

doi: 10.13241/j.cnki.pmb.2023.11.032

对比分析四维容积超声及彩色多普勒超声在胎儿肺静脉异位引流诊断中的应用*

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摘要 目的:对比分析四维容积超声及彩色多普勒超声在胎儿肺静脉异位引流(APVC)诊断中的应用价值。**方法:**采用回顾性分析方法,2019年1月到2022年1月选择在本院进行诊治的胎儿肺静脉异位引流孕妇60例作为研究对象,都给予四维容积超声及彩色多普勒超声,记录影像学特征并判断诊断价值。**结果:**在60例孕妇中,彩色多普勒超声检查判断为胎儿肺静脉异位引流51例,诊断敏感性为85.0%;四维容积超声检查判断为胎儿肺静脉异位引流59例,诊断敏感性为98.3%,四维容积超声检查对胎儿肺静脉异位引流的诊断敏感性明显高于彩色多普勒超声检查($P<0.05$)。彩色多普勒超声检查与四维容积超声检查诊断的特异性都为100.0%。在60例孕妇中,判断为胎儿肺静脉异位引流心上型32例,心下型28例;心上型的肺静脉引流途径为肺静脉-垂直静脉-右上腔静脉22例、肺静脉-垂直静脉-左上腔静脉10例,心下型的肺静脉引流途径为肺静脉-垂直静脉-左头臂静脉-右上腔静脉6例、肺静脉-垂直静脉-门静脉22例。合并心脏畸形32例,合并畸形率为53.3%;有51例孕妇终止妊娠,9例孕妇继续妊娠,其中8例未经治疗者新生儿期死亡,1例在3月龄死亡。**结论:**相对于彩色多普勒超声,四维容积超声在胎儿肺静脉异位引流诊断中的应用可提高诊断敏感性,可有效反映肺静脉回流情况,可指导临床进行早期干预。

关键词:四维容积超声;彩色多普勒超声;胎儿;肺静脉异位引流

中图分类号:R543;R445.1 **文献标识码:**A **文章编号:**1673-6273(2023)11-2164-04

Comparative Analysis of the Application of Four-dimensional Volumetric Ultrasonography and Color Doppler Ultrasonography in the Diagnosis of Fetal Anomalous Pulmonary Venous Drainage*

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ABSTRACT Objective: To compare and analysis the application values of four-dimensional volumetric ultrasonography and color Doppler ultrasonography in the diagnosis of fetal anomalous pulmonary venous connection (APVC). **Methods:** A retrospective analysis method was used. From January 2019 to January 2022, 60 cases of pregnant women with abnormal fetal pulmonary vein drainage who were diagnosed and treated in our hospital were selected as the research subjects. Four-dimensional volume ultrasound and color Doppler ultrasound were given to diagnosis, and to record the images characteristics and determine the diagnostic values. **Results:** In the 60 pregnant women, there were 51 cases were diagnosed as fetal pulmonary venous drainage by color Doppler ultrasonography, and the diagnostic sensitivity was 85.0%. Four-dimensional volume ultrasonography judged 59 cases of fetal pulmonary vein ectopic drainage, the diagnostic sensitivity was 98.3%. The diagnostic sensitivity of fetal pulmonary vein ectopic drainage by four-dimensional volume ultrasonography were significantly higher than that by color Doppler ultrasonography ($P<0.05$). The diagnostic specificity of both color Doppler ultrasonography and four-dimensional volume ultrasonography were 100.0%. There were 32 cases were diagnosed as supracardiac type and 28 cases were inferior cardiac type. The pulmonary vein drainage route of supracardiac type was pulmonary vein-vertical vein-right superior vena cava (22 cases), pulmonary vein-vertical vein - Left superior vena cava (10 cases), the subcardiac type of pulmonary vein drainage route is pulmonary vein-vertical vein-left brachiocephalic vein-right superior vena cava (6 cases), pulmonary vein-vertical vein-portal vein (22 cases). There were 32 cases of cardiac malformation, and the combined malformation rate was 53.3%. There were 51 cases of pregnant women terminated their pregnancy, 9 cases of pregnant women continued pregnancy, 8 cases of pregnant women were died in the neonatal period without treatment, and 1 case was died at 3 months of age. **Conclusion:** Compares with color Doppler ultrasound, the application of four-dimensional volume ultrasound in the diagnosis of fetal pulmonary venous drainage can im-

* 基金项目:陕西省重点研发计划项目(2020ZDLSF01-06)

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(收稿日期:2022-10-04 接受日期:2022-10-27)

prove the diagnostic sensitivity, can effectively reflect the pulmonary venous return, and can guide early clinical intervention.

