IMAGING

Ultrasonographic diagnosis of delayed atrioventricular conduction during fetal life: a reliability study

Yvan Mivelaz, MD; Marie Josée Raboisson, MD; Sylvia Abadir, MD; Georgia Sarquella-Brugada, MD; Anne Fournier, MD, FACC; Jean-Claude Fouron, MD, FACC

OBJECTIVE: The objective of the study was to evaluate the reliability of the 2 most commonly used ultrasonographic approaches for monitoring fetal atrioventricular conduction time (AVCT): (1) superior vena cava/ascending aorta (SVC/AA), and (2) left ventricular inflow/outflow tract (LVI/O) Doppler recordings.

STUDY DESIGN: Echographic studies from fetuses followed up for first-degree atrioventricular block (AVB-1) between 1998 and 2008 were reviewed. The ability to identify atrial contractions in the same fetuses by the SVC/AA and LVI/O approaches was analyzed.

RESULTS: Sixty-six studies of 13 fetuses with AVB-1 were available. Atrial contractions were visible in all SVC/AA studies. With the LVI/O approach, atrial contractions could not be identified in 26 studies (39%). AVCT delay was significantly greater in the nonidentifiable compared with the identifiable atrial contraction group ($P < .001$). Differences in heart rate and gestational age were not significant.

CONCLUSION: The LVI/O is unsuitable for prenatal screening of conduction system anomalies.

Key words: antinuclear antibodies, atrioventricular block, lupus, prenatal Doppler ultrasonography

Cite this article as: Mivelaz Y, Raboisson MJ, Abadir S, et al. Ultrasonographic diagnosis of delayed atrioventricular conduction during fetal life: a reliability study. Am J Obstet Gynecol 2010;203:174.e1-7.

Isolated congenital atrioventricular block (AVB) is predominantly linked to maternal autoimmune diseases. This complication occurs in 1-5% of fetuses born to mothers with anti-SSA/Ro and/or anti-SSB/La antibodies.[1-3] The prognosis of complete congenital AVB remains poor. A survival rate of 70-85% at 10 years of age has been reported with the necessity of pacemaker implantation before adulthood in more than 90% of cases.[1-4]

From the Cardiology Division, Fetal Cardiology Unit, Department of Pediatrics, Centre Hospitalier Universitaire Sainte-Justine, University of Montreal, Montreal, QC, Canada.

Received July 10, 2009; revised Oct. 30, 2009; accepted Feb. 10, 2010.

Reprints: Jean-Claude Fouron, MD, Fetal Cardiology Unit, Cardiology Division, Centre Hospitalier Universitaire Sainte-Justine, 3175, chemin de la Côte Sainte-Catherine, Montréal, Québec H3T 1C5, Canada. fouron@sympatico.ca.

Y.M. was supported by the Swiss National Science Foundation, the SICPA Foundation, and the Société Académique Vaudoise.

0002-9378/$36.00

doi: 10.1016/j.ajog.2010.02.024

It is widely accepted that, once installed, complete AVB is irreversible as the fibronecrotic remodeling is irremediable, whatever the therapy.[5] Systematic preventive treatments, such as plasmapheresis, immunoglobulins, steroids, and other immunosuppressants, have never demonstrated substantial benefit.[6-8] Biomarkers appearing prior to irreversible damage have been proposed to restrict the therapy to targeted fetuses.

Delayed atrioventricular conduction time (AVCT) is the most widely used marker.[9-12] Because of the very low voltage of P waves on transmaternal fetal electrocardiograms and very limited availability of magnetocardiography facilities, most centers rely on ultrasonography to determine the fetal atrioventricular (AV) relationship.[13,14]

Essentially, 2 types of ultrasonographic approaches are used. The first type is characterized by the ability to record atrial activity independently of any valve opening or timing of ventricular activity (valve/ventricle-independent [V/Vi] approaches); simultaneous M-mode recording of ventricular and atrial wall motion, superior vena cava/ascending aorta (SVC/AA) or pulmonary artery/vein Doppler approaches or tissue velocity imaging (TVI) curves obtained simultaneously at the atrial and ventricular levels are examples of this approach.[15-17]

Among the V/Vi approaches, most centers favor Doppler techniques because of poor M-mode performance in the identification of onset of mechanical events.[18]

With the second type of approaches, the recording of atrial activity is dependent on both AV valve opening and the timing of ventricular contraction (valve/ventricle-dependent [V/Vd] approaches); examples of this group include the Doppler recordings of left ventricular inflow/outflow (LVI/O) and TVI of the ventricular walls.[9,12,19] With the V/Vd approaches, atrial contraction can be identified only when it occurs during late ventricular filling or when this filling is not impaired by reduced ventricular compliance.

