

Morphometry of human placentas: a comparison of placental parameters

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Summary

We aimed to investigate the relationships between maternal-neonatal parameters and morphometric characteristics of human placenta. We performed this study on 259 human placentas. We observed that 257 placentas were single and two (0.8%) were twin. Number of cotyledon was 16 ± 2.22 . The length of umbilical cord was 57.13 ± 9.08 cm. The cord coiling was 0.18 ± 0.1 per cm. Two out of 259 (0.8%) placentas had knotted umbilical cords. In most of the cases, there were two umbilical arteries and one umbilical vein. In two cases (0.8%), the artery was single. Diameters of umbilical artery and umbilical vein were 2.48 ± 0.38 mm and 2.97 ± 0.49 mm, respectively. We compared the number of cotyledon and hypercoiling of the cord. The differences between them were statistically significant. In addition, there were significant correlations between hypercoiling of the cord, and abortion and APGAR scores.

Key words: Cotyledon, fetal demise, human placenta, morphometry, umbilical cord

Özet

İnsan plasentasının morfometrisi: plasental parametrelerin karşılaştırılması

Bu çalışmada maternal-neonatal parametreler ile insan plasentasının morfometrik karakteristikleri arasındaki ilişkilerin araştırılması amaçlandı. Çalışma 259 insan plasenta üzerinde gerçekleştirildi. Çalışmada 257 tek plasenta ve iki adet ikiz plasenta tespit edildi. Kotiledon sayısı 16 ± 2.22 idi. Umbilikal kordun uzunluğu 57.13 ± 9.08 cm olarak ölçüldü. "Cord coiling index" (her cm başına düşen korddaki kıvrım sayısı) 0.18 ± 0.1 cm olarak hesaplandı. İki yüz elli dokuz plasentanın ikisinde (%0.8) düğümlü umbilikal kord vardı.

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Date submitted: January 30, 2007

Accepted: July 23, 2007

Vakaların çoğunda umbilikal arter sayısı iki, ven sayısı bir olarak bulundu. İki vakada ise sadece bir arter vardı. Umbilikal arter ve ven çapları sırasıyla 2.48 ± 0.38 mm ve 2.97 ± 0.49 mm olarak bulundu. Plasentaların kotiledon sayısı ve kıvrımlılık derecesini karşılaştırdığımızda, aralarındaki farklılıklar istatistiksel olarak anlamlı bulundu. Ek olarak, kıvrımlılık derecesiyle düşük sayısı ve APGAR skoru arasında anlamlı korelasyonlar bulundu.

Anahtar kelimeler: Kotiledon, fetal ölüm, insan plasentas, morfometri, umbilikal kord

Introduction

The placenta is a unique characteristic of the higher mammals. In humans it is a thick mass, about 18 cm in diameter. The placenta is attached to the uterus, and the fetus is connected to the placenta via the umbilical cord.

The human placenta is the functional center of the maternal-fetal system, and is responsible for respiratory, nutritional, excretory, endocrine and immunological functions.

Researchers have, for a long time, emphasized the benefits associated with the anatomical examination of the placenta. The literature presents several studies on the morphology of placenta (1,2).

In this study, we aimed to investigate the relationship between morphometric characteristics of human placenta and maternal-neonatal parameters. The placental and umbilical cord morphologies in relation with some maternal and fetal characteristics were evaluated.

Material and Methods

We performed this descriptive study on 259 human placentas between April 2004 and November 2006. The placentas were obtained from mothers who gave birth at the Turkish Ministry of Health Ankara Etlik

Maternity and Women's Health Academic and Research Hospital, and they were transferred to the Department of Anatomy of Gulhane Military Medical Academy. All were transported within 10% formalin solution. Apgar scores at 1 and 5 minutes after delivery (AI and AV) were recorded. Mothers' age range was 17-42 years.

After removing the excess blood and membrane the placentas were examined macroscopically and the umbilical cords were cut at 1 cm from the placental disc. Afterwards, placentas were fixed in 10% formalin solution for an average period of seven days.

