The Potential Risks of Ultrasound Examinations on Fetal Development

Author: Goldberg, Holly; Verny, Thomas R, MD, DPsych, DHL

Publication info: Journal of Prenatal & Perinatal Psychology & Health 21. 3 (Spring 2007): 261-269.

Abstract: None available.

Full Text: Headnote ABSTRACT: Ultrasound examinations are a trusted diagnostic procedure in prenatal Healthcare. The benefits of ultrasound are numerous. However, research documents physical risks that must be taken seriously. Although many of these findings are inconclusive, they indicate that ultrasound examinations may not be totally benign. The following is an exploration of the current research available on the effects of ultrasound exposure on fetal development with discussion on potential physical, behavioral and psychological health risks. KEY WORDS: Ultrasound, fetus, development. INTRODUCTION Ultrasound is a diagnostic tool that is commonly used during fetal development. The process uses high frequency sound waves to create life-like images of the fetus. Current research documents fetal risk factors associated with ultrasound examinations, however many of these findings are inconclusive. Further research is required to determine conclusive results on the effects of ultrasound on fetal development. The psychological risk factors associated with ultrasound examination have yet to be researched. Early trauma experienced during the prenatal period is encoded in the implicit memory of the fetus (Thomson, 2004). Until data proves otherwise, the possibility of negative psychological implications as a result of ultrasound examinations could exist. This paper examines the current research available on the effects of ultrasound exposure on fetal development with discussion on potential physical, behavioral, and psychological health risks. INDICATIONS FOR ULTRASOUND Ultrasound is a commonly used diagnostic tool during pregnancy for detailed examination of the developing fetus and placenta. According to Cigna (2005): Ultrasound imaging uses high-frequency sound waves to produce dynamic images of organs, tissues, or blood-flow inside the body. The procedure involves the use of a transducer, which sends a stream of high-frequency sound waves into the body and detects their echoes as they bounce off internal structures. The sound waves are converted to electrical impulses, which are processed to form an image displayed on a computer monitor (p. 1). In prenatal healthcare ultrasound is used to detect birth defects, fetal movement, breathing, heartbeat, determine expected due date (EDD), confirm site of pregnancy within uterus, determine number of fetuses, gender of fetus, and position of placenta (Rados, 2004). Due to recent medical advances, intrauterine surgery is now possible when abnormalities are detected during ultrasound examinations (Kroeger &Smith, 2004). In addition, the benefit of ultrasound examinations during the first trimester has been documented as being a more accurate determinate of the estimated date of delivery (EDD) compared to estimates based on physical measurements and last menstrual cycle (Cigna, 2005). The use of ultrasound examinations to determine the EDD reduces errors in gestational age, which minimizes post-term labor-inductions and interventions (Cigna, 2005). DIFFERENCES IN ULTRASOUNDS Three different kinds of ultrasounds are used today, two-dimensional (2D), three-dimensional (3D), and four-dimensional (4D). 2D ultrasound is, and has been, the standard in ultrasound practice for the past thirty years (Cigna, 2005). 2D ultrasound captures series of thin image slices, which can be seen one at a time similar to a photograph (Cigna, 2005). 3D ultrasound provides added depth and clarity of images compared to the 2D ultrasound. Volumes of irregular or disconnected structures can be measured with added accuracy, automation, and ease (Cigna, 2005). In addition, "3D ultrasound allows for the evaluation of the presence of vessels in relation to surrounding anatomic structures" (Cigna, 2005, p. 2). 4D ultrasound offers the life-like fetal features captured in the 3D ultrasound in a real-time movie (Cigna, 2005). However, 3D and 4D ultrasounds use even higher frequencies than 2D ultrasounds, which potentially pose a greater risk factor to the developing fetus (Ang, Gluncic, Duque, Schafer, &Rakic, 2006). According to The American Institute of Ultrasound in Medicine (AIUM), 2D ultrasound is

