An image processing for umbilical artery blood flow velocity waveforms

M.Sinan BEKSAÇ[1], Cem GÖREN[1], Galip KARTAL[1], Aydan ERKMEN[2]

[1] Hacettepe University, Medical School, Department of Obstetrics and Gynaecology, Ankara-TURKEY
[2] Middle East Technical University, Electrial and Electronics Engineering, Ankara-TURKEY

This study is objected to effective use of Doppler technology in perinatal medicine. Fetal blood flow velocity waveforms are good predictors of fetal conditions and abnormal pregnancy outcome. By using image analysing techniques, features about Fetal blood flow velocity waveforms can be extracted automatically. This enables us to cover limitations of Doppler ultrasound equipments and get better measurements about blood flow velocity waveforms. 3.75 MHz dupplex pulsed wave Doppler probe, IBM-PS2 micro computers, frame grabber and a special software were used to acquire blood flow velocity waveform images. An edge detection algorithm is implemented for the image analysis of fetal blood flow velocity waveforms. [Turk J Med Res 1992; 10(6):298-300]

Key Words: Perinatal surveillance, Doppler, Ultrasound, Blood flow velocity waveforms, Image analysing

INTRODUCTION

Since the introduction of Doppler ultrasound, increasing number of reports suggested that the Doppler flow velocity waveforms in the uterine arteries, umblical artery and fetal vessels are good parameters of abnormal pregnancy outcome (1-9). However, no conclusive evidence has been provided that these Doppler studies lead to an improvement in perinatal morbidity and mortality (1-10).

Technological improvements enable investigators to acquire clear blood flow velocity waveforms (BFVW) images (1-10). There is a quick technological development in the Doppler ultrasound equipments. Three kinds of Doppler equipment are presently used in obstetrics such as pulsed wave Doppler (PWD), continuous wave Doppler (CWD) and color flow imaging (CFI) with very complicated probes. However, comparatively less Improvement is observed in the interpretative methodology for perinatal surveillance.

There is a certain consensus in the regulations for the use of Doppler technology in perinatal medicine. Present methodology works with various parameters (Pulsatility Index, Resistance Index, A/B Ratio, Conductance Index) manually extracted from BFVW

images (11). We believe that image analysis and signal processing techniques should replace the algorithms of conventional methodology.

In this study, we have performed an image analysis technique to extract the necessary features to be used in signal analysis with neural networks in future.

MATERIALS AND METHODS

Data Acquisition: Umblical BFVW's were acquired by 3.75 MHz dupplex pulsed wave Doppler probe (General Electrics, Radius HR). The Doppler ultrasound image is transferred from video output to IBM-PS by means of a frame grabber (IRIS DT 2853, Data Translation Inc, 100 Locke Drive Marlboro MA 01752-1192, USA) and a special software.

In this stage, we have acquired the images by means of IRIS sofware on 3.5 inch floopy diskets or/and hard disk as an image file. Unfortunately, our frame grabber was unable to display the image on CRT monitors so we have raised our own software with Turbo Pascal 5.5 (Borland Inter. Inc., 1800 Green Hills Road, Scotts Valley, CA 95067-0001, USA).

Image Analysis: An edge detection algorithm is used for analysing of BFVW images (12). We applied different filters to remove noises on waveforms. Laplacian and X-Y filtering techniques are used for this purpose (12).

