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Original Article

# The use of Sanskrit, an ancient language, as a tool to evaluate cleft palate speech problems

**Kalpesh Gajiwala**
Holy Family Hospital and Research Center, Bandra, Mumbai; Ramkrishna Mission Hospital, Khar, Mumbai; Saifee Hospital, Charni Road, Mumbai, Ali Yavar Jung National Institute of Hearing Handicapped (AYJNIHH), Mumbai, India

**Address for correspondence:** Kalpesh Gajiwala, 1st Floor, Navaz Mansion, 25, Shahid Bhagatsingh Road, Mumbai - 400 001, India.
E-mail: gajiwalakalpesh@gmail.com

## ABSTRACT

Speech is a complex process. The evaluation of speech in an individual with cleft palate is difficult, and the existing classification of phonemes is complicated.
Sanskrit, an ancient language, has an arrangement of alphabets that is orderly and scientific and therefore provides a simple means to understand the production of phonemes and memorize them. This article demonstrates the inherent advantage of this arrangement of Sanskrit alphabets to effectively analyze defective cleft palate speech and provides a tool for surgeons to decide a course of action in their routine clinical practice. Improved insight into the speech defect by the surgeon also facilitates better coordination with the speech language pathologist in assessment and treatment of a child with cleft palate.

## KEY WORDS

Cleft palate speech, palatal fistula, phoneme classification, Sanskrit, velopharyngeal incompetence

## INTRODUCTION

A cleft palate is a multidimensional challenge needing a team of experts. A child with a cleft palate may present with any of the following problems: difficulty in feeding, i.e., suckling and regurgitation; defective speech; impaired hearing; dental irregularities; malocclusions and facial deformity due to impaired growth. Repair of a cleft palate requires all of these to be addressed, of which restoring speech and maintaining harmonious facial growth is the most difficult. Surgeons are expected to restore the speech apparatus to normalcy, and parents invariably are anxious to know whether their child will be able to speak normally. To answer that question, nevertheless, it is necessary to understand the mechanism of speech.

Speech is the most essential element of communication in human life. It is an acquired, complex phenomenon and depends upon the finest equilibrium between hearing, the brain, its neural pathways and the speech apparatus. Being acquired, it is heavily influenced by the environment. Essentially it is composed of different sounds; and it is necessary for surgeons repairing cleft palates to understand these sounds, the mechanism of their production and articulation and their classification.

Sounds or phonemes are classified according to the voicing state; manner of articulation, i.e., stops, fricatives, affricatives, glides and nasals; and place of articulation, i.e., velar, palatal, retroflex, alveolar, bilabial, etc. In most languages, phonemes are learnt through the arrangement of alphabets. In English, for example, written symbols A to Z represent most, if not all, phonemes. Some of the phonemes require a combination of these alphabetical symbols like ‘ch’ as in church, ‘th’ as in thought. The problem is all these alphabets are not pure phonemes, but a combination of a consonant and a vowel. Further, the arrangement is haphazard, with vowels and consonants intermingling at irregular intervals. And there is no reason for a particular arrangement of alphabets. They are as if picked at random and strung together. Therefore, one must make a special effort to memorize each and every sound individually vis-à-vis its character regarding voicing, place and manner of articulation.

After the cleft palate surgery, a plastic surgeon usually leaves the development of normal speech to a speech language pathologist, who is expected to work wonders in post-surgical therapy. Quite often the surgeon does not realize the implications of speech evaluation, which states the presence of misarticulations, with or without hypernasality. Unfortunately, there is no unified platform or guidelines for speech language pathologists and surgeons to interpret and analyze the speech data. This results in differing interpretations and expectations. In the absence of a cohesive approach, the line of action is usually inconsistent and depends on the individual surgeon, who often does not have a complete understanding of the evaluation done and technical terms used by a speech language pathologist.

This article describes how the arrangement of Sanskrit alphabets can be used to create a simplified version of speech evaluation, which can be used easily by both the surgeon and the speech language pathologist so that treatment protocols can be scientifically drawn up, giving much better results.

## The science of Sanskrit phonemes

Sanskrit is a valuable tool for evaluating cleft palate speech as its alphabets are arranged in a scientific manner. Not only are the vowels and consonants separated, but also Sanskrit consonants are pure phonemes and are arranged in vertical and horizontal groups according to the voicing state, manner of articulation, place of articulation and the intraoral pressure required to produce them. Understanding the arrangement of alphabets in relation to all these therefore takes away the major burden of memorizing them at random. Further, by looking at the groups and the pictorial diagram of their contact points, one is able to understand production of various phonemes and the causes of misarticulations and their clinical implications.