Key words: Four-dimensional volume ultrasound; Color Doppler ultrasound; Fetus; Pulmonary vein drainage

Chinese Library Classification(CLC): R543; R445.1 **Document code:** A

Article ID: 1673-6273(2023)11-2164-04

前言

胎儿肺静脉异位引流 (Anomalous pulmonary venous drainage, APVC) 是比较罕见的先天性心脏病,是指所有肺静脉没有与左心房相连,而直接连于体静脉或者直接流入右心房^[1,2]。胎儿肺静脉异位引流可分为部分性肺静脉异位引流与完全性肺静脉异位引流两种类型^[3]。胎儿肺静脉异位引流多合并其他心脏畸形,且病因比较多,但是具体的发育机制还不明确,在胎儿时期容易出现漏诊与误诊情况^[4]。胎儿肺静脉异位引流患儿早期即可出现严重的心衰,具有极高的死亡率,为此加强产前诊断具有重要价值^[5]。彩色多普勒超声为常见的超声方法,可获得清晰的血流成像图,提供高分辨率的彩色血流。但是因为胎儿肺静脉具有走行迂回、管细小、管壁薄、流速较低等特点,彩色多普勒超声显示肺静脉的难度比较大,对于胎儿肺静脉异位引流的引流途径与准确分型判定还不明确^[6,7]。四维容积超声可在高帧速率下提供了优越的空间分辨率,能清晰显示微小血管形态,消除血流方位的伪影,可提供可视化的胎儿解剖图^[8,9]。本文对比分析了对比分析四维容积超声及彩色多普勒超声在胎儿肺静脉异位引流诊断中的应用价值。现报道如下。

1 资料与方法

1.1 研究对象

采用回顾性分析方法,2019年1月到2022年1月选择在本医院进行诊治的胎儿肺静脉异位引流孕妇60例作为研究对象,在60例孕妇中,年龄最小26岁,最大39岁,平均年龄(32.58±1.25)岁;孕周最短21周,最大30周,平均孕周(25.79±1.22)周;平均产次(1.34±0.12)次;平均收缩压(124.02±10.22)mmHg;平均舒张压(78.18±5.02)mmHg;平均心率(87.29±2.51)次/min;平均空腹血糖(5.42±0.28)mmol/L。

纳入标准:产后超声结果或引产后尸解结果判断为胎儿肺静脉异位引流;本研究通过医院伦理委员会审批,孕妇自愿参与本研究且自愿签署了知情同意书;单胎妊娠;孕妇无先天性心脏病病史及不良孕产史;临床、影像学等资料完整。

排除标准:具有不良孕产史的孕妇;合并有高危传染性疾病的孕妇;依从性不佳的孕妇;免疫功能障碍者。

1.2 四维容积超声及彩色多普勒超声方法

所有孕妇都给予四维容积超声及彩色多普勒超声检查,分别采用GE公司的Voluson E8超声诊断仪与飞利浦公司的Epic7超声诊断仪,探头频率分别为3.5 MHz-5.0 MHz和1.0 MHz-7.0 MHz,嘱孕妇仰卧或侧卧,由2名具有10年或者10年以上工作经验的超声科医师(具有副高及其以上职称)进行标准化扫查。

在彩色多普勒超声检查中,启用胎儿心脏模式,观察肺静脉血流状况。明确胎儿胎方位,进行胎儿心尖四腔心、动脉导管弓等切面观察;记录心室结构、位置及心房与心室的连接关系,

内脏和心房结构、位置等。在四维容积超声中,避开心房搏动对肺静脉频谱的干扰,对肺静脉频谱进行取样采集,取斜位四腔心切面,从而获取非常典型与清晰的肺静脉频谱。

四维容积超声及彩色多普勒超声检查的特征性图像保存于超声工作站。

1.3 观察指标

(1)胎儿肺静脉异位引流超声判断标准:四支肺静脉均未与左心房连接,直接或间接汇入右心房。产前超声检查结果与随访结果进行分析,判断诊断的敏感性和特异性。

(2)将胎儿肺静脉异位引流超声进行分型分析,分为心上型、心下型。

(3)记录胎儿肺静脉异位引流的四维容积超声及彩色多普勒超声检查特征,包括四腔心比例、左心房与降主动脉之间的异常管腔样结构、冠状静脉窦内径、异位引流肺静脉走行梗阻等。

