CLINICAL USE OF NASAL AIRFLOW IN ASSESSMENT OF THE VELOPHARYNGEAL MECHANISM.

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When inappropriate in degree or timing, coupling between the nasal cavity and the rest of the vocal tract may result in two related symptoms, namely nasality and nasal emission of air. Nasality refers to the altered resonance of voiced sounds caused by the inclusion of the nasal resonance system, while nasal emission of air refers to the escape of air via the nasal route during speech sounds produced with a velopharyngeal leakage. Nasality and nasal emission of air are central concerns in cases of velopharyngeal insufficiency. The clinical routine assessment is - in Denmark at least - normally based on: 1) the perceptual impression of speech, 2) oral mirror inspection, and 3) various traditional tests. However, important limitations are inherent in these methods: re 1) the relationship between the perceptual judgment of speech produced by speakers suffering from inadequate velopharyngeal function and its physiological causes is very complex, and re 2) and 3) the traditional examination procedure and tests can only be applied to non-natural speech - typically isolated sustained speech sounds - or to non-speech tasks, and there is general agreement that these conditions are poor indications of velopharyngeal behaviour in natural speech.

Thus, there is obviously a need for supplementary methods, which more directly inform about the behaviour of the velopharyngeal mechanism in (quasi-) natural speech. There are various possibilities, but most of them are not practicable as tools in the clinical routine assessment due to a complicated application procedure and/or because they are very expensive. One possibility, however, is registration of nasal airflow in order to detect and quantify nasal emission of air. Unfortunately, the relationship between the amount of nasal airflow and the degree of opening at the velopharyngeal port is not simple, since the amount of flow depends not only on the magnitude of the opening but on the behaviour of the whole speech apparatus - including the respiratory mechanism. This is a very important point when we deal with cleft-palate speakers, as they very often exhibit a deviant glottal, subglottal, and supraglottal behaviour, when they attempt to camouflage or compensate for their speech handicap. Therefore, in order to control these other factors, oral airflow and oral pressure should be recorded simultaneously with nasal airflow, if it were not for the complicated recording procedure. Thus, the question is whether nasal airflow - as a single measure - can be a useful tool in the assessment of the velopharyngeal mechanism in determining the choice of treatment and in the subsequent evaluation of this

treatment.

Nasal airflow may be monitored by various instruments based on different principles,but irrespective of principle, the requirements to an optimal flow meter are the following: linear registration, good frequency response, separation of expiratory and inspiratory airflow, non-sensitivity to local tubulence, independence of temperature, and a stable zero-level. The Cleft Palate Department at the Institute of Speech Disorders in Hellerup (abbr. CPD) possesses an Exeter Nasal Anemometer. However, this instrument fulfil none of these requirements, since it is based on the simplest version of the hot-wire principle. But it is a cheap and handy little box, which are important qualities seen from a clinical point of view.

In order to answer the question whether nasal airflow - with special reference to the Exeter Anemometer - can be a useful tool in the assessment of the velopharyngeal mechanism, wer have - at present - recorded and analysed nasal airflow from 1) 16 Danish speakers suffering from velopharyngeal insufficiency and from 2) a normal group comprising 10 speakers. The speech signal has also been recorded. All speakers have been examined by an ENT-doctor and by a speech therapist. For practical reasons, it has not been possible to match the two groups. For the patient's sake and due to the limited time available for the recordings, the test material is minimized to consist of 1) isolated, sustained speech sounds [i α u s m] and 2) the words 'pige' (*girl*), 'side'/'sure' (*side/acid*), 'lampe' (*lamp*) said in the frame sentence 'jeg siger ... i dag' (*I say ... to-day*). The isolated oral speech sounds were included for comparison with other investigations published in the literature - all dealing with non-Danish speakers - and with the normal routine examinations based on these same sounds. The Exeter Anemometer is delivered with a standard calibration curve, which seems to be only roughly reliable. Therefore, [m] was included as a relative reference in case the calibration should prove to be useless. The test words include a stop consonant, a sibilant, and a stop following a nasal consonant, as these sound categories are the most sensitive to velopharyngeal insufficiency. The test material was recorded several times for each speaker in order to observe the variation in airflow from token to token, which is supposed to be a powerful cue in the assessment of the velopharyngeal mechanism.