“The structure we find (in Sanskrit) is one of extraordinary initial simplicity and also of extraordinary scientific regularity of formation,” writes Sri Aurobindo.[1] The arrangement of Sanskrit alphabets is called *Varnmaalaa* (vərɳmɑlɑ), or the garland of phonemes. It is divided into two parts: the open sounds, or vowels, called *svar* (svər) [Table 1]; and closed sounds, or consonants, called *vyanjana*[2] (vjəndʒən). *Svar* (svər), according to the great grammarian Patanjali (pətəndʒəli), is self-luminous and does not depend on anything else for its existence.[2] That means there is no contact required to produce vowels. Sounds are further classified according to the place of origin along the tract (*sthaan* - st̪ʰɑn); effort required to produce them (*prayatn* - prəjət̪n); the duration (*kaal* - kɑl) of sound; and whether it is reflected, attenuated or amplified (*karan*- kərəɳ).[2] The consonants are classified in five symmetrical *vargas* (vərg), or classes, plus glides, sibilants and an aspirate[1] [Tables 2, 3]. The five *vargas* are called *sparsh* (spərʃʹ ),[2] or touch consonants, meaning

**Table 1: Arrangement of vowels in Sanskrit[1] (English symbols as used by Sri Aurobindo)**

| | | | | |
|---|---|---|---|---|
| Pure vowels | a (A) | i (#) | u (%) | å ( \ ) |
| Corresponding lengthened form | ä (Aa), | é ($) | ü (^) | è ( \ ). |
| Modification of vowels when added to ‘a’ (A) + | | a + i (#)→ e (@)<br>a + é ($) → ai (@) | a + u (%) → o (Aa)<br>a + ü (^) → au(Aa) | |
| ‘a’ (A) nasalised<br>with anusvär | am (A) | | | |
| Visarga ‘a’ (A) + h aspirate | aù (A>) | | | |
| Glides - liquids<br>semivowels | i + a → j<br>(#) + (A) → (y) | u + a→ w<br>(%) + (A) → (v) | å + a → r<br>( \ ) + (A) →(r) | lå + a → l<br>(¤) + (A) → ( l ) |

**Table 2: Classification of Sanskrit consonants[1, 2]**

| | *Hard sounds* | *Hard + Asp.* | *Soft* | *Soft + Asp.* | *Nasals* |
|---|---|---|---|---|---|
| Gutturals | k k | o kh | g g | " gh | ' ì |
| Palatals | c c | D ch | j j | H jh | \| ï |
| Cerebrals | | | | | |
| (English dentals) | q ö | Q öh | f ò | F òh | [ ë |
| Pure dentals (Celtic and continentals) French etc. | t t | w th | d d | x dh | n n |
| Labials | p p | ) ph | b b | É bh | m m |
| Liquids | | | | | |
| (semivowels) | y y | r r | l l | v v | |
| Sibilants | z ç | ; ñ | s s | | |
| Aspirates | h h | | | | |
| | ¦ ÿ | | | | |

**Note:** Sanskrit is phonetically exact, i.e., there is complete and constant consistency between the written script or symbols and pronunciation. The string of alphabets (phonemes) continues from top left to right and above downwards, i.e., (k) k... (') ì, followed by (c) c... (|) ï and (q) ö ... ([)ë, so on. Usually k = k + A, i.e., (alphabet = consonant phoneme + vowel phoneme), and is written as 'ka'. An 'a' is omitted in the above chart for the purpose of simplification. k is written instead of k in the above chart for convenience. Actually, all pure consonants (phonemes) are written as k o g " ..as they are abruptly cut off in pronunciation without extending them by an inaudible 'a' at the end. Thus they are pure sounds without associated vowels, compared to English alphabets A, B, C, D. For example, in 'Yoga' (to be pronounced as yog - /jog/- yãg), 'a' is added at the end of 'g' so that 'g' is not abruptly cut off; and it is not to be extended as 'gaa', as mispronounced in English. Mispronunciation also changes the meaning – for example, Krishn is masculine, Krishna is feminine. The symbols depicted in the above chart are the ones used to denote English equivalents in Sri Aurobindo's original article. Therefore, 'y' is used for y instead of /j/ as phonetically in English it is used as in 'yellow' and 'yes'. Some of the other examples are as follows: [Table 2a]

**Table 2a: Sanskrit symbols and examples of equivalent pronunciation in English (in italics)**

| | | | |
|---|---|---|---|
| K k | *cu*t, *k*ite | x dh | *Th*us, *th*ere |
| o kh | *Kh*artoum, *Kh*an, *kh*akhi | n n | *N*umber |
| g g | gut, gum | p p | *P*urse, *p*ump |
| " gh | A*gh*ast, *gh*ost | ) ph | *Ph*ilosopher |
| ' ì | Ri*ng* | b b | *B*ut, *b*ulb |
| c c | *Ch*urch, *ch*oice | É bh | *Bh*arat |
| j j | *j*ump, *j*udge | m m | *M*um |
| H jh | | y y | *Y*es, *y*ellow |
| q ö | *t*urn, *t*ongue | r r | *R*un |
| Q öh | | l l | *L*ove, *l*earn |
| f ò | *D*ust | v v | *V*ulnerable |
| F òh | | z ç | *Sh*irt, *sh*e |
| t t | French t | ; ñ | *Sh*unt, |
| w th | *Th*ought | s s | *S*erve |
| d | French *d* | h h | *H*umble |

