Laryngeal resistance as a marker of altered aerodynamic mechanism in parkinsonian dysarthria

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LARYNGEAL RESISTANCE AS A MARKER OF ALTERED AERODYNAMIC MECHANISM IN PARKINSONIAN DYSARTHRIA

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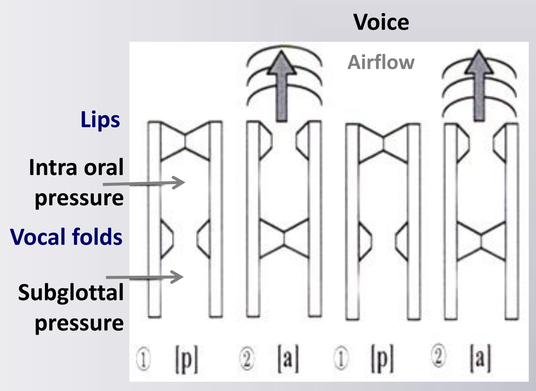
BACKGROUND

Laryngeal resistance (LR) is a parameter able to further document the laryngeal activity by linking two aerodynamic dimensions (Smitheran and Hixon, 1981, J Speech Hear Disord 46, 138-146): **LR** is the ratio between the estimated subglottal pressure (**ESGP**) and the oral airflow (**OAF**).

Subglottal pressure and its temporal course within a sentence production is relevant for evaluating speech motor control, particularly pneumophonic coordination. If subglottal pressure is difficult to estimate non-invasively, several methods have been developed and are used to estimate indirectly this parameter (*Bard et al., 1992, Ann Otol Rhinol Laryngol 101, 578-582; Jiang et al., 1999, Laryngoscope, 425-432; Jiang et al., 2006,. Laryngoscope, 89-92*). We decided to measure the estimated subglottal pressure (ESGP), which is known to be equivalent to the subglottal pressure during the occlusive consonants (*Laukkanen et al.. 2006. J Voice 20. 25-37*), just before voicing (see figure below).

As a matter of fact. it is important to consider laryngeal resistance - **LR** - as a means to assess globally and dynamically laryngeal rigidity in Parkinson's disease (PD).



OBJECTIVE

To determine the aerodynamic relevance of laryngeal resistance in Parkinsonian dysarthria.

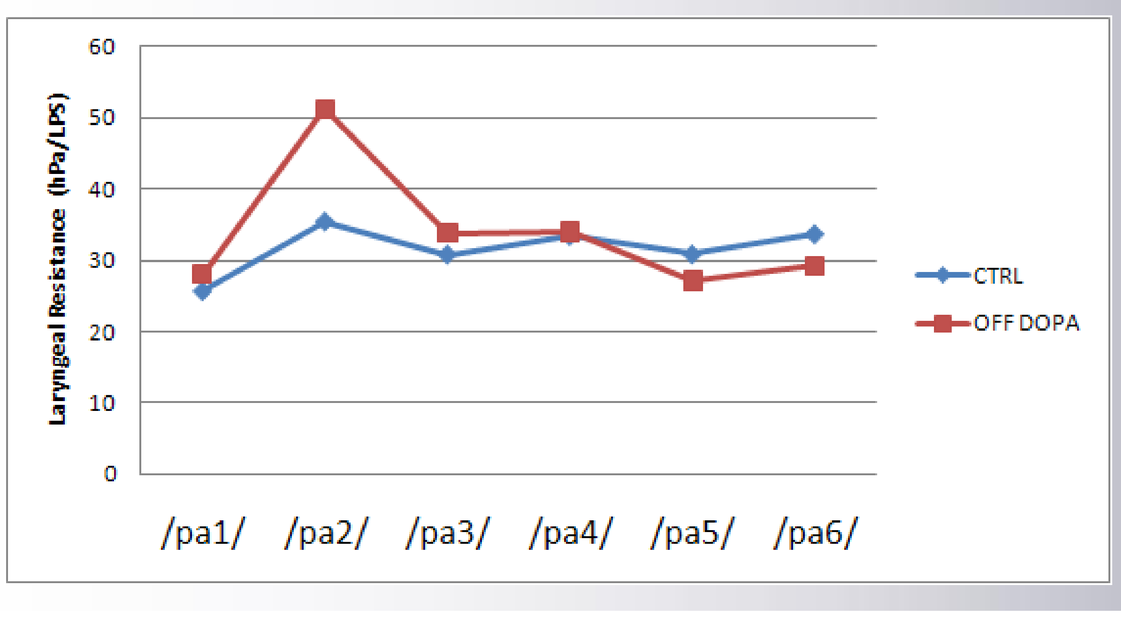
RESULTS

For all /pa/ syllables. ESGP and OAF measurements showed significant differences ($p < 0.001$) between control subjects and patients off L-dopa, patients presenting reduced values as a reflect of the disease impact.