the current primary method of medically indicated anatomic imaging (Cigna, 2005). "While 3D sonography may be helpful in diagnosis, it should be considered only as a developing technology and not as a replacement for 2D ultrasound" (Cigna, 2005, p. 2). RISK FACTORS IN ULTRASOUND USAGE Despite the medical benefits of ultrasound use, there are risk factors (Rados, 2004). According to the FDA Consumer Magazine, "Ultrasound is a form of energy, and even at low levels, laboratory studies have shown it can produce physical effects in tissue, such as jarring vibrations and a rise in temperature. The US Food and Drug Administration (FDA) states that the fact that these effects exist means that prenatal ultrasounds can't be considered completely innocuous" (Rados, 2004, Why All the Fuss? section, ¶1). However, the FDA declared that the medical benefits outweigh the risk (Rados, 2004). The Society of Maternal and Fetal Medicine (SMFM), The American College of Obstetricians and Gynecologists (ACOG) and the FDA recommend one ultrasound exam, usually done between 18-20 weeks of pregnancy, as standard of care (Rados, 2004). SMFM stated, "A second [ultrasound] should not be performed unless there are extenuating circumstances with a new diagnosis" (Cigna, 2005, p. 2). Despite these recommendations, ultrasound scans are commonly repeated throughout pregnancy (Bellieni, et al., 2005). "The medical applications of diagnostic ultrasound are numerous, and its use is increasing rapidly because of the absence of a clinically perceived risk of diagnostic ultrasound" (Suresh, Devi, Ovchinnkov, &McRae, 2002, p. 340). Current statistics show the average amount of ultrasounds administered in France is 4.3 times per pregnancy and Italy 5.2 times per pregnancy (Bellieni, et al., 2005). According to Cigna Healthcare's 2005 report, 60-70% of pregnant women in the United States receive at least one ultrasound examination during the course of pregnancy (Cigna, 2005). Disruption of Cell Migration Patterns The exploration of how ultrasound exposure affects the developing fetus is the mission of numerous studies on primates, mice, and rats. One of the most significant findings on mice reports that ultrasound exposure disrupts the migration of brain cells in the developing mouse fetus. Ang, Gluncic, Duque, Schafer, and Rakic's (2006) study on the impact of ultrasound on the migration of brain neurons in mice concludes, "when exposed to ultrasound waves (USW) for a total of 30 minutes or longer during the period of their migration, a small but statistically significant number of neurons fail to acquire their proper position and remain scattered within inappropriate cortical layers and/or in the subjacent white matter" (p. 12903). The disruption of neuronal migration in humans resulting from ultrasound exposure is still unknown due to the ethical limitations of testing. However, results of misplacement of brain cells in human fetal development can be linked to various disorders. "These disorders range from mental retardation and childhood epilepsy to developmental dyslexia, autism spectrum disorders and schizophrenia" (Schmid, 2006, ¶10). Decrease in Fetal Weight In addition to neuronal cell migration disruption in mice, extensive studies report decrease in fetal weight as a result from ultrasound exposure in both humans and mice. However, mixed study outcomes of infant growth rate resulting from ultrasound exposure have been reported. Newnham, et al. (2004) report contradictory outcome statements on the effects of ultrasound on newborn growth. The report states, "Those pregnancies allocated to receive multiple [ultrasound] examinations had an unexplained and significant increase in the proportion of growth restricted newborns" (p. 2038). The report also states, "prenatal ultrasound scans are not followed by smaller body size in infancy or childhood" (p. 2042). Studies on mice support the link between ultrasound exposure and decreased fetal weight outcomes. Hande, Devi and Karanth (1993) reported a decreased body weight from second week onward up to fifth week of age for baby mice as a result of ultrasound. According to Ang, et al., (2006), "There is some evidence that the frequent exposure of the human fetus to ultrasound is associated with a decrease in newborn body weight" (p. 12903). Despite the outcome of these studies, decrease in fetal weight associated with ultrasound exposure is still inconclusive. Delayed Speech and Behavioral Effects Contradictory conclusions on the effects of ultrasound exposure are common. Delayed speech and locomotor behavior have been documented. Mel Stratmeyer, Ph.D., in the FDA's Office of Science and Technology, states, "A few studies suggest that exposure to diagnostic ultrasound during pregnancy may have an effect on human development, such as delayed speech in children" (Rados, 2004, Why All the Fuss? section, ¶6). Newnham, et al. (2004) reported the most significant difference in developmental