they need contact of the tongue and roof, thereby becoming stops or affricatives. One can see that Sanskrit alphabets are well arranged in all the three categories of consonant classifications – namely, voicing state, manner of articulation and place of articulation [Table 3]. In the first 25 *sparsh* (spərʃ' ) consonants [Table 3], the first two vertical columns of /k/, /tʃ/, /t/, /t̪/ , /p/ and their aspirates /kʰ/, /tʃʰ/, /tʰ/, /t̪ʰ/, /pʰ/ are voiceless; and the last three columns /g/, /dʒ/, /ɖ/ , /d̪/, /b/ an d their aspirates /gʰ/, /dʒʰ/, /ɖʰ/, /d̪ʰ/, /bʰ/ and nasals /ŋ/, /ɲ/, /ɳ /, /n/, /m/ are voiced. They are further classified as non-aspirate *alp-praan* (*əlpəprɑɳ*)or aspirate *mahaa-praan* (məhɑprɑɳ)[Table 3], whether the breath is held back or thrown out.[2] So the first and third columns are groups of stops, and the second and fourth are corresponding stops with aspirates, except those in the second row of /tʃ/, which are all affricatives. The second and fourth columns also contain sounds that can be fricatives – for example, /θ/, /ð/ /f/ etc. Further, each class or *varga* of five consonants is arranged from

**Table 3: Classification of Sanskrit consonants, with IPA 1993 equivalents**

| | *stops* | *stops + Asp.* | *stops* | *stops + Asp.* | *Nasals* | | *Gli-des* | *Sibi-lants* | |
|---|---|---|---|---|---|---|---|---|---|
| | *Voice-less* | *Voice-less* | *Voiced* | *Voiced* | *Voiced* | | *Place of articulation* | | |
| Gutturals | k k | o kʰ | g g | " gʰ | ' ŋ | Velar | | | |
| Palatals | c tʃ | D tʃʰ | j dʒ | H dʒʰ | \| ɲ | Palatals Affricat. | y j | z ʃ | |
| Cerebrals (English dentals) | q t | Q tʰ | f ɖ | F ɖʰ | [ ɳ | Retro-flex | r r | ; ʃ | ¦ ɭ |
| Pure dentals (Celticand continentals, French etc. | t t̪ | w t̪ʰ | d d̪ | x d̪ʰ | n n | Alveolar | l l | s s | |
| Labials | p p | ) pʰ | b b | É bʰ | m m | Bilabial | v w | | |
| | f | | | v | | Labio-dental | | | |
| Liquids (semivowels) | y j | r r | l l | v w | | Glides | | | |
| Sibilants | z ʃ | ; ʃ | s s | | | Fricative | | | |
| Aspirate | h h | | | | | Fricative | | | |
| | ¦ ɭ | | | | | | | | |

back to front – starting with velars, palatals, retroflex, alveolar, bilabials and labiodentals. Even glides /j/, /r/, /l/, /w/ and sibilants /ʃ/, /ʆ/, /s/ are arranged back to front [Table 3]. Sounds are also arranged according to the force or the effort required. As we go from left to right, the force required diminishes. They are arranged as *kathor* ( kət$^h$or ),[2] or hard sounds like /k/, /tʃ/, /t/, /t̪/, /p/; and *mridu* (mådu̪),[2] or soft sounds like /g/, /dʒ/, /ɖ/ , /d̪/, /b/. Glides are called *ishat sparsh* (ɪʃət̪ spərʃ'),[2] or very light touch, and therefore are called semivowels. Further, /j / is semivowel of /ɪ/, /r/ of /å/ and /l/ of /lå/ and /w/ of /u/.[1] Sibilants are called *ushmaan* ( uʃmɑn ), [2] or warm sounds, as they produce warmth at the point of production, indicative of fricative nature.

### Sanskrit and the modern mind

*Varnmaalaa* of Sanskrit may be called the oldest phonetic classification known to humanity. Rick Briggs,[3] a NASA researcher, wrote in Artificial Intelligence magazine:

"In ancient India the intention to discover truth was so consuming that in the process, they discovered perhaps the most perfect tool for fulfilling such a search that the world has ever known -- the Sanskrit language. Among the accomplishments of the grammarians can be reckoned a method for paraphrasing Sanskrit in a manner that is identical not only in essence but in form with current work in artificial intelligence (AI). … and that much work in AI has been reinventing a wheel millennia old".

A great linguist and the founder of the Linguistic Society of America, Leonard Bloomfield,[4] commenting on Panini's *Ashtadhyayi*, a book on Sanskrit grammar, called it "one of the greatest monuments of human intelligence."

So, how do Sanskrit phonemes help? For surgeons, who are not speech language experts, it is quite difficult and tedious to understand and memorize the nature of phonemes. The international classification, which is the most comprehensive, requires much effort. Even if one learns this classification, memory recall will be poor after a few weeks or months, unless one uses it on a regular basis. Alphabets in most of the languages are randomly arranged and therefore lack order, which otherwise can make memorization of relevant phonetic aspects easy.