RESULTS

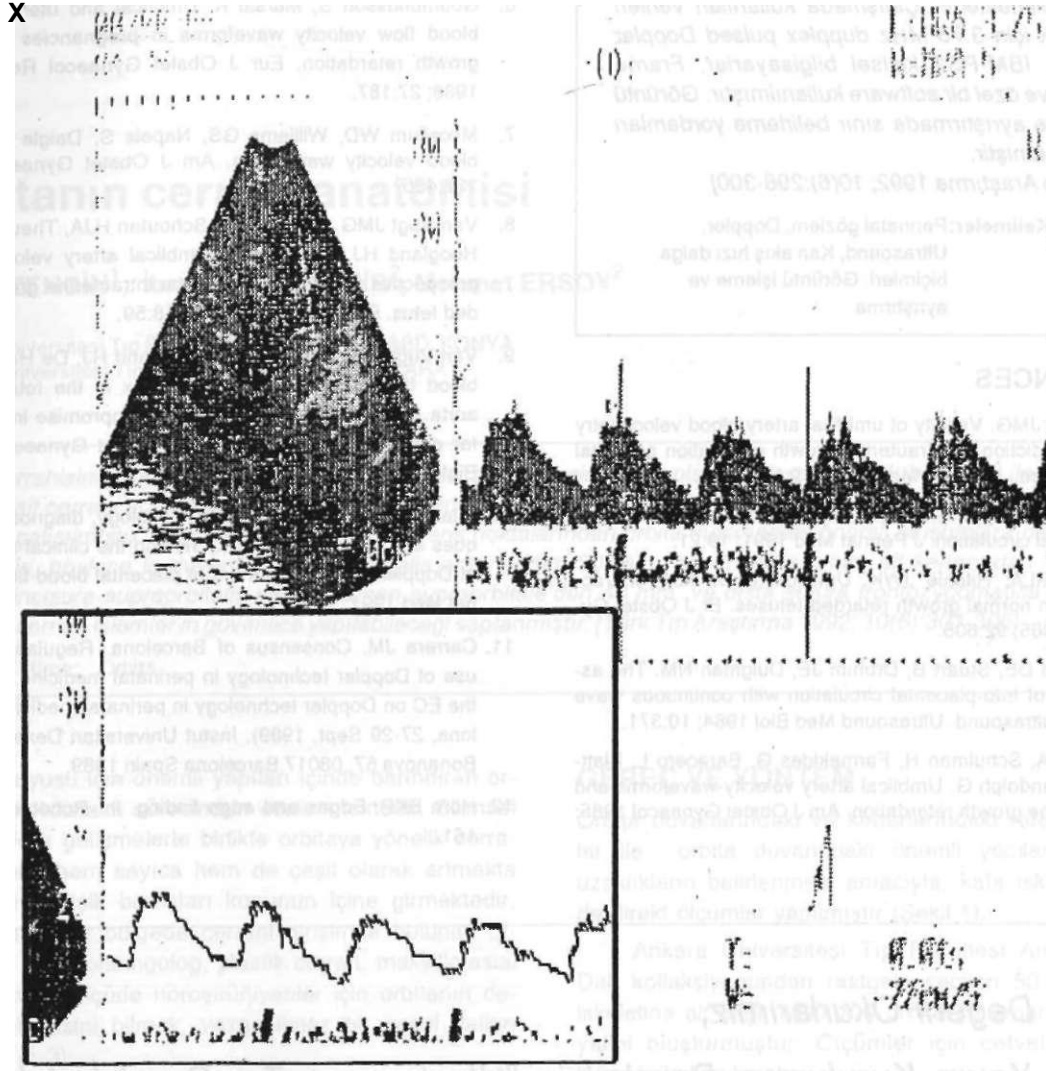Figure 1 shows the result of the image analysis on umblical BFVW.

Figure 1. Umblical artery blood flow velocity waveforms before and after image analysis.

DISCUSSION

There are at least 18 different parameters for assessing the flow velocity waveforms (11). Very expensive equipments which are denoted by high technology utilizes these algorithms for the evaluaiton of the BFVW images (1-11). However, investigators are limited with the medical decision-making algorithms of different ultrasound equipments. We believe that open systems are essential to break up the limitations of individual Doppler ultrasound image on personel computer or Work stations.

We also believe that we need better feature extraction and processing technology to improve the predictive value of BFVW measurement.

