

This chapter should be cited as follows:

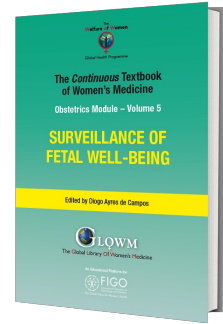
Araújo C, Clode N, et al, *Glob. libr. women's med.*,

ISSN: 1756-2228; DOI 10.3843/GLOWM.411653

## **The Continuous Textbook of Women's Medicine Series – Obstetrics Module Volume 5**

### **SURVEILLANCE OF FETAL WELL-BEING**

**Volume Editor: Professor Diogo Ayres-de-Campos, University of Lisbon, Portugal**



## *Chapter*

# **Biophysical Profile: A Critical Evaluation**

First published: February 2021

## **AUTHORS**

### **Cláudia Araújo**

*Consultant in Obstetrics and Gynaecology Departamento de Obstetrícia, Ginecologia e Medicina da Reprodução Centro Hospitalar Universitário Lisboa Norte - Hospital de Santa Maria, Lisboa, Portugal*

### **Nuno Clode**

*Senior Consultant in Obstetrics and Gynaecology Departamento de Obstetrícia, Ginecologia e Medicina da Reprodução Centro Hospitalar Universitário Lisboa Norte - Hospital de Santa Maria, Lisboa, Portugal*

### **Diogo Ayres-de-Campos**

*Senior Consultant in Obstetrics and Gynaecology Departamento de Obstetrícia, Ginecologia e Medicina da Reprodução Centro Hospitalar Universitário Lisboa Norte - Hospital de Santa Maria; Associate Professor Faculdade de Medicina da Universidade de Lisboa, Lisboa, Portugal*

## **INTRODUCTION**

The detection of fetuses at risk of stillbirth or permanent neurological sequelae due to chronic placental insufficiency remains a challenge in current obstetric practice. The decision to deliver preterm pregnancies with fetal growth restriction and progressive deterioration of placental function relies heavily on signs of impending fetal damage, due to the effects of chronic hypoxia and malnutrition.

As a concept, the biophysical profile, proposed by Manning *et al.* in the early 1980s, was derived from that of the Apgar score.<sup>1</sup> In these early days of fetal ultrasound, it was rapidly seen as a convenient way of integrating complimentary information from cardiotocography and ultrasonography. At the time, the scientific community was only just beginning to understand the fetal physiologic responses to hypoxia. The biophysical profile was seen as a natural evolution in the capacity to monitor progressive fetal deterioration, widening the range of evaluated fetal parameters. It was becoming apparent at the time that cardiotocography changes appeared late along this pathway and were not specific of fetuses at risk of damage.<sup>2</sup>

With time, healthcare providers realized that it could sometimes be a very long exam, as it was necessary to wait until the fetus exited the behavioral state of deep sleep. With the emergence of fetal Doppler, several simplifications and modifications of the method appeared<sup>3,4</sup> – although potentially beneficial, these resulted in a lack of standardization of the biophysical profile score, with the corresponding difficulties in scientific evaluation. Later, many healthcare

professionals realized that it was preferable to value the individual components of the biophysical profile, rather than to lump them all together in a score, and the method began to lose popularity.

---

## BIOPHYSICAL PROFILE SCORE

---

The original biophysical profile score consists of four observations made with real-time ultrasonography performed over 30 minutes, combined with cardiotocography, referred to at the time as “non-stress test”.<sup>5</sup>

1. Cardiotocography – presence of two or more fetal heart rate accelerations of at least 15 bpm in amplitude and at least 30 seconds duration associated with fetal movements, during a 20-minute period.
2. Fetal breathing movements – one or more episodes of rhythmic fetal breathing movements of 30 seconds or more.
3. Fetal movement – three or more discrete body or limb movements.
4. Fetal tone – one or more episodes of extension of a fetal extremity with return to flexion, or opening or closing of a hand.
5. Amniotic fluid volume – presence of a single deepest vertical pocket greater than 2 cm.

Each of the five components was assigned a score of either 2 (present as previously defined) or 0 (not present). A composite score of 8/10 or 10/10 was considered a normal biophysical profile, a score of 6/10 was considered equivocal, and a score of 4/10 or less was considered abnormal. Regardless of the composite score, in the presence of oligohydramnios (defined as an amniotic fluid volume of 2 cm or less in the single deepest vertical pocket) further evaluation was recommended.