(4)记录合并心脏畸形情况,包括室间隔缺损、肺动脉瓣狭窄、心内膜缺损等。

(5)随访胎儿的预后,比如引产后尸体解剖、继续妊娠、出生后手术等。同时记录所有孕妇的收缩压、舒张压、年龄、孕周、产次、心率、空腹血糖等指标。

1.4 统计方法

本次研究统计软件为SPSS19.00,计量数据与计数数据分别以均数±标准差、率等表示,涉及的对比如t检验与卡方 χ^2 分析等,检验水准为 $\alpha=0.05$ 。

2 结果

2.1 超声诊断敏感性对比

在60例孕妇中,彩色多普勒超声检查判断为胎儿肺静脉异位引流51例,诊断的敏感性为85.0%;四维容积超声检查判断为胎儿肺静脉异位引流59例,诊断的敏感性为98.3%,四维容积超声检查对胎儿肺静脉异位引流的诊断敏感性明显高于彩色多普勒超声检查($P<0.05$),彩色多普勒超声检查与四维容积超声检查诊断的特异性都为100.0%。具体情况见表1与表2。

2.2 不同分型胎儿肺静脉异位引流的彩色多普勒超声表现

在60例孕妇中,判断为胎儿肺静脉异位引流心上型32例,心下型28例,共同表现为左心房缩小,左心房与降主动脉之间距离增宽,未见肺静脉开口,左心房后方光滑。心上型:出现升垂直静脉,经左垂直静脉回流入上腔静脉、左无名静脉等。心下型:下腔静脉与降主动脉旁出现离心血管,也可见降垂直静脉,通过垂直静脉回流入门静脉。

2.3 不同分型胎儿肺静脉异位引流的四维容积超声表现

心上型的肺静脉引流途径为肺静脉-垂直静脉-右上腔静脉(22例)、肺静脉-垂直静脉-左上腔静脉(10例),心下型的肺静脉引流途径为肺静脉-垂直静脉-左头臂静脉-右上腔静脉(6例)、肺静脉-垂直静脉-门静脉(22例)。

表 1 四维容积超声及彩色多普勒超声在胎儿肺静脉异位引流的诊断价值(n)

Table 1 Diagnostic value of four-dimensional volume ultrasound and color Doppler ultrasound in fetal pulmonary vein ectopic drainage (n)

Follow-up diagnosis results	Four dimensional volume ultrasound		Color Doppler ultrasound		Summation
	Anomalous drainage of fetal pulmonary veins	Non-fetal anomalous pulmonary venous drainage	Anomalous drainage of fetal pulmonary veins	Non-fetal anomalous pulmonary venous drainage	
	Anomalous drainage of fetal pulmonary veins	59	1	51	
Non-fetal anomalous pulmonary venous drainage	0	0	0	0	0
Summation	59	1	51	9	60

表 2 四维容积超声及彩色多普勒超声在胎儿肺静脉异位引流的诊断敏感性对比(n)

Table 2 The diagnostic sensitivity comparison of four-dimensional volume ultrasound and color Doppler ultrasound in fetal pulmonary vein ectopic drainage (n)

Check the method	n	Detection	Sensitivity
Color Doppler ultrasonography	60	51	85.0%
Four dimensional volume ultrasound	60	59	98.3%
χ^2			6.982
P			0.008

2.4 合并畸形情况

在 60 例孕妇中,合并心脏畸形 32 例,合并畸形率为 53.3%,其中房间隔缺损 10 例、心内膜缺损 6 例、肺动脉瓣狭窄 8 例、肺动脉瓣闭锁 4 例、有动脉弓 2 例,双出口左心室 2 例。

2.5 预后情况

在 60 例孕妇中,有 51 例孕妇终止妊娠,所有胎儿均行引产后尸体解剖证实;9 例孕妇继续妊娠,其中 8 例未经治疗者新生儿期死亡,1 例在 3 月龄死亡。

3 讨论

原始的胎儿静脉系统包括卵黄静脉、主静脉、脐静脉,肺芽不与心脏连接,而是通过上述静脉系统丛获取营养^[10,11]。随着胚胎进一步发育,肺芽便与原始肺静脉建立了连接,原始肺静脉形成于左房后壁,然后进行自行脱离,如果在此过程中发生异常,则会形成肺静脉异位连接^[12,13]。

