General Section

Single umbilical artery: fetal and placental histopathological analysis of 24 cases

A. Kondi-Pafiti[1], K.C. Kleanthis[1], P. Mavrigiannaki[1], C. Iavazzo[2], K. Bakalianou[2], D. Hassiakos[2], A. Liapis[2]

[1]Pathology Laboratory, [2]2nd Clinic of Obstetrics and Gynecology, "Aretaieion" University of Athens (Greece)

Summary

Aim: 24 cases of single umbilical artery (SUA) are presented and the related histopathological findings of the fetuses and placentas examined. SUA is the most common congenital anomaly of the umbilical cord, resulting in the absence of one of the two umbilical arteries. It has an incidence of approximately 2.1% in autopsy material and there is evidence that is associated with anomalies of the fetus and placenta. *Material-Method:* The files were reviewed of 24 cases with SUA, out of 1,570 autopsies of fetuses and placentas performed in the Pathology Laboratory of Aretaieion Hospital, due to spontaneous or induced abortions after written parental consent. *Results:* The incidence of SUA was 1.6%. Gestational age ranged between the 15th and 33rd week and mother's age ranged from 17-44 years. Three of 24 cases were twin pregnancies; 17/24 fetuses were male. In 21/24 cases complex congenital anomalies were observed and in five of 24 cases chromosomal anomalies were detected. In eight of 24 placentas extensive infarcts were observed; 7/24 dysmaturity, 5/24 severe chorioamnionitis, 3/24 extensive fibrin accumulation and 1/24 chorioangiosis. *Conclusion:* SUA is an umbilical congenital anomaly associated with severe fetal congenital anomalies and once detected with ultrasound techniques, further and more detailed control of the fetus is considered mandatory.

Key words: Umbilicus; Placenta; Single umbilical artery; Autopsy; Congenital anomalies.

Introduction

The development of the umbilical cord takes place between the 13th and 38th day after fertilization [1, 2]. It contains three vessels, one vein and two arteries, but occasionally, in one out of 200 newborns (approximately 0.3% of all neonates) only one artery is present [1]. In 20% of these cases various congenital anomalies are reported, mainly of the heart and great vessels [1-4]. Single umbilical artery (SUA) is the most common congenital anomaly of the umbilical cord and is the result of agenesis or atrophy of the one umbilical artery, or, of failed separation of the common umbilical artery, which derives from the single allantoic artery [1, 3]. The significance of SUA was realized as its association with fetal congenital anomalies, placental anomalies, increased risk of preterm labor, intrauterine growth retardation (IUGR), stillbirth or neonatal death was observed [1, 5]. The histopathological findings of fetuses and placentas of 24 cases of SUA examined in the Pathology Laboratory of Aretaieion Hospital are presented.

Material and Methods

During the period 1980-2009, 1,570 stillborn fetuses, after miscarriage or induced termination of pregnancy, were examined in the Pathology Laboratory, Aretaieion University Hospital of Athens. Complete autopsy of the fetuses and histopathological examination of the placentas was performed after written parental consent. The files were reviewed and 24 cases with SUA were reexamined. Information about the obstetric and genetic history, as well as additional information of the prenatal control of these cases was obtained from the files of the 2nd Obstetrics and Gynecology Department of Aretaieion Hospital.

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Results

The incidence of SUA in our autopsy material was 1.6% and the gestational age ranged between the 15th and the 33rd week. Induced abortion was performed in five cases due to chromosomal anomalies. Patient age ranged between 17-44 years (mean age 30.5 years). The histopathological findings of the fetuses and the placentas examined are presented in Table 1. Sixteen fetuses were male and eight female. In 5/24 cases no fetal anomalies were found but the placentas presented extensive infarcts and inflammatory changes. There were four cases of twin pregnancy. Three of these cases were terminated due to miscarriage prior to the 22nd week of gestation without any fetal congenital anomalies. SUA was observed in one-half of the umbilical cord. The third case was that of an incomplete fetal separation, with multiple fetal defects and a single umbilical cord, terminated at the 22nd week of gestation. Congenital anomalies were found in 19 cases. In 7/19 cases complex congenital anomalies were involved more than one system. According to the prominent defect observed, we can note that: anomalies of the CNS were the most common, observed in six cases (31.5%) and usually complicated by other complex anomalies (anencephaly in one case, holoprosencephaly in one case, hydrocephalos and spina bifida in one case, hydrocephalos in one case, and meningomyelocele in two cases). In 5/19 cases (26.3%) a prominent malformation of the cardiovascular system was observed (one case of an intraventricular defect, two cases of left heart hypoplasia, one case of coarctation of the aorta and hypoplastic pulmonary artery, and one case of translocation of the great vessels). The case with an intraventricular defect was part of the complex congenital anomalies involving the kidneys as well. Anomalies of the genitourinary

Table 1. — *Single umbilical artery: fetal and placental histopathological analysis*..