Later on, evidence appeared suggesting that cardiotocography did not enhance the performance of the biophysical profile, when the score was already 8/8, so many authors recommended leaving out the cardiotocography in these situations, significantly reducing the average testing time per patient.<sup>6</sup>

The initial parallel between biophysical profile and Apgar score was gradually lost, and more relevance was given to the detection of compensatory fetal responses to persistent hypoxemia. Fetal breathing and body movements are controlled by specific centers in the central nervous system (CNS), and the presence of these complex biophysical activities requires a well-oxygenated and functioning CNS.<sup>7</sup> Lack of normal biophysical activity can be due to hypoxia, but also to fetal malformations. Of note, it can also occur temporarily in healthy fetuses during periods of “deep sleep”. The latter lasts on average 20 minutes, but may reach 50 minutes.<sup>7</sup> It became clear that the clinical significance of absent biophysical activity was related to the duration of the ultrasound evaluation, and occasionally up to 60 minutes of observation time was required.

Studies in which cordocentesis was performed shortly after biophysical profile evaluation showed that a score of 8/10 or 10/10 virtually excluded the possibility of fetal umbilical vein acidemia.<sup>8</sup> For biophysical profile scores of 4/10, umbilical vein pH <7.20 occurred in about 10% of cases, for scores of 2/10 it occurred in about 20% of cases, and for scores of 0/10 it occurred in 100% of cases.<sup>9</sup>

---

## FETAL MULTIVESSEL DOPPLER ASSESSMENT

---

Placental resistance to umbilical blood flow usually decreases over the course of pregnancy, as primary, secondary, and tertiary branching of the villus vascular architecture develops.<sup>10</sup> Several placental diseases (abnormal development, infarction, fibrosis) may result in reduced umbilical blood flow. This usually manifests by increased systolic to diastolic ratios, and latter evolves into absent or reverse end-diastolic flow. As placental function decreases and hypoxemia ensues, physiological compensatory mechanisms aimed at maintaining the perfusion of key organs also come into place, with selective vasoconstriction that results in redistribution of blood flow to the heart, brain and suprarenal glands. Cerebral blood flow is maintained, and renal blood flow is reduced, leading to decreased amniotic fluid production. Finally, deterioration in venous Doppler parameters appear, reflecting a failing cardiac function.

Multivessel Doppler assessment of the fetal circulation can illustrate the progression of disease in cases of deteriorating placental function. On the other hand, fetal breathing movements and heart rate variability are maintained until late in this process, as they are mainly dependent on CNS activity, which is protected during the initial phases. Reduced fetal

movements and decreased amniotic fluid volume usually occur earlier in the process and are less specific findings.

Reverse umbilical artery end-diastolic flow and elevated ductus venosus Doppler indices are accurate predictors of cord artery pH below 7.20. An additional loss in fetal tone is strongly associated with a pH <7.00.<sup>8</sup> Results of the TRUFFLE study suggest that changes in ductus venosus waveform, low variability on computerized analysis of cardiotocography, and recurrent decelerations, are the best determinants of intervention, when considering survival without neurological impairment.<sup>11,12</sup>

---

## BIOPHYSICAL PROFILE SCORE IN CURRENT CLINICAL PRACTICE

---

Several large series document a significant association between low biophysical profile scores and fetal acidosis, perinatal mortality, and cerebral palsy. The American College of Obstetricians and Gynecologists and the Society of Obstetrics and Gynaecology of Canada recommend its use in antepartum surveillance of high-risk pregnancies.<sup>10,13</sup> As occurs with other methods of fetal surveillance, evidence from randomized controlled trials is insufficient to support the routine use of biophysical profile in low- or high-risk pregnancies. A Cochrane review of 2008, including five trials and 2974 high-risk pregnancies, concluded that there is insufficient evidence to support the use of biophysical profile as a test of fetal well-being.<sup>14</sup> The method was not associated with reduced incidences of perinatal death or low Apgar score. Fetal multivessel Doppler assessment and a more detailed analysis of antepartum cardiotocography have refined the documentation of deteriorating fetal hypoxemia in the setting of placental insufficiency. The most recent Cochrane review on the use of umbilical artery Doppler ultrasound in high-risk pregnancies, evaluating 19 trials and 10,667 women, concluded that it was associated with reductions in perinatal deaths, labor inductions, and cesarean sections.<sup>15</sup> The use of ductus venosus Doppler evaluation and computerized cardiotocography was associated with an improvement in long-term neurological outcomes.<sup>15</sup>

Because biophysical profile scores may be more time consuming, and because there are so many variations in biophysical profile score evaluation, the technology has lost many of its followers. Some individual components continue to be evaluated, usually in a more refined fashion than originally described, but in many centers they are not added up into a score.

