Tissue Characterization with Gray-level Histogram Width in Obstetrics and Gynecology

Kazuo Maeda, PE Kihaile, T Ito, M Utsu, N Yamamoto, M Serizawa

ABSTRACT

Aim: Clinical ultrasound tissue characterization, using usual B-mode devices.

Materials and methods: Malignant neoplasia in ovary, uterine cervix, and endometrium; placental intervillous space fibrin deposit; fetal growth restriction; fetal brain, fetal lung immaturity; meconium-stained amniotic fluid and healthy adult liver; Tissue was characterized by gray-level histogram width (GLHW) divided by full gray scale length.

Results: Malignant GLHW was higher than in benign one (it was malignant if the GLHW was 50% or more in ovary, uterine cervix, and endometrium). The GLHW of placental fibrin deposit was higher than normal placenta. It was reduced by heparin and normal neonate was obtained. Fetal brain echo density, immature fetal lung, and meconium-stained amniotic fluid were diagnosed by GLHW, and normal adult liver GLHW was studied. Helsinki declaration was followed.

Conclusion: The GLHW tissue characterization objectively diagnosed ultrasound B-mode image in obstetrics and gynecology; thus, it would also be applied in common adult human cases.

Keywords: Fetal growth restriction, Fetal organ, Gray-level histogram width, Liver, Malignancy, Placenta, Tissue characterization, Ultrasound.

INTRODUCTION

Although ultrasound B-mode image diagnosis was excellent, objective tissue echogenicity characterization was desired; however, particular computer and programs were mandatory. Ultrasound B-mode gray-level histogram width (GLHW) achieved clinical tissue characterization in obstetrics and gynecology.

MATERIALS AND METHODS

The clinical tissue characterization was achieved by GLHW divided by full gray scale length (Fig. 1), of which value was called GLHW, which was standardized by studying RMI 412 phantom (Radiation Measurement Inc., Middleton, Wisconsin, USA), of which histogram width did not change when the B-mode device gain controlled, while image contrast had to be the lowest, because histogram width was enlarged when the image contrast was high. The GLHW of RMI 412 phantom was studied to be standardized in various Aloka machines (Aloka, Tokyo) and Voluson 530D (GE Health care). The GLHW was manually calculated, and also automatically calculated by “%W” index in the histogram of Aloka B-mode devices (Tokyo), where the value was the same as manual determination.

RESULTS

Diagnosis of Malignancy

Ultrasound GLHWs of five connecting regions of interest (ROIs) in preoperative ovarian masses were compared...
with postoperative pathology in benign and malignant
tumors,\(^4\) where mean GLHW was 18 ± 10% in benign
masses, while it was 51 ± 11% in malignancy, and mean
GLHW values were larger in malignant masses than
benign tumors (Graph 1),\(^4\) therefore, ovarian malignant
neoplasia is diagnosed by GLHW. Ovarian dermoid cyst
was intermediate between benign and malignant masses;
however, a dermoid cyst is diagnosed by its characteristic
B-mode image, which is the niveau formation.

In other studies, mean GLHW was 42.7 ± 5.0% in
normal endometrium, while it was 58.2 ± 11.2% in
endometrial cancer; thus, endometrial cancer will be
diagnosed using GLHW.\(^5,6\)

The author found that the GLHW of uterine cervical
cancer was higher than 50%. Thus, general malignancy
will be indicated if its GLHW is 50% or more.

Recently, Nam et al\(^7\) reported differentiation of
malignant and benign thyroid nodules using histogram
analysis of gray scale sonograms. Ultrasonic B-mode
histogram diagnosis of malignancy was also supported
by the report.

**Grade 3 Placenta and Intervillous Fibrin Deposit**

The GLHW of 1 cm\(^2\) ROI of placental image was manu-
ally determined at every two gestational weeks in 20 to
41 weeks of normal pregnancies, where mean ± 1.5
standard deviation (SD) of GLHW were determined.
The GLHW was larger in grade 3 placenta than normal
placenta.\(^3\)

**Placental Fibrin Deposit in Fetal Growth
Restriction Treated by Heparin**

Placental GLHW of a case of intrauterine growth restric-
tion [Fetal growth restriction (FGR)] was larger than that
of normal placenta and diagnosed by Utsu to be inter-
villous fibrin deposit (Fig. 2) due to positive cardiolipin
antigen in the pregnant woman, and daily 5,000 units of
heparin were administered to the woman. The GLHW
decreased, estimated fetal weight increased to normal,
and normal neonate was obtained (Graph 2),\(^3\) despite
the death of an FGR fetus in a previous pregnancy of the
mother in the present study.\(^3\)

**DISCUSSION**

The deposited fibrin would reduce placental active trans-
fer of fetal nourishing material developing FGR, and
further damaged passive transfer of oxygen would cause
fetal demise in previous pregnancy. Heparin solved depos-
ited fibrin to promote placental transfer function and then
treated FGR and prevented fetal demise after hypoxia.