No.	Pathology report/year	Maternal age (weeks)	Gestational age (weeks)	Clinical information	Sex	Histological findings Fetus	Placenta
1	N618/1988	39	22	No relevant maternal history	M	Left renal aplasia, cleft lip and palate, deficit of abdominal wall with umbilical hernia, clubfoot	Infracts, old and new amniotic cysts
2	N686/1990	26	33	No relevant maternal history	M	Encephalomyelocele, amniotic fluid aspiration	Villamentous insertion of the umbilical cord
3	N696/1990	29	30	No relevant maternal history	M	Diaphragmatic hernia, displacement of abdominal viscera in the thoracic cavity, lung hypoplasia, heart displacement, intraventricular septal communication, polycystic kidneys with immaturity	Old infarcts
4	N701 & 5362/1990	40	20	Twin pregnancy, intrauterine death of one fetus	M	One macerated fetus, second fetus without congenital anomalies, amniotic fluid aspiration	Diamniotic monochorionic placenta with infracts, chronic inflammation and calcifications. SUA in the macerated fetus
5	N742/1992	17	21	No relevant maternal history	M	Fetal anencephaly	Old infarcts
6	N766/1992	24	21	No relevant maternal history	F	Cord wrapped round neck, normal length. neck lymphangioma	No specific findings
7	N1043/1997	32	22	Twin pregnancy (males)		Incomplete separation of fetuses, multiple birth defects (two heads, one trunk, cleft lip and palate, duplication of spine-esophagus, stomach, thymus, thyroid, l diaphragmatic hernia)	Infarcts. One umbilicus
8	N1075 & 1716/1998	29	22	Twin pregnancy (male and female)		Fetuses without congenital anomalies Aspiration of amniotic fluid	Dichorionic placenta chorioamnionitis, normal umbilical cord of the female SUA in the male fetus
9	1178/2001	28		Therapeutic abortion due to pathologic antenatal check	M	Seirenomely, cystic renal dysplasia, ectopic renal tissue	No remarkable findings
10	1187 & 915/2001	28	18	Therapeutic abortion due to pathologic antenatal check	M	Holoprosencephaly, polydactyly	No pathological findings
11	1210/2001	24	22	Therapeutic abortion due to pathologic antenatal check	M	Left heart hypoplasia	No pathological findings
12	1237/2002	23	23	Therapeutic abortion	F	Spina bifida, hydrocephalus, cerebral hemorrhage	No pathological findings
13	1321/2004	32	26	No relevant maternal history	F	Intraventricular septum defect, coarctation of the aorta, hypoplastic pulmonary artery	Excesive fibrin accumulation
14	1329 & 2611/2004	44	22	Therapeutic abortion due to trisomy 16	M	Low set ears, hydrops	Inflammation, villus immaturity parenchymal hemorrhage
15	1338 & 3094/2004	34	23	Chromosomal abnormalities	M	Potter's syndrome- multiple congenital anomalies	Chorioamnionitis, chorangiosis, villus immaturity
16	N1344 & 298/2005	26	18	Therapeutic abortion, Anydramnion Chromosomal anomalies	M M	Low set ears, IUGR	Dysmaturity, infarcts
17	1377 & 2725/2005	29	23+6	Meningomyelocele, microcephaly	F	Meningomyelocele, multiple congenital anomalies	No remarkable findings
18	1392 & 65/2006	24	22	Therapeutic abortion trisomy 18	F	Heart and lungs hypoplasia, exomphalus, choroids plexus cysts, skeletal disorders	Villus immaturity recent infracts. Chorionamnionitis umbilicitis
19	1393 & 87/2006	34	18	Chromosomal anomalies	M	Low set ears, absence of nasal bone	Villus immaturity
20	1431 & 424/2007	34	22	Pharmaceutic abortion due to CNS anomalies	M	Dandy-Walker syndrome	Dysmaturity
21	1436 & 1175/2007		33	Chromosomal anomalies (46)	F	Intraventricular communication	Placenta with infracts
22	1477 & 659/2008	34	22	Congenital cardiovascular malformations	M	Translocation of great vessels, intraventricular communication	Excessive fibrin accumulation
23	1482 & 1150/2008	41	15	Twin pregnancy (males)		Fetuses without congenital anomalies, meconium aspiration	Placenta of twin pregnancy with villi fibrosis, calcifications and focal degeneration. One umbilical cord with SUA. Second umbilical cord normal.
24	1512 & 50/2009		20	Therapeutic abortion due to congenital abnormalities	F	Meningomyelocele, cystic adenomatous lung malformation, clubfoot	Villus immaturity, excessive fibrin accumulation

