a 'three-tier' protective mechanism has been created by the present operation: (i) the highest one, at the level of the retro-displaced levator eminence (Fig. 4A); (ii) the middle one, at the level of the isthmus (Figs. 3 and 6, I_1); and (iii) at the level of the 'check-valve', at about the junction of the check-valve flap and the posterior pharyngeal wall (Fig. 6). It is a 'reverse' representation of the 'three-tier' laryngeal protective mechanism which prevents the downward aspiration of unwanted material into the tracheo-broncheal tree during deglutition, vis-a-vis the prevention of upward aspiration of the unwanted phonetic stream into the nasopharyngeal and nasal chambers during the utterance of non-nasal pressure sounds. In this case the preventing mechanism stops the unwanted leakage of the phonetic stream upwards into the nose.

It is no wonder that the human phonetic organs can produce enormous varieties of pleasant and unpleasant sounds which, in times of necessity, are easily interchangeable since the component parts are extremely dyn-

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CHECK-VALVE PALATOPHARYNGOPLASTY

I_1 -DYNAMIC SPHINCTER(ISTHMUS)
C -CROSSED FLAPS
CVF-CHECK-VALVE FLAP
PS- PHONETIC STREAM
I_2 - POSTERIOR POTENTIAL SPHINCTER(ISTHMUS)

FIG. 6

Diagrammatic representation of 'Check-valve' palatopharyngoplasty and 'Crossed' palatopharyngoplasty.

amic, being controlled by a very rich and efficient neural mechanism under the overall guidance of the highly developed 'speech-brain', a gift unique to human beings. The factor of 'ideation', a very special function of the 'speech brain' with respect to speech and language, imparts additional efficiency to the already efficient dynamic phonetic chambers. Speech movements of the articulators are distinctly different from the vegetative ones, though they may at times be coincident. The latter are simpler than the former and are dependent on the integrity of the lower brain-stem, whereas the former are dependent on the 'speech brain' (viz. the cortex and centrencephalic system). It has been noted in a number of cases that the articulators and the palate move normally (as is evident clinically and radiologically); but there is nasality in the speech though there is no vegetative dysfunction. This is also evident in a number of cases of dysphasia in which the patient may retain good vegetative function, viz. the movements for eating and drinking, but may lose the speech movements. Apraxia is a well known manifestation of an associated ideational abeyance of the expressive aspect of speech, adversely affecting the highly specialized speech movements of the articulators. Speech is a highly co-ordinated, semi-automatic function of the speech brain and, under normal conditions of speech, the articulators are activated in perfect co-ordination between their component parts with respect to their static (at rest) and dynamic (during speaking) relationships. Therefore, it is inferred that the speech brain can act better on a nasopharyngeal mechanism which is in perfect or near-perfect alignment intrapalatally (as brought about by the transplantation of the levator

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posteriorly) and palatopharyngeally (as brought about by elevation of the palate to the desired level, by new palatopharyngeal contact, by dynamic closure of the newly created isthmus and by the anatomical palatopharyngeal coupling by the check-valve flap). Such a highly specialized function can be carried out only by a mechanism, the functional units of which are in optimum anatomical alignment (spatial disposition); this is brought about by the realignment of units which is achieved by the present procedure. So it is natural that the production of a near-normal spatial realignment amongst the components of the palatopharyngeal mechanism by combined approach palatopharyngoplasty will result in the production of better speech as well as a competent and dynamic sphincter, as has been observed in these patients. It is encouraging to note that there was minimal fibrosis (leading to negligible impairment of the palatal movements) in only one case following such extensive separation of the mucosal layers and manipulation of the levator muscles. All these cases, except the one referred to earlier with flap necrosis, have acquired satisfactory speech. This is a preliminary report and the study continues.

Summary

A new surgical approach (CAP—Combined Approach Palatopharyngoplasty) is described for the correction of speech defects in palatopharyngeal incompetence. In palatopharyngeal incompetence the spatial relationships between the various components of the palatopharyngeal mechanism are disturbed. This combined approach brings about near-normal relationships (viz. intrapalatal and palatopharyngeal), as well as providing a competent palatopharyngeal sphincter, thus offering a remarkable improvement in speech. The operation comprises a two-stage procedure: stage I:—(a) submucosal transplantation of the levator palati muscles posteriorly to the region of the uvula and (b) 'crossed' palatopharyngoplasty; isolation of the palatopharyngeus muscles (posterior pillars) with their bases superiorly placed at their junctions with the soft palate, and transplantation of the lower free ends into the transverse retropharyngeal musculo-fascial pockets on the opposite side, the flaps thus crossing each other in the midline: stage II:—'check-valve' palatopharyngoplasty; elevation of a superiorly based posterior pharyngeal flap with anastomosis to the soft palate. The dynamics which are responsible for the improvement in speech are: (a) elevation of the palate to about the level of the atlas; (b) statico-dynamic constriction of the pharyngeal phonetic passage at the following levels: (i) at the newly placed levator eminence, (ii) at the newly constructed dynamic sphincter situated between the above-mentioned crossing and the free margin of the soft palate, and (iii) at the junction of the check-valve flap with the posterior pharyngeal wall; (c) increase in the effective length of the soft palate. The phonetic stream is prevented from entering the nasal chambers during the utterance of non-nasal pressure sounds by the newly constructed three-tier

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protective mechanism. This is identical with, but a 'reverse' representation of, the normal three-tier protective mechanism of the larynx, which prevents food from entering the tracheo-broncheal tree during deglutition. The operation has been performed in eight cases and the results are satisfactory, in so far as improvement in the quality of speech is better than that observed following other operations. In conclusion, the principles of phonosurgery may well be diagrammatically represented in Fig. 7.

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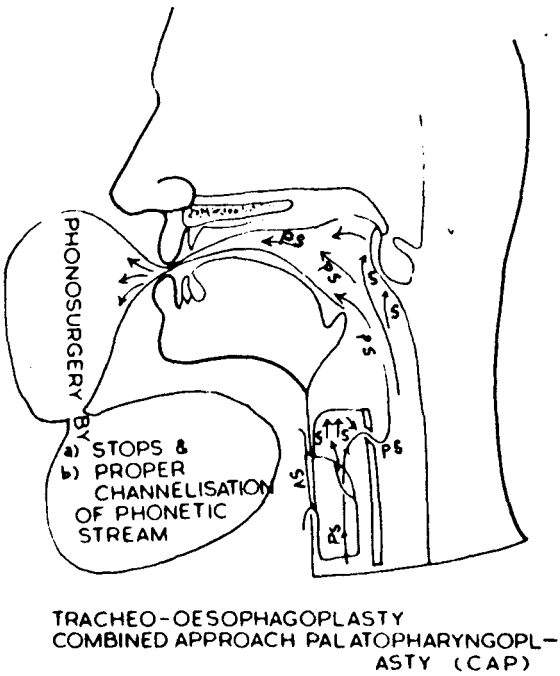


FIG. 7

Diagrammatic representation of the principles of 'Phonosurgery'. S = Stops at the palato-pharyngeal region and at the upper closed end of trachea. P.S. = Phonetic stream properly channelled. S.V. = Speaking valve.

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