PHONETOGRAPHY DATABASE FOR ELDERLY WOMEN

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Abstract: The aim of this work was to create a software that, from the phonetography measures of elderly women, generates the phonetogram, evaluates its area, vocal extension (VE), and the dynamic extension (DE) and elaborates a database. The phonetography exams were carried out based on the European Phoniatrics Rules. The software tools used for development were Delphi® and Paradox®. The results related to the voice evaluation of elderly women compares favorably with the normal aging process. The software stores and recovers the exams data as well as evaluates voice characteristics and presents graphical outputs in an appropriate way.

1 INTRODUCTION

The speech has its origin at the vocal folds level, through the air flux coming from the lungs, passing throughout the larynx constriction, the equalized by the vocal tract and radiated by the lips (Boone and McFarlane, 1994).

The voice exam only is complete when the sound properties are stored and analised in some way (Damsté, 1970).

The phonetography is a exam that allows to evaluate both the frequency extension and dinamic range for each frequency value. The result of this method produce a graphic called phonetogram. This exam allows to identify changes in the voice associated with common pathological conditions to verify the progression resulting from the vocal therapy or simply to follow the voice development of the individual (Damsté, 1970; Gramming, 1988; Higgins and Saxman, 1991; and Teles-Magalhães, Pegoraro-Krook and Pegoraro, 2000).

The rapid growth of elder population has brough some concern in the last few decades. The concern is more related to the added life in years than the added years in the life (Leden, 1977). These considerations bring some questions like : what is the vocal

extension of elderly people? What is the boundary between aging and pathological conditions in the vocal changes ?

Several papers about voice in the aging have maked clear that there is a great interest in better knowing the voice characteristics of this population. So the effects of the age on the voice have to be clearly defined in order to stablish the healthy range of the voice characteristics.

The effects of the age on the vocal behavior seems to be different in type and level for men and women (Higgins et al., 1991). In this work just the women voices are considered.

The informatic has auxilied the speech therapists in their diagnosis efforts. Unfortunately, for the phonetography case, the few softwares commercially available do not present database facilities or have prohibitive cost, making the storage or recovery of data cumbersome.

Taking in account all this shortcomings, the objective of this work was to elaborate a software that from the measures of phonetography of elderly women elaborates the phonetogram, evaluation of its area, of the vocal extension (VE) and the dinamic extension (DE) storing all this information in a database.

2 MATERIAL AND METHODS

2.1 Phonetography

Forty volunteers women from Bauru city, São Paulo state participated of this work, aging from 60 to 84 years old ($\overline{X}$=68,2 ± 5,74 years old). All of these women were interviewed besides the submission of perceptive and audiologic exams.

The exam procedures follow the standards proposed by Shultte e Seidner (1993) and recommended by the European Phoniatrics Union. Basically the exams were issued in a acoustic room of the Experimental Phonetic Laboratory of the Hospital de Reabilitação de Anomalias Craniofaciais, of the São Paulo University. A Casio Model CA-110, miniorgan was used to generate the musical notes, and an Entelbra 142 analogical sound level meter (sound pressure level gauge) to obtain the intensity measurements.

2.2 Database Program

Equipment (hardware): one IBM-PC® presenting the following characteristics: Pentium IV® processor (3.0 GHz), RAM memory 512 Kb, hard disk of 80 Gb and CD_ROM Creative® was used. The video resolution was 800 x 600 pixels per inch. Also has been used a HP Deskjet 692C.

Programs (software): the software was developed in Windows XP® using Delphi® from Borland Inprise Corporation (version 5.0) and Paradox® from Paradox Corporation for the database.

2.3 Parameters Evaluated from Phonetography

Vocal Extension evaluation: by using the fundamental frequencies values (F_0), in semitones (st), it is applied the following formula:

$$EV = F_0 \max - F_0 \min \qquad (1)$$

Where:
- EV = Vocal extension (st);
- F_0 max = Maximum frequency (st) produced by the individual;
- F_0 min = Minimum frequency (st) produced by the individual;

All evaluations related to the frequency are made using semitones (st).

Dynamic Extension and Maximum Dynamic Extension: after all obtained values for maximum and minimum magnitude for each frequency to be introduced, the following formula for dynamic extension is applied:

$$DE = Int \max - Int \min \qquad (2)$$

where:
- DE = Dynamic extension (dB);
- Int max = Higher magnitude (dB) produced by the individual;
- Int min = Lower magnitude (dB) produced by the individual.

The maximum dynamic extension (MDE) is the higher dynamic extension found among all tested frequencies.