It is known that the normal sequential relationship between atrial and ventricular contractions is modified in different types of supraventricular tachycardia, conducted or blocked premature atrial contractions, complete AVB and second-degree atrioventricular block (AVB-2), potentially preventing the accurate assessment of these arrhythmias with the V/Vd approaches.[14,20-22]

TABLE 1
Fetal AVB-1: etiology, diagnosis, therapy, and follow-up

Fetus	AVB-1 etiology	GA at diagnosis wks	Steroid therapy	Number of echography studies	AVCT with SVC/AA range[a]		Diagnosis with SVC/AA						
							Normal AVCT		AVB-1		AVB-2		
							A wave identifiable with LVI/O		A wave identifiable with LVI/O		A wave identifiable with LVI/O		
					msec	z-score	Yes	No	Yes	No	Interm	AVCT last SVC/AA	Postnatal PR
1	SSA/SSB	29	Yes	2	133–142	2.6–2.9	1	—	1	—	—	Normal	Normal
2	SSA/SSB	24	Yes	9	154–186	3.8–7.6	—	—	1	3	5	AVB-2	AVB-2
3	SSA/SSB	24	Yes	11	202–287	10.2–20.8	—	—	—	11	—	AVB-1	AVB-1
4	Antiarrhyt	32	No	5	107–121	0.06–3.3	2	—	3	—	—	Normal	Normal
5	Bradycardia	23	No	1	160	5.7	—	—	1	—	—	AVB-1	IUD
6	Idiopath	23	No	7	107–138	–0.86 to 3.06	6	—	1	—	—	Normal	Normal
7	Malform	19	No	2	116–149	0.5–4.8	—	1	—	1	—	Normal	IUD
8	Nodal	27	No	4	227–262	13.04–14.06	—	—	—	2	2	AVB-1	Normal
9	SSA/SSB	23	No	6	113–133	0–2.5	5	—	1	—	—	Normal	Normal
10	Malform	24	No	3	133–151	2.3–4.0		—	1	2	—	AVB-1	Normal
11	Idiopath	25	No	4	127–142	0.6–3.1	1	—	3	—	—	Normal	Normal
12	SSA/SSB	21	No	5	125–141	1.7–2.5	3	—	2	—	—	AVB-1	Lost F/U
13	SSA/SSB	25	Yes	7	202–279	12.2–19.8	—	—	—	6	1	AVB-1	AVB-1
Total				66			18	1	14	25	8		
Percent				100.0			27.3	1.5	21.2	37.9	12.1		

Antiarrhyt, antiarrhythmic therapy for supraventricular tachycardia; *AVB*, atrioventricular block; *AVCT*, atrioventricular conduction time; *GA*, gestational age; *Idiopath*, no identified etiology at the time of diagnosis; *Interm*, intermittent; *IUD*, intrauterine fetal demise; *Lost F/U*, lost to follow-up; *LVI/O*, left ventricular inflow/outflow tract; *Malform*, congenital cardiac malformation; *Nodal*, dual nodal pathway; *PR*, atrioventricular conduction time on the electrocardiogram; *SSA/SSB*, SSA and/or SSB antibodies; *SVC/AA*, superior vena cava/ascending aorta.

[a] AVCT range only for studies with normal AVCT or AVB-1.

Mivelaz. Fetal atrioventricular block monitoring. Am J Obstet Gynecol 2010.

Despite all these limitations, in many centers, the monitoring of fetuses at risk of impaired AV conduction remains based on LVI/O approaches.[9,12] The objective of this study was therefore to compare the reliability of the LVI/O and SVC/AA Doppler approaches for prenatal incomplete AVB identification, related or not to immune-mediated inflammatory processes.

Materials and Methods

Subjects and study design

Since 1998, assessment of fetal AV conduction is routinely based in our unit on recordings of both LVI/O and SVC/AA Doppler tracings. AVCT is measured in all fetuses referred for arrhythmias or maternal anti-SSA/Ro and/or anti-SSB/La antibodies. Videotapes of all fetuses classified in our computerized database under the diagnosis of first-degree AVB (AVB-1) from 1998 to 2008 were reviewed.

During this period, 115 fetuses from mothers with anti-SSA/Ro and/or anti-SSB/La antibodies were referred: 6 (5.2%) had AVB-1. These 6 fetuses were included in the study with 7 other cases of nonimmune AVB-1. For the latter group, the diagnosis was: cardiac malformation in 2 (fetus 7: hypoplastic left heart syndrome; fetus 10: complete AV septal defect with left isomerism), idiopathic in 2 (fetuses 6 and 11), antiarrhythmic medications in 1 (fetus 4), extreme sinusal bradycardia in 1 (fetus 5), and dual nodal pathway in 1 (fetus 8), already published elsewhere.[23]

We reviewed all echocardiographic studies recorded for each of the 13 fetuses with AVB-1 (7 permanent and 6 transient). Inclusion of a study was based on the availability of adequate LVI/O and SVC/AA Doppler tracings, allowing comparative assessment of the reliability of identifying atrial contraction (A wave), the latter being mandatory to determine AVCT. Etiology, management, and follow-up of the 13 cases appear in Table 1.

Echographic data

Doppler tracings were recorded on 2 ultrasound systems (a 128 XP/10c and a Sequoia; Acuson, Mountain View, CA) and reviewed by 3 observers (Y.M., M.J.R., J.-C.F.) independently. Any disputed results on the ability to identify the A wave on Doppler tracings were adjudicated by consensus opinion among the 3 observers. The final decision was based on unanimity or the majority (2/3) of the observer's votes.

The technique used to acquire 2-dimensional pictures suitable for simultaneous Doppler flow recording through