outcomes revealed from the control group (who had one ultrasound examination) compared to the intensive ultrasound group (who received five ultrasound examinations) was speech and language delay at one year of age. At later stages of development language development was similar. Despite this conclusion, the study stated that these findings could have occurred "by chance" or by parenting differences. Mice studies report consistent behavioral delays resulting from ultrasound examinations. According to Suresh, et al. (2002) "There was a noticeable impairment in both locomotor and learning behavior even after a ten minutes exposure, which further increased with increases in exposure time. Thus, the present study demonstrates the neurotoxicity of diagnostic ultrasound and the high susceptibility of early fetal brain to induction of lasting detrimental changes by ultrasound exposure" (p. 339). Hande, et al. (1993) further support the effects of ultrasound exposure on postnatal behavior. "Exposure to diagnostic ultrasound during late organogenesis period or early fetal period in mice may cause changes in postnatal behavior as evidenced by selected adult offspring behavior tests" (p. 433). Among behavioral delay findings, there has also been documentation of increased frequency of lefthandedness especially among boys, according to FDA Consumer magazine (Rados, 2004). Maternal /Paternal Bonding with Fetus Ji, Pretorius, Newton, Uyan, Hull, Hollenbach, and Nelson, (2005) studied the effects of ultrasound on maternal-fetal bonding. They report that 3D and 4D ultrasounds stimulate a parental bond with fetus, which reduces anxiety, thus increasing prenatal bonding. Campbell, who recently retired from the British National Health Service, states, "I have seen fathers kiss the screen or (more appropriately) their partner's abdomen in an ecstasy of recognition and pleasure" during a 4D ultrasound (Campbell, 2002, p. 1). The additional time required for parents to see and bond with the fetus increases ultrasound exposure time, which can heighten the potential risks to the developing fetus (Campbell, 2002). Conversely, Righetti, Dell'Avanzo, Grigio, and Nicolini (2005), who studied maternal/paternal antenatal attachment and 4D ultrasound found "No significant differences are shown between 2D and 4D ultrasound scanning groups [in maternal/paternal antenatal attachment]" (p. 129). Keepsake Ultrasound Companies like, Fetal Fotos, Peek-a-Boo, Womb with a View, and Baby Insight are piggybacking on the concept of enhanced maternal/ paternal bonding and are offering 3D and 4D ultrasound scans in shopping malls as a keepsake entertainment niche. The FDA clearly does not support the non-medical use of ultrasound and has stated that anyone administering ultrasound to consumers without a medical prescription is breaking the law (Rados, 2004). According to FDA Consumer magazine, "Expectant women and their families need to know that the long term effects of repeated ultrasound exposures on the fetus are not fully known. In light of all that remains unknown, having a prenatal ultrasound for non-medical reasons is not a good idea" (Rados, 2004, ^f 3). The FDA, American Institute of Ultrasound Medicine (AIUM) and the European Committee for Medical Ultrasound have made public statements against the use of keepsake and non-medical ultrasound usage (Rados, 2004). The keepsake ultrasound industry is susceptible to heightened risk factors due to variations in ultrasound equipment and maintenance. In addition, many keepsake ultrasound companies are using higher frequency exposures for longer periods of time to capture optimal images and movie segments. The FDA has reported keepsake ultrasound scans as long as an hour (Rados, 2004). According to The FDA Consumer magazine, higher frequency and longer duration of ultrasound exposure heightens risk factors to fetus (Rados, 2004). IMPLICATIONS FOR THE FIELD OF PRENATAL AND PERINATAL PSYCHOLOGY Advancements in ultrasound technology increase data on fetal behavior (Campbell, 2002). "This allows a re-evaluation of early fetal motor activity and behavior," according to Campbell (Campbell, 2002, p. 3). Yawning, sucking and swallowing, facial expressions, and behavior responses to external stimulation can be observed with greater accuracy (Campbell, 2002). Quantitative data on fetal behavior captured through ultrasound contributes to the increased scientification of the field of prenatal and perinatal psychology. SUMMARY The vulnerable nature of the fetus both physically and psychologically demands our careful attention and regulation in the use of ultrasound. The European Committee for Medical Ultrasound declared, "The embryonic period is known to be particularly sensitive to any external influences. Until further scientific information is available, investigations should be carried out with careful control of output

