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CORRESPONDENCE

Vocal markers of preoperative anxiety: a pilot study

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Editor—Recent European guidelines in anaesthesia recommend systematic preoperative anxiety management to prevent its negative perioperative impact,[1] including impaired memory of important instructions and higher incidence of postoperative acute and chronic pain. Usual self-administered questionnaires or scales to assess anxiety in the preoperative setting are time consuming and rely on patient willingness to comply with instructions.[2] Physiological signals, such as patient voice, may provide useful information for objective, reliable, and accurate anxiety assessment before surgery. Because of the extensive parasympathetic innervation to the larynx, pharynx, face, and head, stress modifies vocal parameters.[3,4] The effects of acute anxiety on voice are poorly explored in the preoperative context. Our objective was to describe the characteristics of patient vocal parameters related to declared anxiety level in a day-care ophthalmic surgical unit performing cataract surgery.

With approval from the Ethics Committee of the French Society of Ophthalmology (IRB 00008855 Société Française d'Ophtalmologie IRB#1), vocal conversations between patients and nurse assistants were recorded during admission interviews on the day of surgery. The standardised 5 min interview aims at validating patient identity, address, surgical indication, fasting status, and removal of all jewellery, and also assessing patient anxiety. At the outset of the interview, both patients and nurse assistants evaluated patient anxiety using a 0–10 VAS. The criteria for exclusion were age <18 yr, under guardianship, non-French-speaking patients, communication difficulties, or hearing or speaking impairment. All participants gave their written informed consent.

In each recording, patient voice was separated from the nurse-assistant voice by manual screening using Audacity software. An utterance was defined by each moment where the patient was speaking alone, surrounded by words from the nurse assistant, or by silent periods >2 s. We also excluded non-verbal sequences (background noise, coughs, etc.) using automated criteria. For each patient utterance, we then extracted a number of acoustic features traditionally associated with emotional expressivity and vocal stress,[3,4] including utterance duration; mean, maximum, minimum, and standard deviation (SD) of fundamental frequency (F_0); four standardised measures of pitch perturbation quotient (jitter), five measures of amplitude perturbation quotient (shimmer), and two measures of noise-to-harmonic ratio (NHR/HNR). Acoustic features were extracted with the Praat software (see Supplementary material for details).

To analyse the effects of patient anxiety on average vocal features, we calculated the mean of each utterance feature, weighted by utterance duration, and tested for the main effects using a one-way analysis of variance, using patient self-reported VAS anxiety as a binary factor ('low' if VAS <5; 'high', otherwise). To analyse the effect of patient anxiety on the temporal evolution of features, we controlled for differences in interview duration by normalising the utterance time location between 0 and 1, and indexed each utterance's feature with its normalised time location. We then used the generalised linear mixed models to evaluate the contribution of the anxiety factor to the linear regression of each feature's values on normalised time, using random intercepts to account for patient differences. In both procedures, we took α=0.05 as the significance threshold, and applied Bonferroni corrections for alternative measures of the same feature (F_0: α_{Bonf}=0.013; jitter: α_{Bonf}=0.013; shimmer: α_{Bonf}=0.010; NHR: α_{Bonf}=0.025; see Supplementary material for details).

Between April 1 and June 30, 2016, data for 44 patients were collected, including 29 female, with a median age of 74 (interquartile range [IQR]: 69–79). The median duration of interviews was 6 min 50s (IQR: 5 min 49s–7 min 38s), of which a median of 1 min 55s (IQR: 2 min 47s–1 min 19s) was spoken by patients. The median duration of manually segmented patient utterances was 1 min 65s (IQR: 2 min 5s–1 min 0s]). The mean F_0 was 165 Hz (SD=16 Hz) for female patients, and 143 Hz (SD=18 Hz) for male patients. The mean anxiety score in patient VAS