With such a basic difficulty, it is hard to comprehend the implications of various articulatory problems of cleft palate speech. More often than not, one receives the speech analysis reported as presence of hypernasality and misarticulations. The surgeon is at a loss to draw pertinent conclusions of clinical value. For example, is the hypernasality due to velopharyngeal incompetence or a palatal fistula? In fact, there are very few pointers as to how the speech analysis should be used to decide the future course of action.

A careful study of the Sanskrit chart reveals many interesting details. The phonemes are phonetically exact (see note with Tables 2 and 2a). The chart itself is simple, easy to comprehend and remember. It separates vowels and consonants in two distinct groups. It classifies phonemes in all the three categories of consonant classifications – namely, voicing state, manner of articulation and place of

**Table 4: Glossary**

| *English* | *Sanskrit equivalent as written in English* | *in IPA* | *in Sanskrit* | *Examples* |
|---|---|---|---|---|
| Vowels | Svar | svər | Svr | |
| consonants | vyanjana | vjəndʒən | VyN j n | |
| Contact sounds (consonants) | Sparsh | spərʃ′ | Sp z | stops |
| Aspirate | Mahaa-praan | məhɑprɑɳ | mhapa [ | /k$^h$/, /tʃ$^h$/, /t$^h$/, /t̪$^h$/, /p$^h$/<br>/g$^h$/, /dʒ$^h$/, /ɖ$^h$/, /d̪$^h$/, /b$^h$/ |
| Non-aspirate | alp-praan | əlpəprɑɳ | ALppa [ | /k/, /tʃ/, /t/, /t̪/, /p/<br>/g/, /dʒ/, /ɖ/ , /d̪/, /b/. |
| Sibilants | ushmaan | uʃmɑn | %:man | /ʃ/, /ʆ/, /s/ |
| Harsh | Kathor | kət$^h$or | kQar | /k/, /tʃ/, /t/, /t̪/, /p/ |
| Soft | mridu | mrid̪u | md | /g/, /dʒ/, /ɖ/ , /d̪/, /b/. |
| Class | Varga | vərg | vg | /k/…, /tʃ/…, etc. |
| String of phonemes | Varnmaalaa | vərɳmɑlɑ | v [ ma l a | |
| Place of articulation | sthaan | st̪$^h$ɑn | Swan | |
| effort | prayatn | prəjət̪n | pyTn | |
| duration | kaal | ̤kɑl | ka l | |
| | Karan* | kərəɳ | k r [ | |

*whether sound is reflected, attenuated or amplified articulation. In fact, it also classifies phonemes according to intraoral pressure required to produce them. This comprehensive, methodical and scientific character of arrangement becomes quite apparent when one superimposes the basic standards of the International Phonetic Alphabet (IPA) classification, developed by the International Phonetic Association [Table 4]. In addition, by virtue of its arrangement it also throws light on the understanding of various effects of cleft palate deformities and velopharyngeal incompetence on the production of phonemes [Figures 1-4]. The explanations one derives are simple and logical. The systematic arrangement of phonemes therefore creates the possibility of producing customized, simple and easy-to-remember models of sound samples to understand speech problems and interpret them.

## SANSKRIT PHONEMES AND RELEVANCE

### Dental malalignments and maxillary retrusion

For example, consider what may happen when there is maxillary retrusion resulting in crowding of articulatory contact points. In his article Sri Aurobindo writes, "The cerebral class (i.e., retroflex, class/t/...) has close kinship to the dental sounds (i.e., alveolar, class /t̪/...) both in sound and use that they may almost be regarded as modified dentals rather than an original separate class."[1] This kinship gets reflected in the case of maxillary retrusion.

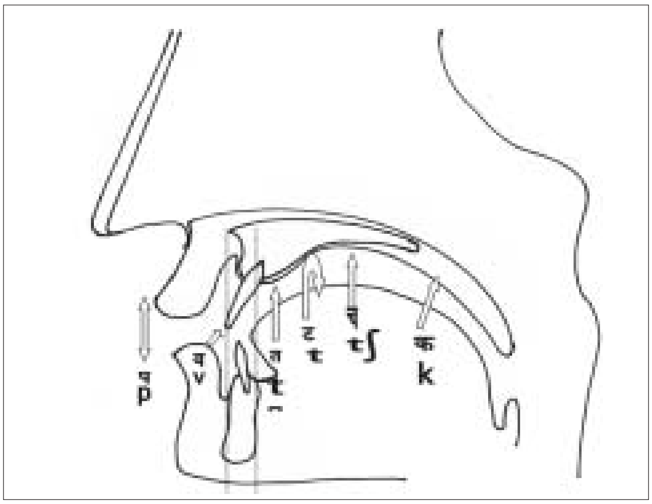


**Figure 1:** Normal points of articulation of each class of Sanskrit sounds. Class /k/.., soft palate; class /tʃ/.., midpalate; class t/.., retroflexed tongue touching little behind the alveolar ridge; class t̪/.., alveolar; class p/.., bilabial

