

# Three-dimensional ultrasound STIC-HDlive rendering: new technique to assessing of fetal heart

*Ultrassonografia tridimensional STIC-HDlive no modo de superfície: nova técnica para avaliação do coração fetal*

Edward Araujo Júnior<sup>1</sup>, MD, MSc, PhD; Luciano Marcondes Machado Nardozza<sup>1</sup>, MD, MSc, PhD; Antonio Fernandes Moron<sup>1</sup>, MD, MSc, PhD

DOI: 10.5935/1678-9741.20130070

Congenital heart diseases (CHD) are the most common fetal congenital malformations, corresponding to an incidence six higher than chromosome anomalies and four higher than neural tube defects [1]. The prevalence of CHD in newborns ranges from 0.6% to 5% [2]. It's too known that the prenatal diagnosis can modify the outcome of some types of CHD [3,4]. The two-dimensional echocardiography is the "gold standard" exam to the diagnosis of CHD; however, it is operator-dependent and only is realized in high risk pregnancies [5]. Although, the majority of CHD cases occurring in low risk pregnancies [6], being necessary appropriate screening in the second trimester ultrasound scan.

Due the high incidence of CDH in low risk pregnancies, several international associations tried to incorporate the "extended basic" cardiac scan in the second trimester ultrasound exam. In other words, the "extended basic" would be the inclusion of ventricles outflows in the four chamber view [7,8]. The incorporation of medical ultrasound obstetrics education has proved to be an effective method to improve the detection rate of CHD [9]. Despite of these improvements in the fetal cardiac screening, the second trimester ultrasound scan continues being operator-dependent and time-consuming.

In the begging of 2000, a new software named spatio-temporal image correlation (STIC) has been available in several three-dimensional ultrasound machines. STIC enables acquisition of fetal heart volume and vascular connection data. The images generated by this software can be evaluated both in multiplanar and in rendering modes. They can also be evaluated both statically and in movement (4D) through a cineloop sequence that simulates an entire cardiac cycle [10,11]. The advantages of STIC for fetal heart evaluation are the following: lower dependency on the operator's experience, in obtaining diagnostic planes; shorter time taken to perform

the examination, without the patient's presence during the volume analysis; possibility of evaluating structures through the render mode with assessment of their morphology and function [12]; and the capacity to send volumes for analysis at other fetal cardiology reference centers via an internet link [13]. Nowadays, the STIC has been utilized in the rendering mode to assess the atrioventricular valves [14,15] and inter-ventricular septum [16]. STIC and virtual-organ computer-aided analysis (VOCAL) has been used to assess the fetal cardiac function by means heart stroke, cardiac output and ejection fraction [17,18]. In relation to screening of CHD, the isolated use of STIC still remains controversial. Some studies have shown advantages of two-echocardiography under STIC in the screening of CHD [19,20]; however, one study showed a great accuracy of STIC in the diagnosis of CHD in a high risk pregnancies [21]. Its necessary new multicenter studies with large samples both low and high risk obtaining definitive results [22].

Recently, a new software named HDlive has been available in Voluson E8 (General Electric Medical System, Zipf, Austria) ultrasound machine. HDlive is a new technique of surface designs, in which the operator performs light settings, creating depth effects by means of adequate lighting and shading of the images [23]. HDlive has been used in the assessment of normal development of embryo/fetus [24,25] as well as in several cases of fetal malformations [26,27].

The STIC-HDlive rendering is a new algorithm to assess the fetal heart structures similarly to other fetal structures. This new algorithm permits to assess the standard fetal echocardiography views as the four chamber and ventricles outflow views (Figure 1). Furthermore, this technique permits to reconstruction of all fetal heart and your connections (Figure 2). Recent study assessed four normal and three abnormal fetal hearts (Ebstein's anomaly, hypoplastic left heart syndrome and tetralogy of Fallot) [28]. The authors refer that STIC-HDlive permitted realistic sensations of each leaflet of the atrioventricular valves. In the case of Ebstein's anomaly, natural and ana-

<sup>1</sup>Universidade Federal de São Paulo, Department of Obstetrics (UNIFESP), São Paulo, SP, Brazil.  
E-mail: araujojred@terra.com.br

#### Abbreviations, acronyms & symbols

CHD	Congenital heart diseases
STIC	Spatio-temporal image correlation
VOCAL	Virtual-organ computer-aided analysis

tomically realistic images of significantly low attachment of the tricuspid valve and the atrialized portion of the right ventricle obtained. In the case of hypoplastic left heart syndrome, thickened tricuspid and dysplastic pulmonary valves were clearly revealed. In the case of tetralogy of Fallot, the overriding aorta and ventricular septal defect were realistically depicted [28]. In other article, the authors have made the reconstruction of normal fetal heart showing the four chamber view and the left ventricle and descending aorta. The authors refer that the HD*live*

