From Fetal Imaging to Pediatric Gynecology Imaging in a 22-Year Span

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ABSTRACT

A review of the ultrasound experiences of the author since 1989 up to the present. Ultrasound pictures taken for fetal and pediatric gynecology imaging are presented. The impact of ultrasound examination is the improvement of perinatal outcome and diagnosis and management of gynecological problems of children, thus preserving their future fertility.

Keywords: Fetal growth curve, IUGR, 2D, 3D and Doppler ultrasound, Pediatric gynecology, Transabdominal sonography (TAS), Transvaginal sonography (TVS), Transrectal sonography (TRS), Transperineal sonography (TPS), Breast ultrasound.

INTRODUCTION

A perinatal center was established in 1988 in a children’s hospital, one of the few such centers in the world at that time. The objective was to reduce perinatal mortality through maternal transport instead of neonatal transport. This was made possible through a JICA (Japan International Cooperation Agency) grant of 343 million yen (37 million pesos, 2.4 million usd) to upgrade medical equipment. The equipment donated was used for diagnosis and therapy of mothers and newborns and also for education and training in perinatology of doctors and nurses and midwives in the Philippines.

The perinatal center was inaugurated on June 28, 1988, and was graced by the presence of the Japanese ambassador to the Philippines, the secretary of health and lecturers to the first postgraduate course on fetus as a patient: Professors Asim Kurjak, Kazuo Maeda, Hitoo Nakano, Benjamin P Sachs and Victor Yu.

Provision of services to the high-risk mother, fetus and newborn, training of health workers and stimulation of research would be the means of achieving the ultimate goal of reducing perinatal mortality, which was 18.5/1,000 live births in QC in 1987.

The establishment of the QC Perinatal Council in 1986, composed of four tertiary hospitals, Children’s Heart, Lung and Kidney centers, four secondary hospitals, four Lying-in centers and 48 health centers was the initial step. Assessment, resuscitation, stabilization before transport of the high-risk mother and fetus were the emphasis of the initial training. The next subject of training was when, where and what to refer to the perinatal center. The first workshop on basic ultrasound was conducted at the perinatal center by Professor Branko Rajhvan of the University of Zagreb (Courtesy of Professor Kurjak in 1989).

OBJECTIVE

This is a review article that would highlight the ultrasound training of the author at the WHO coordinating center for ultrasound of the University of Zagreb, the Ian Donald Inter-University School of Medical Ultrasound in 1989, the Master of Science degree in 1992, and the Doctor of Science degree in 2000 at the University of Zagreb.

This will show the impact on the community on the purpose for which the perinatal center was established in 1988, on the country by the training of the country’s specialists and on research productivity.

FETAL IMAGING

Fetal Growth Curve

Measurement of fetal BPD, FL and FAC at different ages of gestation serially on 200 normal pregnancies generated a formula to estimate the gestational age and 48 pregnancies that delivered 0 to 7 days after an ultrasound examination generated a formula on the estimation of birth weight at different ages of gestation. The formulas are shown, number 1 and 2. The data generated are shown in Figure 1.

Twenty thousand normal newborns delivered at different ages of gestation were weighed, head, chest and abdominal circumference were measured and a fetal growth curve was generated. Figure 2 is the fetal growth curve based on newborn weight. Notice the dip in the 50th percentile curve from gestational ages 26 to 32 weeks. This is a proof that babies born prematurely might be growth retarded.4,5

A fetal growth curve was generated for the Filipino population because the average Filipino baby weighs 3000 gm at birth in contrast to those of other countries like USA where

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the average weight is 3,300 gm and those of Europe where the average weight is 3,500 gm. The Filipino baby on ultrasound will fall below the average of gestational age if the measurement made is compared to those of other country’s values.

Computer Generated Formulas for Estimating Age of Gestation and Fetal Weight

**Estimation of Gestational Age**

$$AOG = 3.348 + 0.47 \times BPD - 3.066 \times 10^{-4} \times FAC - 2.992 \times 10^{-4} \times BPD^3 + 2.656 \times 10^{-5} \times FL^3 + 1.173 \times 10^{-6}$$

**Estimation of Birth Weight**

$$BW = 598.5 + 0.004 \times FL^3 - 0.029 \times FAC^2 + 0.92 \times 10^{-4} \times FAC^3 + 21.79 \times BPD$$

**Estimation of Birth Weight for LGA using 2D**

$$EFW (kg) = 3.291 + 0.1238 (BPD) - 0.147081 (FL) + 0.0101 (AC)$$

Mean error: 207 gm (43-566)

**Estimation of Birth Weight for LGA using 3D and 2D**

$$EFW (kg) = -4.42 + 0.07 \times TV - 0.183 \times AV - 0.17 \times BPD + 0.1238 \times BPD - 0.147 \times FL$$

Mean error: 81 gm (0-140)

**TV—the thigh volume, AV—arm volume**

Ultrasound Pictures

The ultrasound pictures are from two patients that the author handled at the perinatal center of the Philippine Children’s Medical Center recently. Figures 3A to G show the first patient.

