COMPUTER-ASSISTED ASSESSMENT OF FETAL GROWTH AND DEVELOPMENT

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Abstract

The analysis of fetal development through ultrasonic examination is a safe, noninvasive and valuable procedure. However, the quantitative analysis of data collected during the examination is tedious and time-consuming. A computer application has been developed to aid in this process. The program estimates Gestational Age and provides a comprehensive Growth Profile of the fetus. Obtained values that fall outside allowable ranges are noted and brought to the user's attention. The program has met with great success.

Introduction

Monitoring fetal growth and development is a vital concern for the obstetrician. Defects can be detected, and, if possible, corrective treatment planned. Diagnosis of Intrauterine Growth Retardation (IUGR) can also be made. A positive indication of IUGR can alert the medical staff to potential complications, as low birth-weight is a major contributor to perinatal mortality.

Ultrasound is rapidly becoming the preferred vehicle for this monitoring. It is non-invasive, reproducible and, as an added benefit, is harmless to the mother and child. The fetus is easily localized and examined with the use of sound waves.

From the images obtained, parameters of fetal anatomy can be measured. These can be used to estimate fetal age and development.

While ultrasound is a safe and effective tool, analysis of data collected in the study is lengthy and involved. For each parameter to be studied, there exists a great variety of equations, charts, graphs and tables. The data is calculated and interpolated in a number of ways. In some cases, results obtained in one equation must be entered into algebraic algorithms to provide other answers. Through these the fetus' relation to population norms is established.

For the busy physician, the extensive nature of this operation poses problems. The heavy emphasis on mathematics exposes the procedure to systematic and precision errors. Graphs may be difficult to use, causing poor placement of data points.

Additionally, demands on a physician's time may cause him to omit, either consciously, or unintentionally, certain parameters from his determination. This could result in missing information that could enhance the diagnosis.

The basic quantitative nature of this operation makes it perfect for the use of computer-aided diagnosis.

Background

The Western Pennsylvania Hospital is a 608 bed referral and teaching facility located in Pittsburgh, Pennsylvania. Its Ultrasound Division has a staff of eight employees, including two full-time physicians. Equipment includes one ATL and two Diasonics real-time sector scanners and a Searle B-Scanner. An average of 4,400 examinations are performed annually, of which, twenty percent are pregnancy related.

In 1980, the sister Division of Nuclear Medicine acquired a DEC PDP-11/34 mini-computer with RT-11 operating system. The primary use of this system is for acquisition and analysis of data.
in nuclear medicine examinations through the use of B Gamma software. Input-output is accomplished by means of a DEC writer-2 console/prINTER. The program described below was developed on this system.

Development

A number of physicians in the Pittsburgh area were interviewed regarding ultrasonic fetal growth analysis. The major part of this interview concerned their particular procedures and techniques. Additional questioning tried to determine their attitudes toward computer assistance and sought their recommendations.

Most of those interviewed indicated that any computer application which differed significantly from their own examination practice would meet with a great deal of resistance. All felt that a method of quickly analyzing all pertinent parameters at one time would be very popular, especially if alterations could be made easily.

Although individual physicians had individual styles, the general pattern was similar.

The first step was to estimate Gestational Age (GA). This estimate is used as the basis for establishing expected values and error ranges for the parameters of interest. Actual obtained values are compared to these norms and any discrepancies noted.

The computer program at West Penn was designed to recapitulate this process.

The user is prompted as to the entry of demographic and measured data. Depending on expected fetal age and other factors up to four estimates of GA are calculated and displayed. These are based on dates from Last Menstrual Period (LMP), Crown-Rump Length (CRL), Biparietal Diameter (BPD), and Growth Adjusted Sonographic Age (GASA). Based on the confidence limits of these estimates, the program selects and suggests a GA. The user may accept this suggestion or enter one of his own.

From this GA estimate, expected values are derived for all relevant parameters. Calculations are done on the basis of equations obtained and adapted from the literature.

The expected values, acceptable ranges and actual measurements are displayed in a Growth Profile (GP). Any results that fall outside "allowable" limits are brought to the user's attention. The GP has the capability of analyzing and displaying values for Head Circumference (HC), Abdominal Circumference (AC), HC/AC ratio, Femoral Length (FL), Total Intrauterine Volume (TIUV), and Lateral Ventricle-Hemisphere ratio (LV/H). Some additional relations are also analyzed, e.g. BPD/FL ratio, an indicator of dwarfism.

The GA used for the norm estimates is again displayed, and the user may, if desired, readjust his estimate. If a new estimate is indicated, all expected values are immediately recalculated and a new GP generated.

Once the user is satisfied with the GA and GP, he is prompted as to certain textual entries such as fetal anatomy, activity, placental description and presentation. Space is also provided for free form commentary.

The final step in the process is the printout. The entries and results obtained above are printed onto a report form, designed by the user.

Discussion

This application has been developed with the support and advice of the physician-users at West Penn. The problem-solving process of the program follows the actual diagnostic procedure. Benefits include improvements in time, accuracy and completeness. The program routinely and easily incorporates measurements that may otherwise be omitted due to time pressure.

The Growth Profile has been of special value. At one time the user can view a summary of all applicable parameters with obtained and expected values. The GA estimate on which the GP is based can be easily adjusted, facilitating the asking of "what if" questions.

Furthermore the program itself is well documented and can readily be altered. Equations used have been selected and adapted from readings, however they reflect the preference of the in-house users. But, if others are found to be more desirable, they can be replaced. This has already happened with the formula used for fetal weight estimation.
The success of this project is in a large part due to the cooperation of the users. Hopefully, it will lead to other successes in other areas.

References