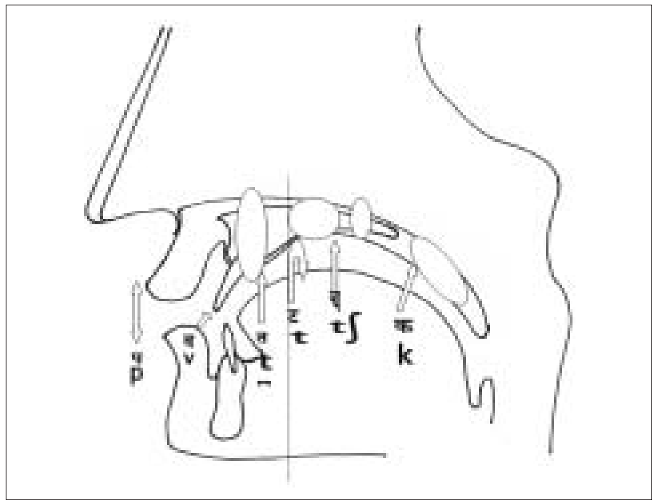


**Figure 3:** Depending upon the site of the fistula various classes of sounds will be affected. Soft palate fistula will affect all the sounds. As the fistula site becomes more anterior, class /k/.., /tʃ/..and /t/.. will become normal or less nasal, if there is no VPI, as the fistula could be blocked or excluded. /s/, an anterior fricative, is more frequently affected

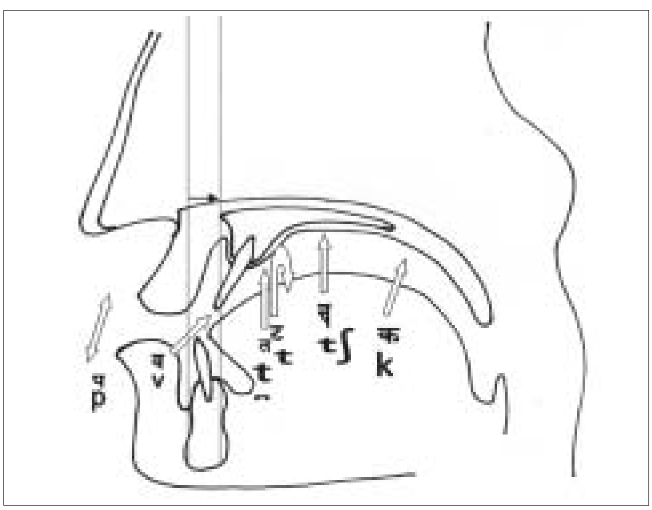


**Figure 2:** The effect of maxillary retrusion on the points of articulation. There is crowding of the points of contacts. There is reduced space with difficulty in retroflex which may be replaced by corresponding alveolars. Also note the effect on bilabials and labiodentals

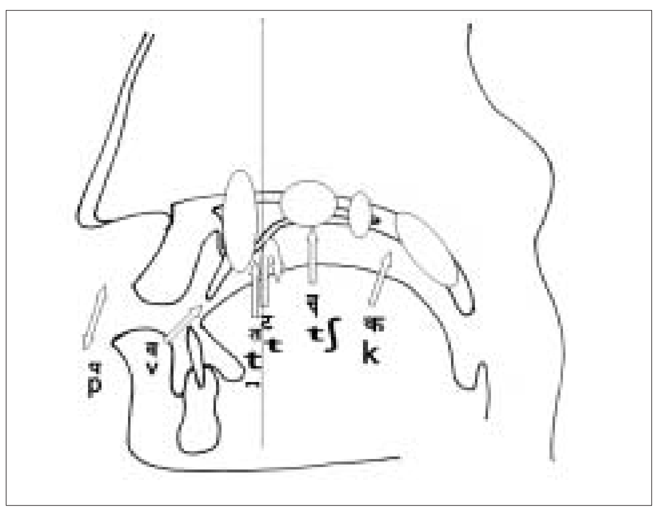


**Figure 4:** Combination of maxillary retrusion, arch collapse, fistula and VPI can cause severe speech impediment. If VPI is absent words of K class like kaka, koko, gaga, gogo could still be unaffected. But misarticulations may be present depending upon the severity