In this study, we established an open system which can be accesible easily. In future, we are planning to establish an expert system with neural network gohthms and set up our own automated analysis system for perinatal surveillance.

Turk J Med Res 1992; 10 (6) .

ACKNOWLEDGEMENT

Umbilikal arterde kan akım hızı dalga formunun görüntü analizi

Bu çalışmada, Doppler teknolojisinin perinatal tıpta daha verimli kullanımı amaçlanmıştır. Doppler tekniği yardımıyla elde edilen kan akış hızı dalga biçimleri doğacak bebeğin sağlığına ilişkin oldukça önemli ve belirleyici bilgiler taşımaktadır. Görüntü işleme ve ayrıştırma teknikleri kullanılarak kan akış hızına ilişkin özellikler ekrandaki dalga görüntüsü üzerinden otomatik olarak toplanabilmektedir. Böylece ölçümleri daha sağlıklı hale getirmek ve Doppler cihazlarının sınırlamalarını aşmak müm-

kün olabilmektedir. Çalışmada kullanılan verileri toplamak için 3.75 MHz dupplex pulsed Doppler probları, IBM-PS2 kişisel bilgisayarlar, Frame grabber ve özel bir software kullanılmıştır. Görüntü işleme ve ayrıştırmada sınır belirleme yordamları gerçeklenmiştir.

Anahtar Kelimeler: Perinatal gözlem, Doppler, Ultrasound, Kan akış hızı dalga biçimleri, Görüntü işleme ve ayrıştırma

REFERENCES

1. Van Vugt JMG. Validity of umblical artery blood velocimetry in the prediction of intrauterine growth retardation and fetal compromise. J Perinat Med 1991; 19:15.

2. Campbell S, Vyas S, Nicolaides KH. Doppler investigation of the fetal circulation. J Perinat Med 1991; 19:21.

3. Erskine RLA, Ritchie JWK. Umblical blood flow characteristics in normal growth retarded fetuses. Br J Obstet Gynaecol 1985; 92:605.

4. Fitzgerald DE, Stuart B, Drumm JE, Duigman NM. The assesment of feto-placental circulation with continuous wave Doppler ultrasound. Ultrasound Med Biol 1984; 10:371.

5. Fleisher A, Schulman H, Farmakides G, Baracero L, Blattner P, Randolph G. Umblical artery velocity waveforms and intrauterine growth retardation. Am J Obstet Gynaecol 1985: 151:502.

6. Gudmundsson S, Marsal K. Umblical and utero-placental blood flow velocity waveforms in pregnancies with fetal growth retardation. Eur J Obstet Gynaecol Reprod Biol 1988; 27:187.

7. Mccallum WD, Williams GS, Napels S, Daigle RE. Fetal blood velocity waveforms. Am J Obstet Gynaecol 1978; 132:425.

8. Van Vugt JMG, Ruissen CJ, Schouten HJA, Theunissen M, Hoogland HJ, De Haan J. Umblical artery velocimetry: a prospective study in search of the intrauterine growth retarded fetus. Early Hum Dev 1988; 18:59.

9. Van Vugt JMG, Ruissen CJ, Hoogland HJ, De Haan J. The blood flow velocity waveforms index in the fetal thoracic aorta and its ability to detect fetal compromise in the small for gestational age fetus. Eur J Obstet Gynaecol Reprod Biol 1988; 27:105.

10. Wladimiroff JW. A review of the etiology, diagnostic techniques and management of IUGR and the clinical application of Doppler in the assesment of placental blood flow. J Perinat Med 1991; 19:11.

11. Carrera JM. Consensus of Barcelona. Regulation for the use of Doppler technology in perinatal medicine. Report of the EC on Doppler technology in perinatal medicine (Barcelona, 27-29 Sept. 1989). Instut Universitari Dexeus, Paseo Bonanova 67, 08017 Barcelona Spain 1989.

12. Horn BKP. Edges and edge finding. In: Robotvision 1986; 161.