Patient had edema, increase in blood pressure and albuminuria at 36 weeks. Repeated ultrasound did not show increase in fetal weight, the venous and arterial Dopplers did not show any change. She was delivered by cesarean section to a baby girl weighing 1,672 gm estimated to weigh 1,897 gm. Baby and mother went home on the 5th hospital day. Figures 4A to F show the second patient.

The baby was growing, the Doppler values were normal except for notching of the fetal aorta. The patient underwent a cesarean section on the 31st week of gestation because of deterioration of the mother’s serum creatinine from 3 mg at 28 weeks to 3.75 mg at 31 weeks. The baby weighed 1,190 gm at birth, admitted to the NICU and put under nasal CPAP. Baby was observed for necrotizing enterocolitis (NEC).

These two cases illustrate that fetal imaging identifies developing intrauterine fetal growth restriction, assures fetal well-being and serve as guideline on the right timing of delivery when the fetal risks outweigh neonatal risks. The second case shows that the fetus will survive for two weeks more despite absence of diastolic flow in the umbilical artery but with absence of A-wave reversal in the ductus venosus.

A study on 99 hypertensive pregnancies was done in 1998, as subject of author’s doctor of science thesis, Antepartum Assessment of Perinatal Asphyxia. Cardiotocography, biophysical profile and Doppler velocimetry of umbilical artery 1 week before delivery correlated with cord pH at birth and neonatal morbidity and mortality. The objective was to reduce stillbirths, which was 6.79/1000 births in 1987 in Quezon city.

Five (5%) of the 99 patients had intrauterine fetal death. Three (3%) had abnormal fetal tests; one died within 6 hours of admission; two were too premature for active intervention. Two (2%) had normal CTG, biophysical scores and umbilical artery Doppler 48 hours before intrauterine fetal demise. Targeted monitoring intervals as suggested by Rizzo and Arduini will minimize fetal deaths. In 1992, the stillbirth rate in Quezon city was reduced to 4.01/ 1,000 births.

The growth restriction intervention trial (GRIT) should be mentioned here where 588 patients from 69 hospitals in 13 European countries were randomized to immediate delivery and delayed delivery and at 2 years after, 19% died or had severe disability in those delivered immediately and 16% in those with delayed delivery. Odds ratio (OR) 95%, 1.1 (0.7-1.8) disability.
in those delivered before 31 weeks were seen in 13% of those who delivered immediately and 5% in those who had delayed delivery. Follow-up of 302 children at ages 6 to 13 years do not show clinically significant difference between the immediate or delayed delivery.

The GRIT studies may not reflect the effect on the future adult but following Baker’s hypothesis of fetal programming, these IUGR babies must be followed to see how many develop metabolic syndrome, diabetes, hypertension and cardiac diseases later in life.

PEDIATRIC GYNECOLOGY IMAGING

In April 22, 2002, the pediatric and adolescent gynecology unit was opened for service and training at the Philippine Children’s Medical Center, the first in the Philippines and in Asia. The author headed the unit at the same time, head of the perinatal center. A multidisciplinary consultant staff was organized composed of OB GYN reproductive endocrinology, OB GYN oncology, pediatric urology, pediatric anesthesiology, adolescent pediatrics, ambulatory pediatrics, pediatric endocrinology and genetics. Two fellows were accepted for training in the specialty who already were board eligible in the specialty of OB GYN. In October 31, 2003 the author and an OB GYN reproductive endocrinology consultant passed the certifying examination (IFEPAG), the certifying board of the International Federation of Pediatric and Adolescent Gynecology (FIGIJ).

Ultrasound Pictures

The following series of ultrasound pictures Figures 4A to 12F shows the most common cases seen at the Pediatric Gynecology Unit of the Philippine Children’s Medical Center except the two pictures of that of fetal imperforate hymen and fetal ovarian cyst courtesy of Dr Musarat Hasan (Pakistan) (Flow Chart 1). Figure 7 shows how to do ultrasound examination on babies. Some of the ultrasound pictures were correlated with findings on operation as well as histopath of the tumor. Table 1 shows the correlation of the age of the child, the tanner stages of the breast, the size of the uterus and ovaries13 collated from 397 ultrasound examinations of children at the PAG Unit. The manner of ensonation, by TAS (transabdominal), TRS (transrectal), TVS (Transvaginal) and TPS (transperineal) are depicted and explained.
Figs 4A to F: 33-year-old G1PO, type I diabetes mellitus since age 11, developed diabetic nephropathy 5 years before pregnancy at age 28 years. Hypertension set in at the same time. She got married at age 32 years and became pregnant a year later. She was referred by a nephrologist at 5 months AOG with high blood pressure, uncontrolled diabetes with rising serum creatinine and BUN. The possibility of cardiomyopathy was entertained by cardiologist who suggested admission. Patient improved with intensive care at the perinatal center; the baby was growing well as shown by serial ultrasound examinations (Ultrasound pictures from A to F are on file at the author’s clinic): (A) At 29 weeks BPD, FL, FAC measurements were AGA, EFW 1,282 gm, (B) at 29 weeks, UMA studies showed absent diastolic flow, (C) at 29 weeks ductus venosus Doppler do not show reversal of A wave, (D) MCA Doppler, (E) ductus venosus Doppler at 31 weeks, (F) fetal aorta notching at 31 weeks.