When one observes a maxillary retrusion [Figure 2], the normal contact points of linguopalatal retroflex, in fact, appear to lie at the level of alveolars. The space behind the teeth is reduced. There is no possibility of retroflexion of a relatively large tongue; and therefore, when one attempts to produce /t/,/tʰ/, /ɖ/, /ɖʰ/, /ɳ /, they are replaced by /t̪/, /t̪ʰ/, /d̪/, /d̪ʰ/, /n/ respectively [Figure 2]. However, in a few instances some compensation may occur in /t/, /ɖ/, where one produces apparently similar sounds, with some distortion, by striking at the floor of the mouth. In more severe cases, even the palatals may be affected and often get substituted by a respective sound in the vertical column of the Sanskrit chart. In such a case, a maxillary advancement surgery may help create enough space for the tongue to accommodate and maneuver itself normally. In the case of arch collapse and retroposed teeth, there may be distortion of retroflex (class /t/…) and alveolar group (class /t/… ) of sounds, labiodentals as well as sibilants, e.g., lateralization of /s/ [5]; /s, z, ʃ, ʒ, tʃ, dʒ,f, v, θ, ð/.[6] Therefore, in such a case of arch collapse, arch expansion and realignment of teeth will help the child to correct these problems. In case of protrusive premaxilla, bilabial seal for class /p/.. may be affected, making them dentalized; /s,z/ may be distorted and labiodentals /f,v/ may too become distorted when lip has to “reach forward.”[6]

## The Speech mechanism and velopharyngeal port

As we know, the speech mechanism depends on modulating the air passage in such a manner so as to produce different sounds. The closure of the velopharyngeal opening plays an important role. It controls the flow of air into the nasal cavity at will. When, therefore, this control is lost there is unintended escape of air into the nasal cavity, called nasal emission, resulting in coupling of the oral and nasal cavities leading to higher nasal resonance or hypernasality. It also affects production of various sounds that need a certain intraoral pressure. One understands that stops have high intraoral pressure as there is impounding of air when pressure builds up before being released. According to spectrogram reading, “ The plosives involve an explosive burst of acoustic energy following a short period of silence; because of the silence during which the vocal tract is completely blocked, these phonemes are also called stops. The signature of plosives is an almost instantaneous passage from little or no acoustic energy to a short burst of high-energy in a wide frequency band.”[7] In fricatives there is passing of air through a narrow channel to create friction or turbulence, thereby building up the pressure, albeit lesser than stops. But the sounds take a longer time to utter, and hence sustained high intraoral pressure is required. Affricatives are combinations of stops and fricatives. This requires that after initial sudden release, there is some more air required to create additional turbulence and therefore more air pressure is required to be built up intraorally. With glides, also called semivowels, there is much free flow of air through the oral cavity and hence intraoral pressure (IOP) is much lower. In nasal sounds there is an open velopharyngeal port to allow free flow of air into the nasal cavity, and therefore intraoral pressures tend to be zero. As shown by Subtlney *et al.*,[8] intraoral pressure measurements are highest for affricatives, followed by stops and fricatives, then glides, with nasals being zero. As one can notice, the intraoral pressure is highest in the first vertical column of the Sanskrit chart, i.e., /k/, /tʃ/, /t/, /t̪/ , /p/, also called “hard sounds”; and as one goes rightward, the intraoral pressure diminishes, e.g., /p/ > /b/ and /t/ > /ɖ /; whereas for the last vertical column, all nasals, it tends to zero.[8,9]

## Phoneme relationship in backing and fronting

Fronting or backing is another interesting speech phenomenon. In fronting, when sounds, which should be produced at the back of the mouth, are produced further forward in the mouth, ‘car’ becomes ‘tar’ or ‘par,’ ‘gun’ becomes ‘dun’ or ‘pun’ and ‘sing’ becomes ‘sin’ or ‘sim.’ In backing – the opposite of fronting – when sounds are produced further back in the mouth, ‘pen’ becomes ‘ten’ or ‘ken,’ ‘tata’ becomes ‘kaka,’ ‘table’ becomes ‘cable,’ ‘bear’ becomes ‘dere’ or ‘gere,’ ‘dog’ becomes ‘gog.’ It is interesting to note that the sound substitution occurs mostly in the vertical column of corresponding Sanskrit consonants, e.g., /p/, /t/ for /k/ and vice versa. Probably the mechanism of production of these sounds in the vertical column of the Sanskrit chart, for example /k/, /tʃ/, /t/, /t̪/, /p/, must be more or less equivalent; and the difference in sound produced depends upon the point of contact. It is important to note that fronting is considered to occur more often as a normal developmental process.[10,11] Backing is often observed in many cleft palate children, i.e., the sounds are pronounced more in the back than the designated point of articulation by retracted or “backed” tongue placement.[12] Backing is considered more often a lingual assist, a compensatory phenomenon.[13,14] It is rather an ineffective means of achieving a velopharyngeal closure. Most of the speech sounds are created by a close imitation of a sound heard. The cleft palate child in an attempt to achieve velopharyngeal closure pushes the tongue further back and tries to settle with a sound which in her or his perception is closest to the sound s/he wants to mimic.