**Fetal Brain Periventricular Echogenesity**

Yamamoto et al\(^8\) studied fetal brain in preterm preg-
ancy detecting periventricular echodensity (PVE) (Fig. 3), of which 18% (corresponding 0.2% of all births)
preceded neonatal periventricular leukomalacia (PVL)
followed by cerebral palsy (CP), if the PVE lasted until
preterm birth, while there was no neonatal PVL when
the PVE disappeared before birth. Also, no PVE devel-
oped in full-term births’ neonates. The GLHW of fetal
PVE was 36 ± 5%, which was significantly larger than
23 ± 5% of normal fetal brain GLHW,\(^8\) thus, GLHW is
useful to diagnose fetal and neonatal brain PVE in the
prevention of neonatal PVL and CP, namely, the PVE
ultrasonically detected immediately after a preterm
birth will be effectively treated administrating medi-
cines, e.g., growth factor, erythropoietin, hydrocortisone
etc, in the future.
Fetal lung maturity should be detected prior to preterm birth to treat the neonate with artificial surfactant to prevent respiratory distress syndrome (RDS). Since the amniocentesis to analyze amniotic fluid for the detection of fetal lung immaturity is invasive in the present perinatal medicine, noninvasive ultrasonic tissue characterization of immature fetal lung has been studied by Serizawa.  

The GLHW values of fetal lung declined in immature fetal lung, while fetal liver GLHW was constant; the ratio of fetal lung GLHW and fetal liver GLHW was obtained, where fetal lung was immature in young fetus, when the result of gestational weeks multiplied by the ratio of fetal lung to liver ratio was less than 29, i.e., it was the critical level to divide immature and mature fetal lung, namely, 96% of neonatal RDS was predicted by the value lower than 29. The detection rate was highest among various RDS detection parameters. Novel preterm pregnancy management, e.g., maternal steroid administration is monitored by repeated noninvasive GLHW studies. Neonatal surfactant therapy is prepared, or fetal steroid therapy will be repeated, if the fetal lung is still immature with GLHW study.  

**Diagnosis of Meconium-stained Amniotic Fluid**  
Amniotic fluid is a clear fluid accumulated around the fetus in pregnant uterus, which was stained by meconium; fetal stool was released into amniotic fluid in hypoxic fetal asphyxia. The fetus will suffer meconium aspiration syndrom, if the fetus inhales the meconum mixed amniotic fluid. As the amniotic fluid was stained yellowish dirty by meconium expelled through relaxed fetal anal muscle in asphyxia, amniotic fluid GLHW was higher than clear fluid, and its GLHW was similar to that of fetal colon. Results were confirmed by Maeda et al., where normal fluid GLHW was 6.7 ± 2.0%, colon 9.5 ± 2.3%, and meconium-stained fluid 11.0 ± 3.6%, where significant difference was present between meconium-stained and normal fluids, while the difference was insignificant between colon and stained fluid, and significant between colon and normal fluid. Meconium-stained fluid would be diagnosed by ultrasound GLHW, namely, fetal asphyxia will be detected by GLHW of amniotic fluid.  

**The GLHW of Healthy Adult Liver**  
Mean GLHW of 33 healthy adult livers was 34.8 ± 3.7% and its coefficient of variation was 10.5%, where no relation of GLHW was noted to the age or gender. Therefore,
pathological state of adult liver is preferable to be studied by its specialists using GLHW, which is determined by the division of histogram base width by full gray scale length in the ultrasound B-mode, or simply by the “%W” parameter in the Aloka ultrasound B-mode histogram.

CONCLUSION

Gray-level histogram width is updated clinical ultrasound tissue characterization calculated from ultrasound B-mode echogenicity histogram parameter in a commercial B-mode imaging device. Placental intervillous space fibrin deposit, malignant neoplasia, fetal brain echogenicity, immature fetal lung, meconium-stained amniotic fluid, and normal adult liver were studied, where GLHW was a useful noninvasive clinical tissue characterization using commercial B-mode devices.

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