

11.5. CQ 4: “Is Pulsed Doppler Echocardiography Effective for Diagnosing Fetal Arrhythmias?”

Recommendation

Draft recommendation: It is conditionally suggested that pulsed Doppler is added to M-mode imaging for the diagnosis of fetal arrhythmias.

Strength of evidence: D (very weak)

Strength of recommendation: conditionally recommend (suggested)

Course of Making the Recommendation

【Background of the CQ Significance】

Prognosis of fetal arrhythmias is affected by perinatal management. In this respect, accurate diagnosis in the fetus is essential. Not only fetal electrocardiography and fetal magnetocardiography, but also fetal echocardiography is a diagnostic tool widely used for detecting fetal arrhythmias. In addition to the M-mode method, the pulsed Doppler method has been utilized for diagnosis since 1986.^{1,2)} Practically, this method demands more skill of the examiner than the M-mode method does. The level of evidence has not been discussed precisely for the recommendation of the pulsed Doppler method. To summarize the current findings, the CQ “Is pulsed Doppler echocardiography effective for diagnosing fetal arrhythmias?” was set.

【Outcomes】

In pregnant women carrying a fetus with arrhythmia, the outcome whether the arrhythmic diagnosis was more accurately established using pulsed Doppler combined with M-mode imaging rather than the latter alone was reviewed.

【Literature Search and Extraction】

At the primary extraction, the literature was searched for studies regarding the diagnoses of fetal arrhythmias using fetal echocardiography. Thirty-five reports (6 from Cochrane, 22 from PubMed, and 7 from Igakuchuoasshi) were listed. Of these, 14 reports (published between 2008 and 2018, excluding case reports) were included in the secondary extraction process. Eventually, 6 articles fulfilled our extraction criteria. Of these, five³⁻⁷⁾ were review articles and the remaining one⁸⁾ an observational study. The literature before 2008 was also searched, because the number of reports other than the review article form were rather limited. Unfortunately, no reports were found eligible.

【Evaluation of Outcomes】

No randomized trials were identified regarding this CQ. A meta-analysis could not be carried out using the 6 reports extracted. The outcome, therefore, could not be objectively evaluated. Five review articles were narrative in the form of general remarks, and were useful for understanding trends in the field, while the contents appeared biased by the authors' opinions. One observational study⁸⁾ was a multicenter and retrospective case-control report. It was limited to the detection rate of fetal long QT syndrome. Whether the pulsed Doppler method is useful is described for long QT syndrome and for other arrhythmias separately.

【1. Usefulness of the Pulsed Doppler Method for Long QT Syndrome】

The report of a multicenter and retrospective case-control study⁸⁾ described: The left ventricular isovolumic relaxation time (LVIRT) measured from the simultaneous waveform of the left ventricular inflow and outflow tracts using the pulsed Doppler method was significantly longer in fetuses with long QT syndrome than in normal fetuses. The LVIRT is a value that cannot be measured using the M-mode method; therefore, the pulsed Doppler method seems useful for improving the detection rate of fetal long QT syndrome. The diagnosis of long QT syndrome was made using postnatal electrocardiography in this report. The QT interval during the fetal period was not necessarily evaluated. Most of the participants in the control group (the normal fetuses) were evaluated only once. These are limiting factors.

【2. Usefulness of the Pulsed Doppler Method for Diagnosing Arrhythmias Other Than Long QT Syndrome】

No randomized trials were available matching the outcomes. No evidence is provided to evaluate the outcomes. Extensive discussion would be in vain whether the pulsed Doppler method is useful for diagnosing arrhythmias other than long QT syndrome. The 5 reviews extracted³⁻⁷⁾ and the 2014 American Heart Association statement⁹⁾ stated that use of the pulsed Doppler method is already a widely accepted maneuver for diagnosing extrasystoles and tachy- or brady-arrhythmias. It seems unlikely that a randomized trial newly designed is to be conducted in the future. The M-mode method can document the atrial rate, the ventricular rate, the mode of AV conduction, and the AV or VA interval; these

are fundamental for diagnosing arrhythmias (see “Prenatal diagnosis and treatment of arrhythmia” in these guidelines). The pulsed Doppler method would be more suitable^{7, 10)} in case these M-mode analyses were difficult due to the fetal position, less contractile atria/ventricles, or maternal obesity. Among the pulsed Doppler techniques for clarifying tachyarrhythmia, the superior vena cava/ascending aorta simultaneous waveform may be more efficient than the left ventricular inflow/outflow simultaneous waveform,^{2, 6)} because the E wave and the A wave are fused together when the fetal heart rate is high. In other words, the atrial contraction cannot be identified separately and the AV relationship, the AV or VA interval cannot be measured. A fetal diagnosis of arrhythmia is known to influence neonatal prognosis. The American Heart Association⁹⁾ stated classification of recommends and the levels of evidence for in-utero treatment and management based on the diagnosis of arrhythmia. The first multicenter clinical study of fetal supraventricular tachycardia was conducted in Japan. The protocol was verified as effective¹¹⁾ in terms of classification of fetal supraventricular tachycardia based on the VA interval and presence or absence of fetal hydrops. The VA interval classification was of practical use when selecting therapeutic agents.