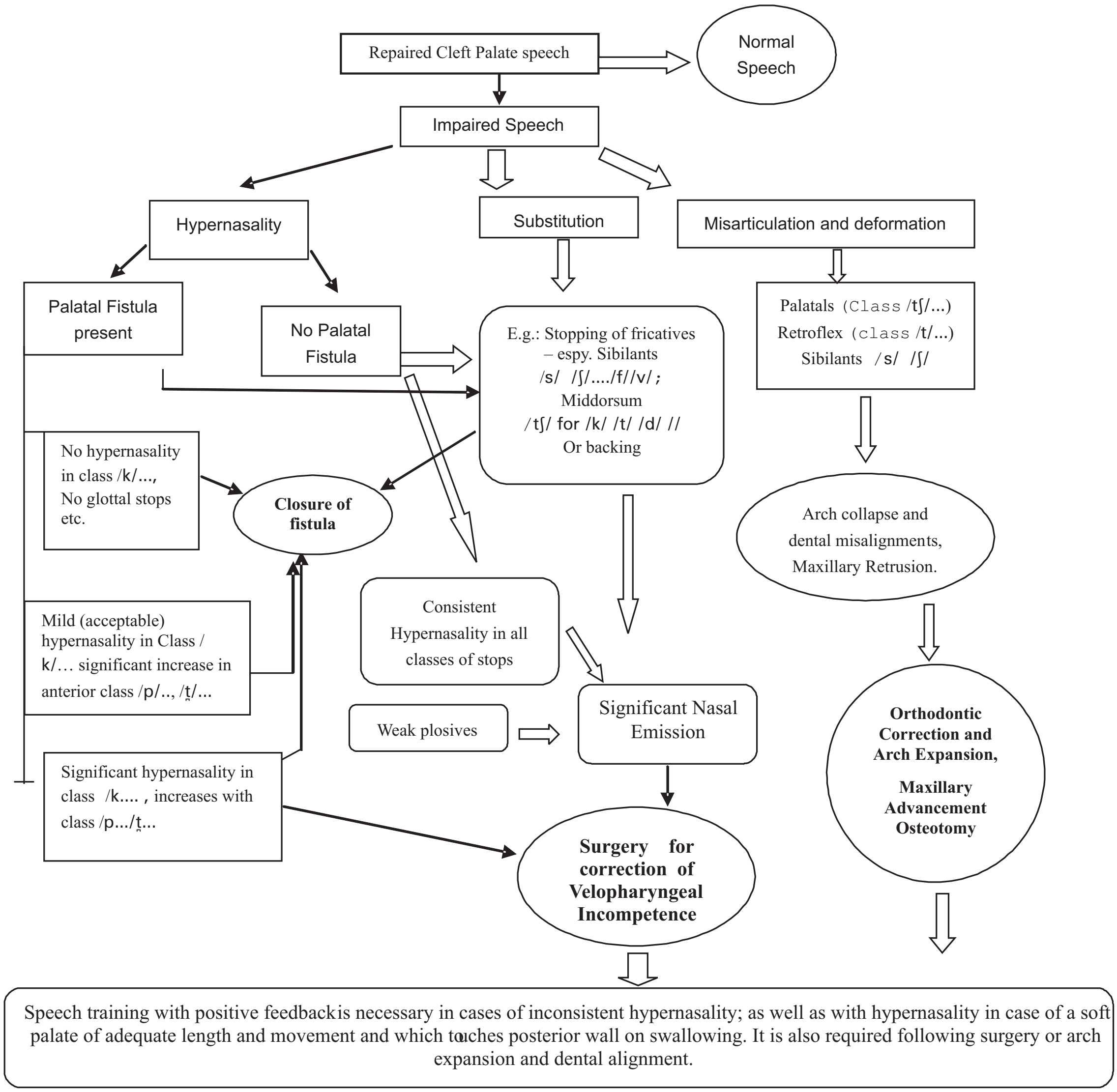
## Sanskrit Phonemes, IOP, VPI and palatal fistula

It is therefore interesting when Aparna Nandurkar[15] notes that the nasalance measure of Marathi (a Sanskrit-derived language with identical phonemes) consonants in repaired cleft palate patients with velopharyngeal incompetence is the highest for affricates, followed by plosives and then fricatives. This means that to compensate for the nasal escape, a greater airflow is required to sustain prolonged highest intraoral pressure to pronounce the affricates, leading to higher nasal emission and therefore higher nasalance. This is also noticed by Laine *et al.*[16] As intraoral pressure requirement diminishes, less airflow is required to compensate for the nasal escape and nasalance too reduces, i.e., nasalance for affricatives > stops > fricatives. Further, weak plosives indicate leakage that cannot be compensated by an increase in the airflow, thereby pointing to significant velopharyngeal incompetence.