system were observed in four cases (21%), usually as part of complex congenital malformations (aplastic-dysplastic changes in two cases and polycystic kidneys in two cases). In 4/19 (21%) cases, rare and complex congenital anomalies were observed, such as sirenomelia, Potter's syndrome, diaphragmatic hernias, and adenomatoid cystic lung malformation. In five cases (26.3%) chromosomal anomalies underlying most of the above findings were detected and therapeutic abortions were performed. Placental histological examination in 6/24 cases did not show any remarkable changes. Infracts were observed in 7/24 placentas, chronic inflammation in 4/24 cases, chorioangiosis in 1/24 cases, extensive fibrin accumulation in 3/24 cases and dysmaturity in 7/24 cases.

Discussion

SUA is the most common congenital anomaly of the umbilical cord [1]. The pathogenesis is not clear but three possible mechanisms have been proposed: a) agenesis of one of the arteries, b) regression of a previously normal artery due to thrombotic or thromboembolic events, and c) persistence of the remains of the common allantoic artery, due to its failure of separation into the common umbilical artery [1, 3]. The incidence of SUA ranges between 0.2-1.5% of all pregnancies [1, 2]. Further studies that have detected the incidence of the SUA in living and dead fetuses separately report an incidence of 0.55% and 2.1%, respectively [4]. SUA is found to be related with various fetal anomalies such as atresia of the visceral organs, anomalies of the cardiovascular and CNS systems as well as the gastrointestinal, urinary and myoskeletal systems [2, 5]. Furthermore, it is associated with increased risk of chromosomal anomalies such as trisomy 13 and 18, preterm labor, IUGR and perinatal morbidity and mortality [1, 6-8]. The incidence of these findings ranges between 25 and 50% in all SUA cases. On the other hand studies that detected SUA in living and dead fetuses separately, report an incidence of 27% and 66%, respectively [4, 5, 8]. In our study, the findings are in accordance with the above and the percentage of pathological findings in autopsy material was 87.5% of cases examined. The placentas examined in our laboratory showed important findings in more than 50% of the cases such as extensive infarction, accumulation of fibrin and chorioangiosis events associated with hemodynamic disorders. The dysmaturity changes observed are probably related to concomitant chromosomal anomalies. There is evidence that many of these anomalies are caused by ischemic lesions [2]. The theory of regression of the one umbilical artery due to thrombotic events could explain these findings as it results in hemodynamic instability of the fetal circulation and finally ischemia [8]. The thrombotic mechanism could be related either to a generalized or multifocal endothelial dysfunction, which could make it prone to thrombosis, or to a general increase of the clotting mechanism, which could be caused by twin to twin blood transfusion and by various metabolic, immunological, genetic and infectious causes [4]. SUA is usually diagnosed during antenatal ultrasound [6, 7]. When one umbilical artery is present, its diameter is usually larger, reaching that of the umbilical vein.

Conclusion

The ultrasound diagnosis of SUA should lead to a thorough fetal examination for congenital anomalies. Fetal ultrasound and karyotype investigation are proposed as well as Doppler ultrasound during the third trimester in order to detect IUGR fetuses [8]. In cases where SUA is observed in neonates a further detailed check for CNS, cardiovascular and renal anomalies is mandatory.

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Address reprint requests to:
A. KONDI-PAFITI, M.D.
Pathology Department
Aretaieion University Hospital 76
Vassilisis Sofias Avenue
11528, Athens (Greece)
e-mail: akondi@med.uoa.gr