---

## CONCLUSIONS AND PRACTICE RECOMMENDATIONS

---

**In the first years of fetal ultrasound, the biophysical profile score was a ground-breaking method for monitoring of progressive fetal hypoxemia in cases of suspected placental insufficiency. Extensive observational studies suggest that it has a strong association with chronic fetal hypoxia and acidemia. However, with the emergence of multivessel fetal Doppler evaluation and computerized cardiotocography analysis, these techniques have largely replaced the role of biophysical profile score evaluation in this setting. They are less time-consuming, as they are not so dependent on fetal behavioral states and provide more accurate information on the use of fetal defence mechanisms, and on signs of central nervous system hypoxia. The detection of blood flow centralization (middle cerebral artery flow), compromised CNS function (fetal heart rate variability) and compromised cardiac function (ductus venosus flow), by reflecting the crucial steps in evolution of chronic hypoxemia, have largely taken over the role of biophysical profile scores in monitoring of placental insufficiency.**

### CONFLICTS OF INTEREST

*The authors of this chapter declare that they have no interests that conflict with the contents of the chapter.*

## REFERENCES

- 1 Manning FA, Platt LD, Sipos L. Antepartum fetal evaluation: development of a fetal biophysical profile. *Am J Obstet Gynecol* 1980;136:787.
- 2 Thacker SB, Berkelman RL. Assessing the diagnostic accuracy and efficacy of selected antepartum fetal surveillance techniques. *Obstet Gynecol Surv* 1986;41:121.
- 3 Nageotte MP, Towers CV, Asrat T, Freema RK. Perinatal outcome with the modified biophysical profile. *Am J Obstet Gynecol* 1987;156:527-33.
- 4 Miller DA, Rabello YA, Paul RH. The modified biophysical profile: antepartum testing in the 1990s. *Am J Obstet Gynecol* 1996;174:812.
- 5 Manning FA. Fetal biophysical profile. *Obstet Gynecol Clin North* 1999;26(4):557-77.
- 6 Manning FA, Morrison I, Lange IR, et al. Fetal biophysical profile scoring: selective use of the nonstress test. *Am J Obstet Gynecol* 1987;156:709.
- 7 Manning FA. Fetal biophysical profile: a critical appraisal. *Clin Obstet Gynecol* 2002;45:975.
- 8 Baschat AA. Planning management and delivery of the growth-restricted fetus. *Best Pract Res Clin Obstet Gynaecol* 2018 May; 49:53-65.
- 9 Manning FA, Snijders R, Harman CR, et al. Fetal biophysical profile score. VI. Correlation with antepartum umbilical venous fetal pH. *Am J Obstet Gynecol* 1993;169:755.
- 10 Liston R, Sawchuck D, Young D. No. 197a – Fetal Health Surveillance: Antepartum Consensus Guideline. *J Obstet Gynaecol Can* 2018;40(4):e251-e271.
- 11 Lees CC, Marlow N, van Wassenaer-Leemhuis A, Arabin B, et al. 2 year neurodevelopmental and intermediate perinatal outcomes in infants with very preterm fetal growth restriction (TRUFFLE): a randomised trial. *Lancet* 2015;385(9983):2162-72. Doi: 10.1016/S0140-6736(14)62049-3. Epub 2015 Mar 5.
- 12 Ganzevoort W, Mensing Van Charante N, Thilaganathan B, Prefumo F, Arabin B, Bilardo CM, Brezinka C, Derks JB, et al. How to monitor pregnancies complicated by fetal growth restriction and delivery before 32 weeks: post-hoc analysis of TRUFFLE study. *Ultrasound Obstet Gynecol* 2017;49(6):769-77.
- 13 Antepartum fetal surveillance. Practice Bulletin No. 145. American College of Obstetricians and Gynecologists. *Obstet Gynecol* 2014;124:182-92.
- 14 Lalor JG, Fawole B, Alfirevic Z, Devane D. Biophysical profile for fetal assessment in high risk pregnancies. *Cochrane Database of Systematic Reviews* 2008, Issue 1. Art. No.: CD000038. DOI: 10.1002/14651858.CD000038.pub2.
- 15 Alfirevic Z, Stampalija T, Dowswell T. Fetal and umbilical Doppler ultrasound in high-risk pregnancies. *Cochrane Database of Systematic Reviews* 2017;6 CD007529. doi:10.1002/14651858.CD007529.pub4.