It is also interesting to note that the time required to utter sounds increases as one goes downwards on the Sanskrit chart, i.e., from five *vargas* of plosives to liquids to sibilants. This means that one is required to sustain some intraoral pressure and airflow for a longer duration in forming sibilants. So, when there is velopharyngeal incompetence, it will be more difficult to sustain the airflow and air pressure for a longer duration in sibilants. Consequently, /s/ should be the most commonly affected sound.[10,15,17,18] It is observed that often /s/ gets converted into stops as there is an attempt to prevent the leakage of air leading to narrowing of air passage with tongue or a closure of the oral aperture by tongue. As Nandurkar[15] notes, for fricative /s/, the most common substitution was of /ʃ/ in medial position, followed by /t̪/, /t̪ʰ/, /tʃ/, /j / in medial or initial position, i.e., class of alveolar or palatal sounds; /ʆ / was substituted by /t̪/, or /t̪ʰ/; /tʃ/ by /t̪/ and /dʒ/ by /d̪/.. Thus, while studying cleft palate speech, if we take samples from a specific *varga* or class, i.e., horizontal row, of Sanskrit chart, we may find simple solutions. In a repaired cleft palate, velopharyngeal incompetence (VPI) exists if there is a short hypoplastic soft palate or severely scarred fibrosed immobile soft palate or there is soft palate dehiscence or relatively large pharynx, as for example, following tonsillectomy and adenoidectomy. In such cases there will be definite nasal escape; and the sounds from class /k/…, i.e., pure velar sounds, and words like 'Kok, koko, kaka, kakakaua, koka, gog, ghog, goga, gogo, gaga, cog' or any combination of velars, which are devoid of nasals, used in repetition, will show hypernasality. This will be present in all subsequent speech samples involving class /tʃ/.., /t/.., /t̪/.. , /p/.., i.e., all pressure consonants,[6] except when there are compensatory articulations like glottal stops, pharyngeal fricatives, etc. On the other hand, if these sounds are without hypernasality, it means that there is no VPI as there is no nasal emission, thereby obviating the need for surgical correction of VPI. If there is hypernasality in the other groups of sounds, like 'bob, pop, popsy,' it may be due to a palatal fistula or, sometimes, faulty speech due to velopharyngeal mislearning, which is correctable by training.[6,19] Shelton and Blank[20] noted sufficient loss of intraoral pressure due to air flowing through the palatal fistula. So if there is a palatal fistula, depending upon its size and position, various groups of sounds belonging to a particular class will be normal or hypernasal. Looking at the Sanskrit chart and the Figures 3 and 4, one can see that the sounds belonging to the class where articulation is posterior to the fistula are likely to be normal, and the class of sounds anterior to the fistula will be hypernasal. A small fistula in the middle of hard palate without maxillary retrusion or arch collapse may be effectively blocked by the tongue in retroflexion. So most likely, most anterior sounds from class /t̪/... and /p/... are likely to be hypernasal [Figure 4]. Also the severity of hypernasality, to a certain extent, will depend upon the size of fistula. Different vowels like o, u, au may prevent anterior valving – a trick a child employs to reduce nasal escape through fistula, by closing it with the tongue, a compensatory strategy to plug a fistula. Thus, depending upon one's judgment of hypernasality, one can even discern whether hypernasality is more due to VPI or palatal fistula, as sounds anterior to fistula will increase the hypernasality and therefore one may be able to decide the course of action [Flowchart 1].

## Complexity of the cleft palate speech

The cleft palate speech problem is a complex maze. One has to keep in mind that various combinations of speech responses are possible depending upon the combination and severity of anatomical factors like maxillary retrusion, arch collapse and dental irregularities or alveolar




**Flowchart 1:** Speech evaluation as per Sanskrit Chart and possible course of action in a repaired cleft palate

gaps, presence of a palatal fistula and VPI. Hearing impairment further complicates the problem, depending upon its severity. Also one has to keep in mind various phonological developments, age-related variations and preoperative speech evaluation as the speech pattern continues in the early postoperative period.[11] According to Trost-Cardamone, compensatory articulatory gesture, occurring at the atypical loci within the vocal tract, persists even after physical management of functional velopharyngeal mechanism is provided.[6]

*Varnmaalaa* of Sanskrit helps us find our way through the maze. The Sanskrit chart with the phoneme characteristics, along with the diagram of articulatory contact points, elucidates various findings in a simple and logical manner [Flowchart 1]. It is therefore possible to choose speech analysis as an initial tool and follow up with nasometry, lateral videofluoroscopic palatography and nasendoscopy to get valuable information.

Though all possible speech variations are not discussed here, it is obvious that the Sanskrit chart can provide a simple tool for added clinical evaluation and may help decide the course of action for both the surgeons and linguists together. According to Grunwell,[11] surgery alone cannot improve speech, but speech can improve with speech therapy. Therefore, constant evaluation and an appropriate intervention by a surgeon and positive feedback on speech training by a trained speech language pathologist can bring the best outcome.

In conclusion, one may say that Sanskrit provides one more tool to tackle the problems of cleft palate speech. Its “scientific, methodical and regular”[1] arrangement simplifies the understanding of phenomenology of sounds, especially for surgeons. Sanskrit contains almost all the consonants of Indian languages and shares also a close relationship with another ancient Indian language, Tamil. It also contains most of the important consonants from the IPA classification as well as those in most of the European languages, including English. Indeed, IPA classification of phonemes is the gold standard; Sanskrit may provide one more user-friendly platform for the surgeons. One has only to memorize the arrangement of alphabets and understand the characteristic of each group to create a simple tool to analyze speech problems in cleft palate children. In doing so, it creates a common ground of understanding between surgeons and speech language pathologists, helping them to decide a course of action.

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