Relation between the collision force between vocal folds and the other parameters in phonating excised human larynges.

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Introduction

The phonotraumatism is a complex mechanism. Collision force between the vocal folds is only one component of it [Titze]. Information about its relation with other aerodynamic, acoustic and electroglottographic parameters is still lacking.

Material and methods

One healthy female larynx was harvested from fresh cadaver (86 years old) according to the french ethical law. The vocal folds were adducted in a stable phonation position using an inter-aryténoïd stitch and bilateral symetric thyroplasty implants of Montgomery (Figure 1), and no tension of the vocal folds was applied. The larynx was then exposed to ramps of subglottal pressure (P_{SG}) from 0 to 20 kPa using the experimental testbench (Figure 2). Recorded parameters were: Sound pressure level (P,Ext), Fundamental frequency (F0), Amplitude of vocal fold contact in electroglottography (Ampl, EGG), and the amplitude of collision force (Ampl, Pcf).

Figure 1: pre-phonation configuration

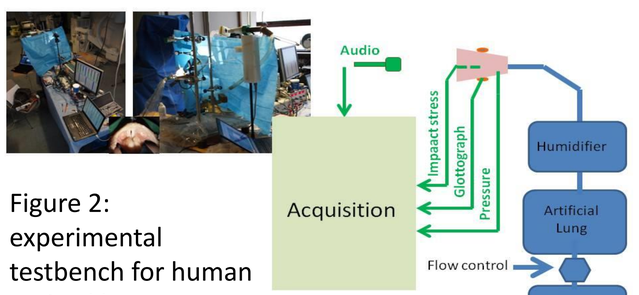

Figure 2: experimental testbench for human excised larynx

Results

Figure 3 shows the variations of the different parameters with the P_{SG}. Relations between P_{SG} and P, Ext (sound pressure level) ans Fundamental frequency (F0) are almost linear. The relation with the amplitude of glottal contact in EGG and with the amplitude of collision force reaches a plateau. The relation between the amplitude of collision force and the other parameters is presented in figure 4. The relation is close, but not linear (polynomial), with P_{SG}, Ampl,Pext and Ampl,EGG. No relation was observed with the F0. Finally, the relation between the Ampl, EGG and the other parameters is presented in figure 5.