【3. Limitations of Arrhythmia Diagnoses Using Fetal Echocardiography】

Even when the pulsed Doppler method is conducted by a skilled examiner, it is not always possible to produce images that offer information to appropriately evaluate atrial and ventricular contractions.

An accurate diagnosis of fetal arrhythmia requires electrical assessments, such as fetal electrocardiography and fetal magnetocardiography. It is not realistic to conduct these examinations in every patient. These investigations are only feasible at a limited number of facilities. In the future, the combination of fetal echocardiographic and electrical evaluations could enable precise diagnoses of fetal arrhythmias still further.

【Summary】

Since no randomized trials have been reported, the pulsed Doppler method cannot be determined as undoubtedly useful. On the other hand, the method itself is widely applicable. The pulsed Doppler method, if added to the routine examination, may contribute to improvements in the detection rate of long QT syndrome or in the diagnosis of arrhythmia. This surely works for appropriate perinatal management and a better prognosis. Use of the pulsed Doppler method is therefore suggested in addition to the M-mode method.

【Summary for the General Public】

Fetal arrhythmia requires an accurate diagnosis, because the perinatal management of the problem affects the prognosis of the fetus/newborn. Fetal echocardiography is the diagnostic method most widely used. Electrical evaluation such as fetal electrocardiography and fetal magnetocardiography is an alternative. The pulsed Doppler method requires more skill of the examiner than M-mode fetal echocardiography does. The CQ “Is pulsed Doppler echocardiography effective for diagnosing fetal arrhythmia?” was set in order to discuss the levels of evidence needed for deciding its application and to summarize the current findings for making sensible recommendations. Currently, the usefulness of the pulsed Doppler method is not concrete due to the lack of accumulation of scientific data for statistical analysis. Still, the pulsed Doppler method is already in use widely. It is expected that use of the method should contribute to improvements in the detection rate of long QT syndrome as well as in the diagnosis of arrhythmia, leading to the optimal perinatal management and a better prognosis. The pulsed Doppler method is therefore suggested in combination with the M-mode technique.

References

- 1) Steinfeld L, Rappaport H, Rossbach H, et al: Diagnosis of fetal arrhythmias using echocardiographic and Doppler techniques. *J Am Coll Cardiol* 1986; **8**: 1425–1433
- 2) Strasburger JF, Huhta JC, Carpenter RJ Jr., et al: Doppler echocardiography in the diagnosis and management of persistent fetal arrhythmias. *J Am Coll Cardiol* 1986; **7**: 1386–1391
- 3) Maeno Y, Hirose A, Kanbe T, et al: Fetal arrhythmia: Prenatal diagnosis and perinatal management. *J Obstet Gynaecol Res* 2009; **35**: 623–629
- 4) Matta MJ, Cuneo BF: Doppler echocardiography for managing. *Clin Obstet Gynecol* 2010; **53**: 899–914
- 5) Wacker-Gussmann A, Cuneo B, Wakai R, et al: Annette Wacker-Gussmann: Janette F. Strasburger, Bettina F. Cuneo, Ronald T. Wakai: Diagnosis and Treatment of Fetal Arrhythmia. *Am J Perinatol* 2014; **31**: 617–628

- 6) Sonesson SE, Acharya G: Hemodynamics in fetal arrhythmia. *Acta Obstet Gynecol Scand* 2016; **95**: 697–709
- 7) Bravo-Valenzuela NJ, Rocha LA, Machado Nardoza LM, et al: Fetal cardiac arrhythmias: Current evidence. *Ann Pediatr Cardiol* 2018; **11**: 148–163
- 8) Clur SB, Vink AS, Etheridge SP, et al: Left ventricular isovolumetric relaxation time is prolonged in fetal Long-QT syndrome. *Circ Arrhythm Electrophysiol* 2018; **11**: e005797
- 9) Donofrio MT, Moon-Grady AJ, Hornberger LK, et al: American Heart Association Adults With Congenital Heart Disease Joint Committee of the Council on Cardiovascular Disease in the Young and Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and Council on Cardiovascular and Stroke Nursing: Diagnosis and treatment of Fetal cardiac disease: A scientific statement from the American Heart Association. *Circulation* 2014; **129**: 2183–2242
- 10) Foron JC: Fetal arrhythmias: The Saint-Justine hospital experience. *Prenat Diagn* 2004; **24**: 1068–1080
- 11) Miyoshi T, Maeno Y, Hamasaki T, et al: on behalf of the Japan Fetal Arrhythmia Group: Antenatal Therapy for fetal supraventricular tachyarrhythmias: Multicenter trial. *J Am Coll Cardiol* 2019; **74**: 874–885