levels and exposure times" (Rados, 2004, last ¶). Differences in types of ultrasounds used, intensity, duration of exposure, age at exposure as well as observational parameters and evaluative devices vary widely within recent studies. These variances contribute to diverse outcomes (Suresh, et al., 2002). Further research is required to fully determine the short term and long term effects of ultrasound examinations on fetal development. The precarious position of balancing the potential harm vs. health benefits of ultrasound examinations needs to be reviewed until conclusive research is established. It is our responsibility as we make advances in technology to protect the inherent susceptibility of the fetus. Despite potential advancements in future studies on fetal behavior, the discussed research documents physical risks that must be taken seriously. Although many of these findings are inconclusive, they indicate that ultrasound examinations are not benign. We have yet to research the psychological risk factors associated with ultrasound examination. Until more research proves otherwise, the possibility of negative psychological implications as a result of ultrasound examinations could exist. According to Paula Thomson, Psy. D., early prenatal trauma is encoded in the implicit memory of the fetus. "These memories will travel with us into our early days of infancy and beyond and more importantly, these early experiences set our ongoing physiological regulatory baselines" (Thomson, 2004, p. 9). Preservation and support of prenatal and perinatal health translates into prevention of fetal trauma, which may require stricter regulations on ultrasound usage. References REFERENCES Ang, E., Gluncic, V., Duque, Á., Schafer, M., &Rakic, P. (2006). Prenatal exposure to ultrasound waves impacts neuronal migration in mice. Proceedings of the National Academy of Sciences of the United States of America, 103(34), 12903-12910. Bellieni, C.V., Buonocore, G., Bagnoli, F., Cordelli, D.M., Gasparre, O., Calonaci, F., Filardi, G., Merola, A., &Petraglia, F. (2005). Is an excessive number of prenatal ichnographies a risk for fetal growth? Early Human Development, 81, 689-693. Campbell, S. (2002). Editorial. Ultrasound Obstetrics and Gynecology, 19, 1-4. Cigna Healthcare Coverage Position: Ultrasound in pregnancy (including 3D and 4D ultrasound). (2005). Coverage position number: 0142, 1-8. Hande, M.P., Devi, P., Uma, &Karanth, S. (1993). Effect of prenatal ultrasound exposure on adult behavior in mice. Neurotoxicology and Teratology, 15, 433-438. Ji, E.K., Pretorius, D.H., Newton, R., Uyan, K., Hull, A.D., Hollenbach, K., &Nelson, T.R. (2005). Effects of ultrasound on maternal-fetal bonding: a comparison of two- and three-dimensional imaging. Ultrasound Obstetrics and Gynecology, 25, 473-477. Kroeger, M. &Smith, L.J. (2004). Impact of birthing practices on breastfeeding: protecting the mother and baby continuum. Sudbury: Jones and Bartlett. Newnham, J.P., Doherty, D., Kendall, G.E., Zubrick, S.R., Landou, L., &Stanley, F.J. (2004). Effects of repeated prenatal ultrasound examinations on childhood outcome up to 8 years of age: Follow-up of a randomized controlled trial. Lancet, 364, 2038-44. Rados, C. (2004). FDA cautions against ultrasound 'keepsake' images. FDA Consumer Magazine, January-February Issue. Retrieved August 12, 2006 from http://fda.gov/ fdac/features/2004/104_images.html Righetti, P.L., Dell'Avanzo, M., Grigio, M., &Nicolini, U. (2005). Maternal/paternal antenatal attachment and fourth-dimensional ultrasound technique: a preliminary report. British Journal of Psychology 96, 129-137. Schmid, R.E. (August 7, 2006). Ultrasound may affect fetal brain: Study. Toronto Star. Retrieved August 12, 2005 from http://www.thestar.com/NASApp/cs/ContentServer? pagename=thesta... Suresh, R., Devi, P., Uma, Ovchinnkov, N., &McRae, A. (2002). Long-term effects of diagnostic ultrasound during fetal period on postnatal development and adult behavior of mouse. Life Sciences, 71, 33-350. Thomson, P. (2004). The impact of trauma on the embryo and fetus: an application of the diathesis-stress model and the neurovulnerability-neurotoxicity model. Journal of. Prenatal and Perinatal Psychology and Health 79(1), 9-64. Who says ultrasound is safe? (2004). AIMS Journal. 16 (4). Retrieved August 12, 2006 from http://www.airms.org.uk/Journal/Voll6No4/ultrasound.htm AuthorAffiliation Holly Goldberg, BA1 and Thomas R. Verny, MD,2 DPsych., DHL, FRCPC AuthorAffiliation 1 Holly Goldberg has been working in the birthing field as an advocate, researcher, child birth educator, prenatal yoga/t'ai chi instructor and birth attendant for more than eleven years. Her experience includes co-facilitating numerous workshops with pioneer midwife, Ina May Gaskin at the Omega Institute and teaching thousands of students throughout the United States. Holly is a

doctoral student in the Prenatal and Perinatal Psychology program at Santa Barbara Graduate Institute. Contact information: Holly Goldberg, Phone: 805-560-6817 Email: Holly@BirthingFromCenter.com www.BirthingFromCenter.com 2 Thomas R. Verny, M.D., author and lecturer, is on the faculty of the Prenatal and Perinatal Psychology Program of the Santa Barbara Graduate Institute.

Publication title: Journal of Prenatal&Perinatal Psychology&Health

Volume: 21

Issue: 3

Pages: 261-269

Number of pages: 9

Publication year: 2007

Publication date: Spring 2007

Year: 2007

Publisher: Association for Pre&Perinatal Psychology and Health

Place of publication: Forestville

Country of publication: United States

Journal subject: Medical Sciences--Obstetrics And Gynecology, Psychology, Birth Control

ISSN: 10978003

Source type: Scholarly Journals

Language of publication: English

Document type: General Information

ProQuest document ID: 198688268

Document URL: http://search.proquest.com/docview/198688268?accountid=36557

Last updated: 2010-06-06

Database: ProQuest Public Health