ESPG	P1	P2	P3	P4	P5	P6
OFF DOPA	3.84 (1.9)	6.22 (2.2)	4.46 (1.8)	4.7 (1.9)	4.49 (1.9)	4.26 (1.7)
CTRL	5.23 (2.00)	6.97 (2.15)	5.73 (1.90)	5.9 (1.93)	6.06 (1.98)	5.67 (2.00)

OAF	P1	P2	P3	P4	P5	P6
OFF DOPA	0.2 (0.09)	0.16 (0.08)	0.17 (0.08)	0.17 (0.08)	0.19 (0.07)	0.2 (0.08)
CTRL	0.2 (0.08)	0.21 (0.07)	0.21 (0.07)	0.2 (0.08)	0.21 (0.06)	0.2 (0.06)

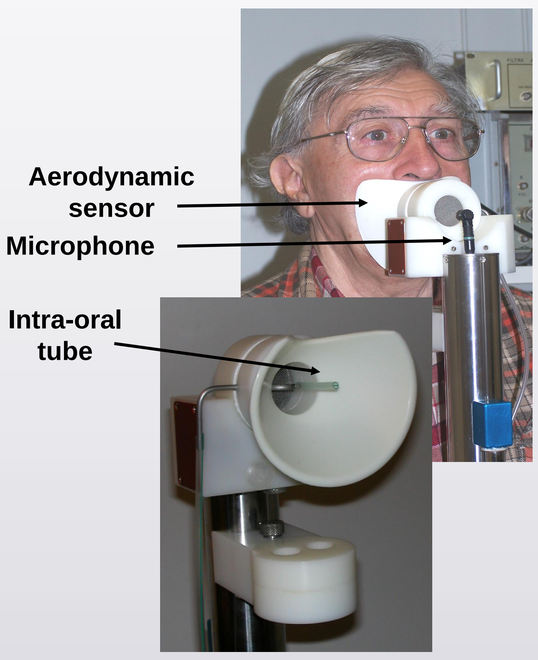
This was not the case for the LR ratio, which displayed a striking increase specifically on the stressed syllable (second /pa/): this data is the result of a supplementary OAF decrease independent from the ESPG reduction. possibly reflecting an "active" strained glottis.



PATIENTS AND METHODS

PATIENTS AND SUBJECTS

51 patients with PD
Off L-dopa (overnight washout > 12 hours)
50 age-matched control subjects



DATA ANALYSIS

The ***EVA*** system (*Ghio & Teston, 2004, International Conference on Voice Physiology and Biomecanics, Conference proceedings, 55-58*) was used for data recording; analysis was performed using the ***Sesane*** environment (SQLAb, Aix-en-Provence, France; http://www.sqlab.fr/).

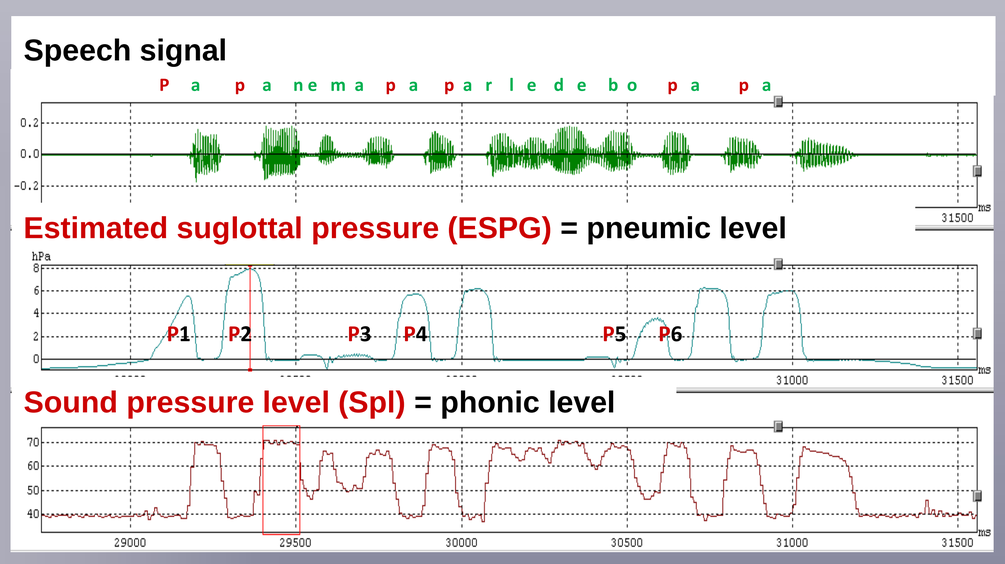
SPEECH PRODUCTION TASK

Production of the following sentence in French «**P**a**P**a ne m'a **P**as **P**arlé de beau-**P**a**P**a», within which measurements were made upon the 6 /p/ occlusive consonants.

ESPG (hPa) = subglottal pressure during the occlusive consonant, just before voicing. Control oral airflow is at level 0.

Spl (dB) = vocal intensity during the vowel following occlusive consonants.

ESPG was measured at every p consonants while the **OAF** was measured on each vowel /a/ following the p consonant.



STATISTICAL ANALYSIS

A linear mixed model (R software. version 2.6.2. http://www.r-project.org) was estimated. for group analyses integrating patient and p consonant as random terms. with a statistically significance level at $p<0.05$.

No significant difference was observed for the LR ratio concerning the latter syllables: as if the LR was progressively normalized, whereas the ESPG became stabilized thus resulting in a restored OAF.

CONCLUSIONS

LR, as previously reported for ESPG (Sarr *et al*., Revue Neurol, 2009), can thus be considered as a marker of altered aerodynamic mechanisms in PD dysarthria. It appears to be a useful, non-invasive and relevant parameter to be measured in order to assess speech motor control deficits in PD.

Speech production in PD seems to benefit from various motor compensation strategies, as observed for limb movements. Vocal forcing may be one of these strategies, leading to an active control of laryngeal activity that have also to deal with PD rigidity.

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