Phonetogram Area Evaluation: the area evaluation follows the standard proposed by Shultte e Seidner (1993). In order to evaluate the area the following formula is used:

$$A = \sum_{i=1}^{n-1} \frac{\left(I_{\max_i} - I_{\min_i}\right) + \left(I_{\max_{i+1}} - I_{\min_{i+1}}\right)}{2} \cdot \left(st_{i+1} - st_i\right) \qquad (3)$$

where:
- A = Area of the phonetogram (cm^2);
- Int max = Higher magnitude (dB) produced by the individual;
- Int min = Lower magnitude (dB) produced by the individual;
- St = Semitone where the maximum and minimum magnitude were evaluated;
- n = Number of elements (semitones) of the phonetogram.

3 RESULTS

3.1 Exam Data Evaluation

Related to the minimum frequencies, their values varied from 110 Hz or 33 st to 220 Hz or 45 st. The average value for minimum frequencies was 154 ± 24,98 Hz or 38,68 ± 2,80 st.

For the maximum frequencies of vocal extension, the higher value was 659 Hz or 64 st, and the lower value was 330 Hz or 52 st. The average value for the maximum frequencies was 478,88 ± 56,11 Hz or 58,35 st ± 2,04 st for all sample.

For the vocal extension, the maximum value was 609 Hz and the lower was 172 Hz or 10 st, with average of 324,05 ± 56,97 Hz or 19,70 ± 3,09 st.

The maximum dynamic estension (MDE) varied from 16 to 43 dB. The average value found in the sample was 29,08 ± 7,09 dB.

As far as the area of the phonetogram is concerned, the lower area found was 162,0 dB.st or 7,3 cm2 and the higher area was 654,5 dB.st or 29,5 cm2. The average value for this parameter considering all the sample was 404,8 ± 135,1 dB.st corresponding to 18,2 ± 6,1 cm2.

3.2 The Software

The computer program developed, that managing the database of phonetography generating the phontogram, is compose by eight modules for diferents tasks:

Menu – this module shows all available options of the program.

Patient schedule – This module contains all information about the patient and, allows to include or make alterations in the schedule.

Phonetography Schedule – The user can manipulate the data related to phonetography (frequency values (st) and magnitudes (dB)). Through these values, the program can evaluates the Vocal Extension (VE), the Maximum Dynamic Extension (MDE) and the graphic area. Also, protocols of palate evaluation, speech, voice and larynx have been included in this module.

Phonetogram Comparisons – in this module, comparisons between 2 or more (maximum 6) phonetograms can be done. Any phonetogram can be choose by the user from database.
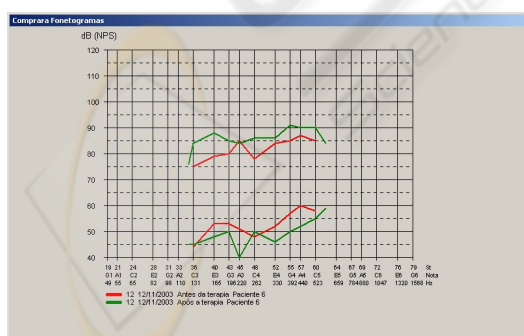

Figure 1: Comparison between phonetograms.

Data Filter – this module allows the user to select any specific class of patients. For example, it is possible to select all patients from 50 to 55 years old or all patients with a specific larynx dysfunction.

Printer Configuration – this module runs a Windows® routine to configure the system printers.

Software Information – this module shows all information related to the program.

End of Program – this module asks for the end procedure and, through the confirmation, closes the database and concludes the process.

4 DISCUSSION AND CONCLUSION

4.1 Characteristics of Elderly Women Voice

Certainly the advance of the age causes lower performance of the biologic systems. Particularly, the vocal behavior of women studied in this work confirms the procedure of normal aging.

Considering the results, it can be observed that:
- Vocal extension was expanded for low frequencies;
- Reduction of higher boundary of the vocal extension;
- Decreasing of the number of tones of vocal extension;
- Restriction of the boundaries of the minimum magnitudes;
- Restriction of the boundaries of the maximum magnitudes;
- Reduction of the maximum dynamic extension;
- Reduction of the phonetogram area;
- Better control of the vocal magnitude at 262 Hz or 48 st, showing high vocal comfort at this frequency.

4.2 Database Utilization

The easy use of the exam information of the database has become a useful tool for the voice specialist. The better flux information saves time with schedule or data files in different places of the hard disk.

The fast parameters evaluation, after the frequency and magnitude data insertion, helps the diagnosis. In many cases, the phonetogram area evaluation can not be at the clinical practice because demands a more complex mathematical formula.

The over plot facility makes the comparison instantaneous. In this way, the comparison among patients or even between pre and pos-therapy makes

the software an attractive tool. Also the visual feedback can helps the patient to correct his vocal gesture.

In conclusion, this software is a potential auxiliary tool for voice specialists by presenting quantitative values of the voice and allowing recording and comparing the voice at distinct times of the rehabilitation procedure.

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