胎儿肺静脉异位引流属于比较罕见的复杂性先天性心血管畸形,其中全部肺静脉均异位引流入体循环静脉或右房称为完全性胎儿肺静脉异位引流,占胎儿肺静脉异位引流的 85.0% 以上^[14]。胎儿肺静脉异位引流胎多呈散发性,无地域性、家族遗传所与种族性,大多数患儿父母非近亲结婚,具有极高的死亡率,故需要准确进行产前诊断^[15,16]。超声在检查过程中不受肺内气体、心脏运动的干扰,具有经济性好、可重复检查、动态性好等特点,已成为临床上首选的无创检查方法^[17]。不过肺静脉异位引流是产前超声心动图检查时容易漏诊的畸形之一,特别是在孕早期及孕中期更加容易出现漏诊与误诊。正常的肺静脉血流波形由 D 波、S 波、A 波等等组成,可较好地反映左心房内血流动力学改变情况^[18,19]。肺静脉异位引流在彩色多普勒超声检查显示左房后方见四支肺静脉汇合的共同静脉腔,引流血管呈现扩张状况,心尖四腔观上左房后壁光滑,无肺静脉血流

信号汇入^[20]。有学者在心尖四腔观上,取心脏十字交叉处到降主动脉中心的连线,测量降主动脉内径、左房后壁到降主动脉前壁的距离,可通过计算两者比值来判断肺静脉异位引流发生情况,但是诊断的敏感性与特异性有待提高^[21]。肺静脉异位引流的临床表现与自身疾病的发展,主要与异位引流肺静脉数目、异位引流途径、心血管畸形、肺静脉发育等存在相关性。绝大多数肺静脉异位引流新生儿可出现反复肺部感染、生长发育欠佳、呛奶、口唇、肢端紫绀等,为此了解肺静脉异常引流途径对于产前诊断具有重要价值^[22]。

肺静脉异位引流的肺静脉频谱失去了正常频谱形态,为连续性匀速频谱,无周期搏动性,可为超声诊断提供了理论基础^[23]。本研究显示在 60 例孕妇中,彩色多普勒超声检查判断为胎儿肺静脉异位引流 51 例,诊断敏感性为 85.0%;四维容积超声检查判断为胎儿肺静脉异位引流 59 例,诊断敏感性率为 98.3%,四维容积超声检查对胎儿肺静脉异位引流的诊断敏感性明显高于彩色多普勒超声检查,彩色多普勒超声检查与四维容积超声检查诊断的特异性都为 100.0%,表明四维容积超声及在胎儿肺静脉异位引流诊断中的敏感性更高。分析可知,四维容积超声对低速血流灵敏度高,能够识别特别小的血管和复杂的血流^[24]。四维容积超声能够消除伪影,可获得更高帧频和更高分辨率的血流成像。其作为一种宽带多普勒成像技术,能够识别非常小的血管和复杂的血流,可提高成像的空间分辨率,可让影像科医生能够更全面地评估肺静脉的发育过程。相较于彩色多普勒超声,四维容积超声可避免血管过度着色的缺点,可以显示更好的血管成像,能够检测出流速较慢的血流信号,可以更清晰地展现纤细血流的灌注情况,提高血流显示的饱和度高。四维容积超声也具有更高的灵敏度和空间分辨率,能充分显示细小血管血流状况,从而提高诊断敏感性^[25-27]。

肺静脉异位引流新生儿出生后由于体循环与肺循环血液

混合,常表现为肺静脉回流梗阻、发绀等临床特征,本研究显示在 60 例孕妇中,判断为胎儿肺静脉异位引流心上型 32 例,心下型 28 例;心上型的肺静脉引流途径为肺静脉-垂直静脉-右上腔静脉 22 例、肺静脉-垂直静脉-左上腔静脉 10 例,心下型的肺静脉引流途径为肺静脉-垂直静脉-左头臂静脉-右上腔静脉 6 例、肺静脉-垂直静脉-门静脉 22 例。合并心脏畸形 32 例,合并畸形率为 53.3%;有 51 例孕妇终止妊娠,9 例孕妇继续妊娠,其中 8 例未经治疗者新生儿期死亡,1 例在 3 月龄死亡。产前超声尤其是四维容积超声可有效显示复杂心血管畸形形态,可以清晰描述脏器及血管走行异常,可为进一步判断肺静脉异位引流的类型及合并心脏畸形提供依据^[28]。特别是产前超声发现胎儿肺静脉异位引流时,应重点观察肺静脉回流情况,明确是否伴随有左心发育不良综合征、主动脉缩窄、法洛四联症、肺动脉闭锁等,及早进行诊断,以改善孕妇与胎儿的预后^[29,30]。本研究由于经费问题,没有纳入其他影像学方法进行对比分析,对比分析资料比较少,将在后续研究中探讨。

综上所述,相对于彩色多普勒超声,四维容积超声在胎儿肺静脉异位引流诊断中的应用可提高诊断敏感性,可有效反映肺静脉回流情况,可指导临床进行早期干预。

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