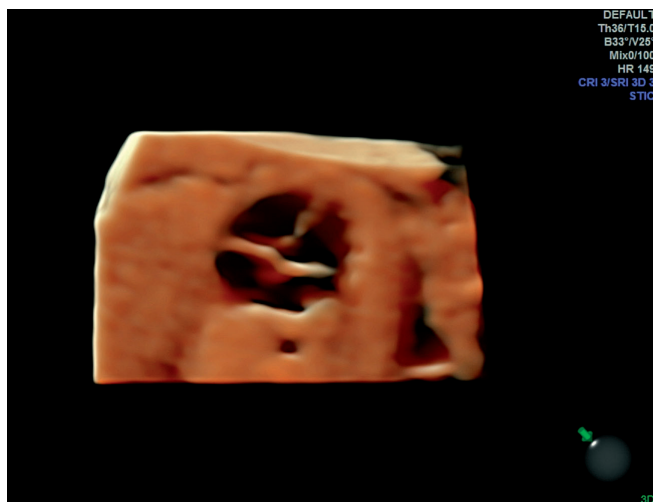


Fig. 1 - STIC-HD*live* rendering showing the reconstruction of fetal heart in the four-chamber view

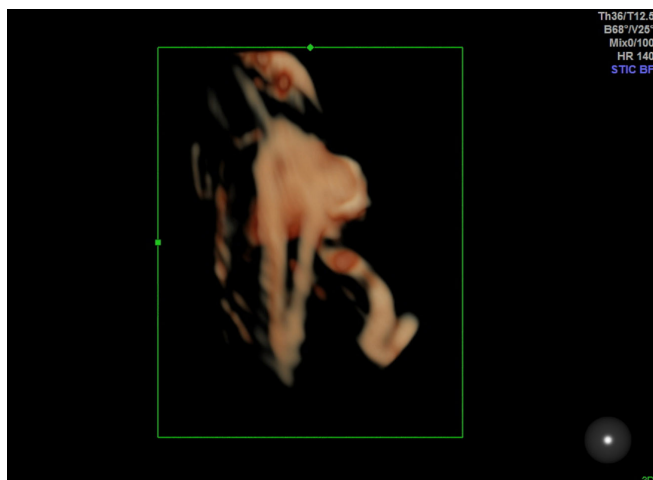


Fig. 2 - STIC-HD*live* rendering showing the reconstruction of fetal heart and its vascular connections

differs from conventional rendering methods because it uses a fixed virtual light source that calculates the propagation of light through skin and tissue. Operators can freely select the light source at any angle relative to the ultrasound volume to enhance anatomical details [29].

In summary, we present a new technique named STIC-HD*live* to the assessing of fetal heart structures. The realistic images provided by this algorithm open new perspectives of non-invasive fetal cardiology, permitting to study in details valves, interventricular septum and venous/arterial connections. New studies comparing the HD*live* and conventional three-dimensional rendering modes are necessary to prove the real application of STIC-HD*live* in fetal echocardiography.

#### REFERENCES

1. Carvalho JS, Mavrides E, Shinebourne EA, Campbell S, Thilaganathan B. Improving the effectiveness of routine prenatal screening for major congenital heart defects. *Heart*. 2002;88(4):387-91.
2. Grandjean H, Larroque D, Levi S. The performance of routine ultrasonographic screening of pregnancies in the Eurofetus Study. *Am J Obstet Gynecol*. 1999;181(2):446-54.
3. Bonnet D, Coltri A, Butera G, Fermont L, Le Bidois J, Kachaner J, et al. Detection of transposition of the great arteries in fetuses reduces neonatal morbidity and mortality. *Circulation*. 1999;99(7):916-8.
4. Tworetzky W, McElhinney DB, Reddy VM, Brook MM, Hanley FL, Silverman NH. Improved surgical outcome after fetal diagnosis of hypoplastic left heart syndrome. *Circulation*. 2001;103(9):1269-73.
5. Allan L. Prenatal diagnosis of structural cardiac defects. *Am J Med Genet C Semin Med Genet*. 2007;145C(1):73-6.
6. Strumpflen I, Strumpflen A, Wimmer M, Bernaschek G. Effect of detailed fetal echocardiography as part of routine prenatal ultrasonographic screening on detection of congenital heart disease. *Lancet*. 1996;348(9031):854-7.
7. International Society of Ultrasound in Obstetrics & Gynecology. Cardiac screening examination of the fetus: guidelines for performing the 'basic' and 'extended basic' cardiac scan. *Ultrasound Obstet Gynecol*. 2006;27(1):107-13.
8. Fetal Echocardiography Task Force; American Institute of Ultrasound in Medicine Clinical Standards Committee; American College of Obstetricians and Gynecologists; Society for Maternal-Fetal Medicine. AIUM practice