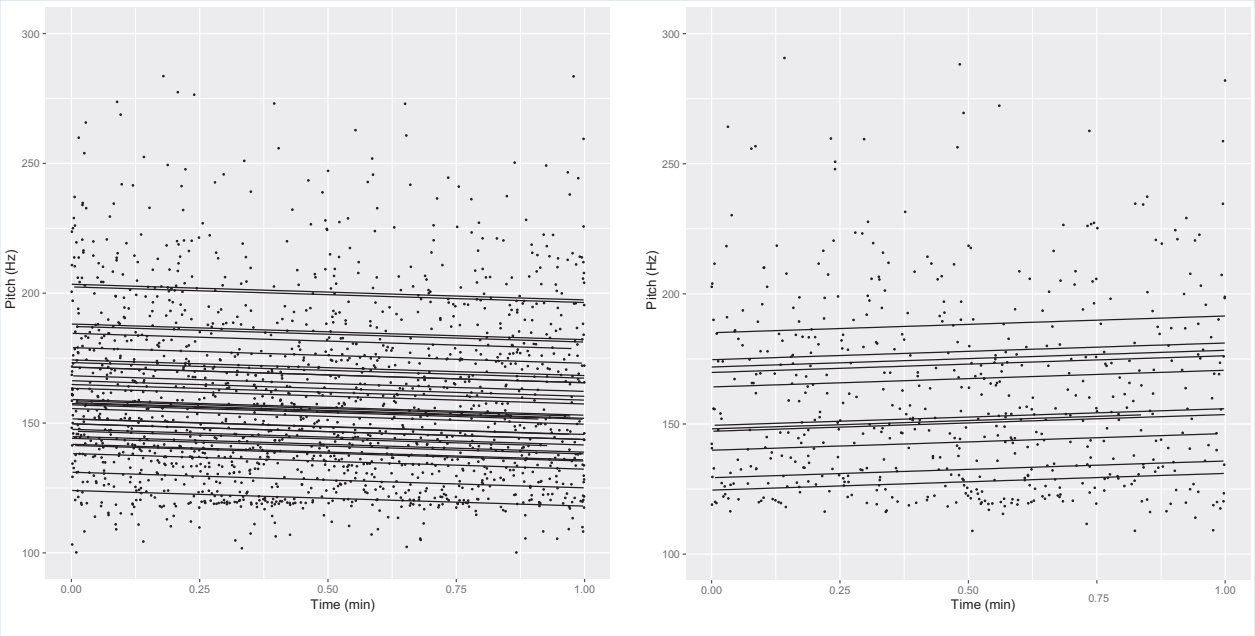

Fig 1. Values and predictions of linear mixed model for the acoustic feature 'pitch' (non-anxious patients (VAS <5) on the left and anxious (VAS ≥5) patients on the right).

reports was 3.5 (SD=2.6), whilst 11 (25%) patients rated their anxiety level >5. The correlation between patient self-report and evaluation by the nursing staff of anxiety level was 91%.

Whilst there was no main effect of anxiety on patient average measures of F_0 (all P-values >0.44), there was a significant effect of anxiety on how F_0 evolved along with interview time for mean F_0 (χ^2=6.85; P=0.008; α_{Bonf}=0.013), SD of F_0 (χ^2=8.52; P=0.003; α_{Bonf}=0.013), and maximum F_0 (χ^2=24.0; P<0.001; α_{Bonf}=0.013) (Fig. 1). Whilst the F_0 of low-anxiety patients decreased by an average 3.8% along the interview, the F_0 of high-anxiety patients increased by 4.1%. None of the other acoustic features (duration, jitter, shimmer, and NHR) appeared to be significantly associated with anxiety levels, either on average or relative to time (see Supplementary material).

To date, preoperative anxiety studies have focused on validating self-questionnaires in different surgical settings rather than identifying reliable objective biomarkers of anxiety. The main finding of our study is that a comparison between repeated F_0 measurements may be an acoustic marker for preoperative anxiety if confirmed by further study. Consistent with the literature, this relative F_0 increase in stressed patients compared with less anxious patients may be attributable to sustained sympathetic nervous system activation[3] balancing the short-term vocal fatigue observed over the course of normal conversations.[4] Contrary to other reports studying anxiety in different stressful contexts, including cognitive workload, social stress, stage fright, and during life-threatening emergencies,[5,6] we found no effect of preoperative anxiety on voice quality features, such as jitter, shimmer, or NHR. The reasons for this discrepancy may include low statistical power, linguistic characteristics of the conversations (short utterances in a question–answer mode), top-down control exerted by the patients in front of medical professionals, or lower emotional load as a result of distant time to surgery. Finally, we found a higher-than-expected correlation between self-reported anxiety level and nurse evaluation of patient anxiety. This suggests that staff's perception might be strongly influenced by patient reporting, and therefore, may lack reliability. In sum, we report a possible association between voice pitch and anxiety amongst patients awaiting cataract surgery. This result needs to be further evaluated in other surgical contexts on a broader scale and corroborated with other biomarkers involving the vagal tone response to anxiety, including HR variability.

Authors' contributions

Study design: GG, ML, CB, J-JA.
Patient recruitment: P-RR.
Data collection: ML.
Data analysis: LL, AV.
Writing of first draft: GG, LL, J-JA.
All authors critically revised the article, approved the final version to be published, and are accountable for all aspects of the work.

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Declaration of interest

The authors declare that they have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bja.2019.06.020.

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