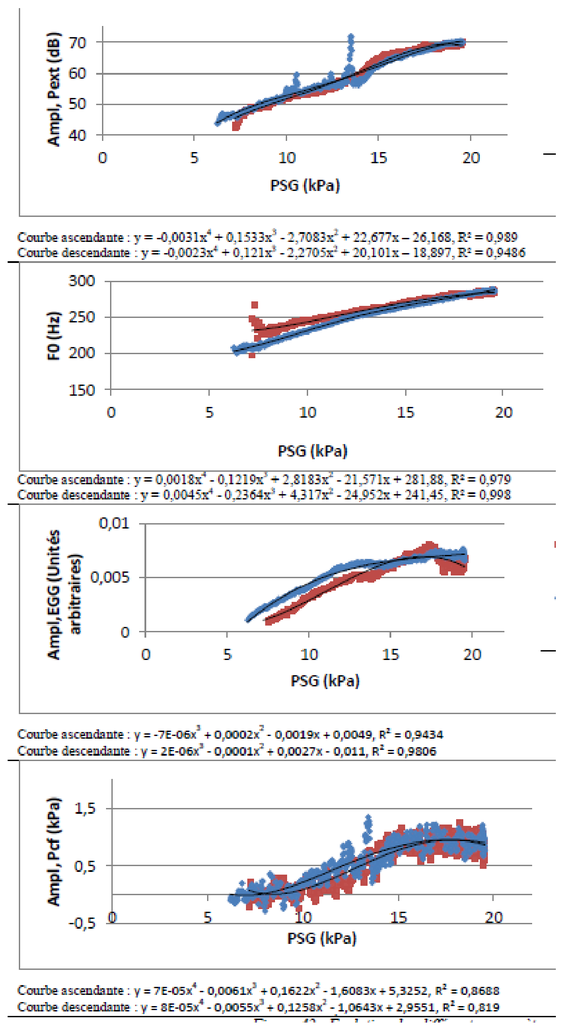

Figure 3: Variations of the different parameters with P_{SG}

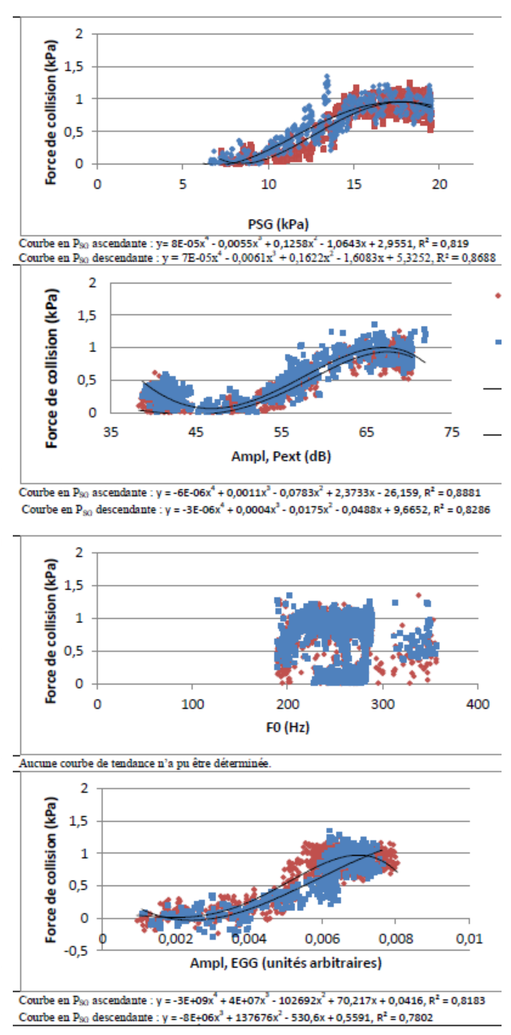

Figure 4: Variations of the collision force and the other parameters

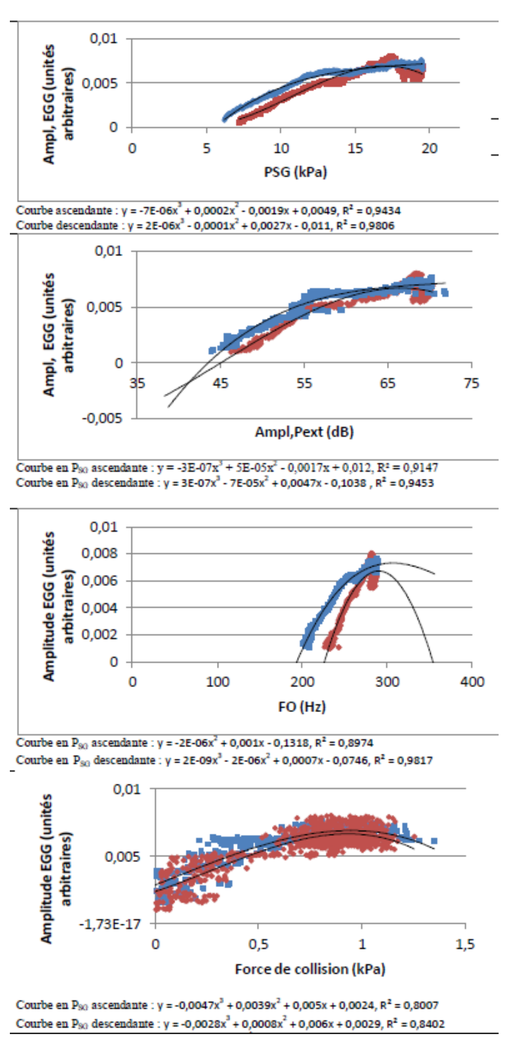

Figure 5: Variations of the amplitude of EGG and the other parameters

Discussion

The collision force increases with P_{SG}, sound pressure level and amplitude of the EGG contact, with a slight hysteresis between ascending and descending P_{SG}. There was no relation with F0, but it is noteworthy that the F0 variations were only due to the P_{SG} here, no tension was applied to the larynx. The amplitude of the EGG signal was also correlated with the collision force. The amplitude of the EGG is the reflect of the glottal contact area (Hampala). The two parameters are complementary to understand the phonotraumatism.

References
1. Titze IR. Mechanical stress in phonation. J Voice.1994;8(2):99-105.
2. Hampala V, Garcia M, Švec JG, Scherer RC, Herbst CT. Relationship Between the Electroglottographic Signal and Vocal Fold Contact Area. J Voice. 2016;30(2):161-71.