Figs 5A to D: Imperforate hymen: (A) Imperforate hymen in a fetus intrauterine (Courtesy of Dr M Hassan, Pakistan) (B) imperforate hymen in a 8-year-old with echogenic fluid in vagina and uterus,15 (C) imperforate hymen in a 8-year-old with precocious puberty, (D) after hymenectomy.
RESULTS

The outcome of the high-risk mother, fetus and newborn had improved on admission to the perinatal center through fetal surveillance and right timing of delivery.

This can be attributed to the ultrasound training that the author got 22 years ago, the training of the 20 fellows that finished the fellowship training program at the perinatal center and the most important of all, the training of the staff in the network of hospitals referring to the perinatal center.

The outcome for the girls who were seen, examined and treated at the pediatric gynecology unit were very good, their fertility was preserved, they got the correct diagnosis and management. “If you don't look for it you won't find it”, this is true for those girls with congenital anomalies of the genital tract.
Figs 8A and B: (A) Transrectal sonography (TRS) of uterus and cystic mass and thickened endometrium. (B) Transabdominal sonography (TAS).

Figs 9A to E: Complex abdominal mass in a 13-year-old: (A) Pelvic ultrasound, (B and C) gross examination on operation, (D) Endodermal sinus tumor in a 2-year-old. TRS with Doppler shows a lot of blood flow, characteristic of malignancy, (E) Schiller-Duvall bodies on histopathologic examination.

Fig. 10: Mass in vagina extending to abdomen up to 1 cm from introitus. UTZ examination using different probes and by different routes: TAS, TPS convex, TPS 3D, TPS vaginal probe, TRS vaginal probe.
Fig. 11: Uterus didelphys, cervical agenesis, rudimentary vagina,\textsuperscript{13} OHVIRA, coronal section of 3D showing two uterine cavities (From author’s file)

Figs 12A to C: Tanner stages of breast and uterine and breast ultrasound findings\textsuperscript{11,13}. (A) a. Breast budding infant, b. breast UTZ: small bud, c. cervix: uterus ratio 1:1; (B) a. Tanner stage 1, b. fibroglandular area, c. tubular uterus 1:3; (C) a. Tanner stage II, b. bigger fibroglandular area, c. cervix: fundus ratio 2:3
SUMMARY

1. A review of the ultrasound examinations done by the author was presented.
2. The impact of the ultrasound training that the author got from the University of Zagreb on the community was presented partially.
3. The 21 fellows in perinatal medicine and six fellows in pediatric and adolescent gynecology got training from the author and they practise in five regions in the Philippines. 350 OB GYN residents rotated to the Center.
4. Some researches on ultrasound examination were shown.
5. Ultrasound examination of the high-risk mother, fetus and newborn has contributed to the improvement of perinatal outcome and the network of hospitals contributed to the dissemination of the excellent care not only in the center but also to the remotest barangay.
Flow Chart 1: Network of hospitals grouped under the QC perinatal council organized by the author in 1986, before the perinatal center was launched (From author’s file)

Table 1: Uterine length, ovarian volume, age range and tanner stages in children

<table>
<thead>
<tr>
<th>Tanner stages</th>
<th>Age range years (mean)</th>
<th>Uterine length (mean) cm</th>
<th>Right ovarian volume (mean) cm²</th>
<th>Left ovarian volume (mean) cm²</th>
<th>Total cases</th>
</tr>
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<tbody>
<tr>
<td>Breast bud</td>
<td>0-1 (6.03 mos)</td>
<td>2.34</td>
<td>1.62</td>
<td>1.50</td>
<td>29 (7.3%)</td>
</tr>
<tr>
<td>I</td>
<td>1-7 (3.43)</td>
<td>2.10</td>
<td>1.04</td>
<td>1.00</td>
<td>74 (18.6%)</td>
</tr>
<tr>
<td>II</td>
<td>7-13</td>
<td>3.19</td>
<td>3.58</td>
<td>3.03</td>
<td>42 (10.6%)</td>
</tr>
<tr>
<td>III</td>
<td>9-18 (12.93)</td>
<td>4.30</td>
<td>5.67</td>
<td>5.40</td>
<td>73 (18.4%)</td>
</tr>
<tr>
<td>IV</td>
<td>11-19 (15.8)</td>
<td>5.44</td>
<td>6.78</td>
<td>6.60</td>
<td>122 (30.7%)</td>
</tr>
<tr>
<td>V</td>
<td>15-19 (17.19)</td>
<td>6.03</td>
<td>7.94</td>
<td>6.62</td>
<td>57 (14.4%)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>397 (100%)</td>
</tr>
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6. Girls with congenital anomalies, tumors, conditions and diseases of the genital tract were identified, managed and treated keeping in mind the preservation of their fertility.

REFERENCES


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