The recordings were made at the CPD by a speech therapist. As she has access only to an AM-tape recorder, two FM-tape adapters have been constructed by S.E. Lystlund and P. Dømler at the phonetics laboratory - one for the recording at the CPD, and one for the reproduction at the phonetics laboratory, where LP-filtered nasal airflow traces and standard curves for

segmentation are made. At the time being, the data processing is performed 'by hand'.

The figures below present nasal airflow traces obtained from two normal speakers (to the left) and from two patients (to the right) showing the inter-speaker variation within the two groups. As expected, the normal speakers in most cases show no nasal airflow during oral sequences as illustrated in fig.1. Only with low vowels - as it appears from [α] - more than a third of the normal speakers produce nasal airflow, and the amount of flow is of the same order of magnitude as seen in the patients. However, some normal speakers produce a small amount of nasal airflow during sequences containing only non-low oral vowels and obstruents, which is exemplified in fig.2.

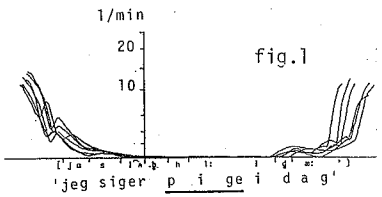
As for the patients, the airflow may be considerable and may show a pattern which tends to be similar to the pattern of intraoral pressure produced by normal speakers as shown in fig.4. In these patients the nasal airflow pattern reflects mainly the supraglottal articulation due to a very poor velopharyngeal function. With other patients the amount of airflow is smaller and does not show this 'pressure'pattern, which indicates a better velopharyngeal function - provided that it is not due to a compensatory or camouflaging articulation. The patient presented in fig.5 shows only a small amount of nasal airflow, which does not deviate very much from the normal speaker seen in fig.2. However, other parts of the material obtained from this patient show a considerable degree of airflow and an appreciable inconsistency from token to token, which reveals an inconsistent velopharyngeal mechanism. This is exemplified in fig.6, which should be compared to fig.3 showing the same normal speaker as in fig.2. Finally, patients may show airflow traces more normal in the isolated sounds than in the sentences - or vice versa - which also indicates an instable velopharyngeal function.

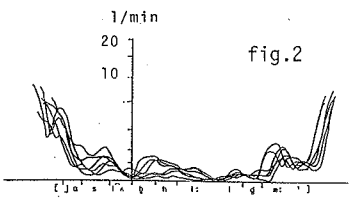
This kind of observations leads us to conclude that nasal airflow can distinguish speakers with velopharyngeal insufficiency from normal speakers, and it can serve to differentiate fair, poor, and very poor velopharyngeal mechanisms. Thus, nasal airflow - as a single measure - is a useful tool in the assessment of the velopharyngeal mechanism. But it should be emphasized that the patient's speech always has to be controlled in order to prevent misinterpretation of the airflow traces. Further, with the Exeter Anemometer one has to take into account especially its poor frequency responce and the non-separation of in- and expiratory airflow.

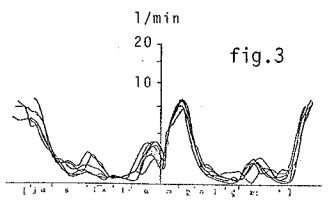
It was mentioned above that the Exeter Anemometer is a cheap and handy instrument. However, to produce airflow curves and curves of the speech signal involves quite a number of expensive accessory instruments, which are

normally not available to speech therapists, and thus, the Exeter Anemometer can no longer be considered a cheap and handy tool. In all fairness it should be mentioned that a more advanced - and a more expensive - version of the Exeter flowmeter is available. With this version the signals are recorded on a small cassette, which can be mailed to a processing centre in England, and from the centre the speech therapist receives a dual-trace chart containing speech and airflow signals (which, howver, do not seem very informative to us). We are convinced that establishing a Nordic centre for signal processing, comprising all kind of signals which may be relevant for the clinical assessment, would be received with open arms.

NORMAL SPEAKERS







PATIENTS