- guideline for the performance of fetal echocardiography. *J Ultrasound Med.* 2011;30(1):127-36.
9. Asplin N, Dellgren A, Conner P. Education in obstetrical ultrasound: an important factor for increasing the prenatal detection of congenital heart disease. *Acta Obstet Gynecol Scand.* 2013;92(7):4-8.
  10. Gonçalves LF, Lee W, Chaiworapongsa T, Espinoza J, Schoen ML, Falkensammer P, et al. Four-dimensional ultrasonography of the fetal heart with spatiotemporal image correlation. *Am J Obstet Gynecol.* 2003;189(6):1792-802.
  11. DeVore GR, Falkensammer P, Sklansky MS, Platt LD. Spatio-temporal image correlation (STIC): new technology for evaluation of the fetal heart. *Ultrasound Obstet Gynecol.* 2003;22(4):380-7.
  12. Vināls F, Poblete P, Giuliano A. Spatio-temporal image correlation (STIC): a new tool for the prenatal screening of congenital heart defects. *Ultrasound Obstet Gynecol.* 2003;22(4):388-94.
  13. Vināls F, Mandujano L, Vargas G, Giuliano A. Prenatal diagnosis of congenital heart disease using four-dimensional spatio-temporal image correlation (STIC) telemedicine via an Internet link: a pilot study. *Ultrasound Obstet Gynecol.* 2005;25(1):25-31.
  14. Rolo LC, Nardoza LM, Araujo Júnior E, Hatanaka AR, Rocha LA, Simioni C, et al. Reference ranges of atrioventricular valve areas by means of four-dimensional ultrasonography using spatiotemporal image correlation in the rendering mode. *Prenat Diagn.* 2013;33(1):50-5.
  15. Araujo Júnior E, Rolo LC, Simioni C, Nardoza LM, Rocha LA, Martins WP, et al. Comparison between multiplanar and rendering modes in the assessment of fetal atrioventricular valve areas by 3D/4D ultrasonography. *Rev Bras Cir Cardiovasc.* 2012;27(3):472-6.
  16. Nardoza LM, Rolo LC, Araujo Júnior E, Hatanaka AR, Rocha LA, Simioni C, et al. Reference range for fetal interventricular septum area by means of four-dimensional ultrasonography using spatiotemporal image correlation. *Fetal Diagn Ther.* 2013;33(2):110-5.
  17. Simioni C, Nardoza LM, Araujo Júnior E, Rolo LC, Zamith M, Caetano AC, et al. Heart stroke volume, cardiac output, and ejection fraction in 265 normal fetus in the second half of gestation assessed by 4D ultrasound using spatio-temporal image correlation. *J Matern Fetal Neonatal Med.* 2011;24(9):1159-67.
  18. Simioni C, Araujo Júnior E, Martins WP, Rolo LC, Rocha LA, Nardoza LM, et al. Fetal cardiac output and ejection fraction by spatio-temporal image correlation (STIC): comparison between male and female fetuses. *Rev Bras Cir Cardiovasc.* 2012;27(2):275-82.
  19. Wanitpongpan P, Kanagawa T, Kinugasa Y, Kimura T. Spatio-temporal image correlation (STIC) used by general obstetricians is marginally clinically effective compared to 2D fetal echocardiography scanning by experts. *Prenat Diagn.* 2008;28(10):923-8.
  20. Cohen L, Mangers K, Platt L, Julien S, Gotteiner N, Dungan J, et al. Quality of 2- and 3-dimensional fast acquisition fetal cardiac imaging at 18 to 22 weeks: ramifications for screening. *J Ultrasound Med.* 2009;28(5):595-601.
  21. Bennasar M, Martinez JM, Gomez O, Bartrons J, Olivella A, Puerto B, et al. Accuracy of four-dimensional spatiotemporal image correlation echocardiography in the prenatal diagnosis of congenital heart defects. *Ultrasound Obstet Gynecol.* 2010;36(4):458-64.
  22. Araujo Júnior E, Rolo LC, Nardoza LM, Moron AF. Fetal cardiac evaluation by 3D/4D ultrasonography (STIC): what is its real applicability in the diagnosis of congenital heart disease? *Rev Bras Cir Cardiovasc.* 2013;28(1):III-V.
  23. Kagan KO, Pintoff K, Hoopmann M. First-trimester ultrasound images using HDlive. *Ultrasound Obstet Gynecol.* 2011;38(5):607.
  24. Hata T. HDlive rendering image at 6 weeks of gestation. *J Med Ultrasonics.* 2013 [ahead of print].
  25. Merz E. Surface reconstruction of a fetus (28 + 2 GW) using HDlive technology. *Ultraschall Med.* 2012;33(3):211.
  26. Hata T, Hanaoka U, Tenkumo C, Ito M, Uketa E, Mori N, et al. Three-dimensional HDlive rendering image of cystic hygroma. *J Med Ultrasonics.* 2013;40(3):297-9.
  27. Tenkumo C, Tanaka H, Ito T, Uketa E, Morin N, Hanaoka U, et al. Three-dimensional HDlive rendering images of the TRAP sequence in the first trimester: reverse end-diastolic umbilical artery velocity in a pump twin with an adverse pregnancy outcome. *J Med Ultrasonics.* 2013;40(3):293-6.
  28. Hata T, Mashima M, Ito M, Uketa E, Mori N, Ishimura M. Three-dimensional HDlive rendering images of the fetal heart. *Ultrasound Med Biol.* 2013;39(8):1513-7.
  29. Grisolia G, Tonni G. Fetal echocardiography using HDlive. *J Obstet Gynecol Can.* 2013;35(6):497-8.