Number of cotyledon (NC), number of umbilical artery (NUA) and number of umbilical vein (NUV) were determined. The umbilical cord coiling index (UCI) was calculated as the number of coils divided by the sample length in cm. Diameter of umbilical artery (DUA), diameter of umbilical vein (DUV), length of umbilical cord (LUC) were measured with Vernier caliper in the Anatomy Dissection Laboratory of Gulhane Military Medical Academy. Additionally, mothers and newborns were evaluated according to maternal (age, gestational age, height and weight) and neonatal (sex, height and weight) parameters.

Statistical analysis was performed by using SPSS 10.0 (SPSSFW, SPSS Inc., Chicago, IL., USA) statistical software. Descriptives of the parameters were given as mean±SD notation. Kendall's tau-b or Spearman ranks correlation of coefficients were calculated. P values less than 0.05 were assumed as statistically significant.

Results

We found that 1 out of 259 placentas (0.4%) was monochorionic monoamniotic twin placenta and 1 out of 259 placentas (0.4%) was dichorionic diamniotic twin placenta (Figure 1). The number of cotyledon was 16 ± 2.22 .

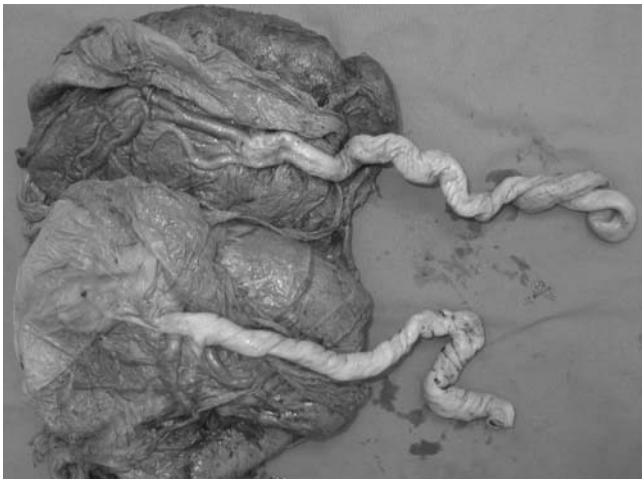


Figure 1. Dichorionic diamniotic twin placenta

The length of umbilical cord was 57.13 ± 9.08 cm (range 22-76 cm). The distribution of cord coiling in 259 placentas was 0.18 ± 0.1 per cm. Hypercoiling of the cord was 0.34 ± 0.38 (10.8%), and 2 out of 259 (0.8%) placentas had knotted umbilical cords (Figure 2).

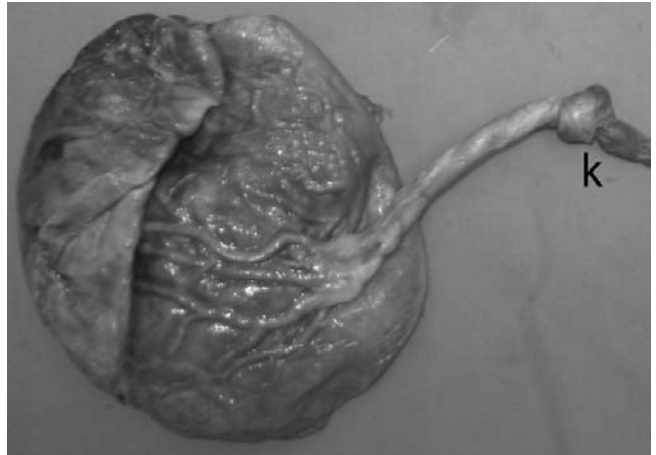


Figure 2. A knotted (k) in an umbilical cord

Number of umbilical artery was two and of umbilical vein was one in most cases. In two cases (0.8%), the artery was single. We found the diameter of umbilical artery as 2.48 ± 0.38 mm, diameter of umbilical vein as 2.97 ± 0.49 mm. In the two-vessel cord (single umbilical artery and single umbilical vein), the blood flow to the placenta is only through the single umbilical artery, resulting in a compensatory increase of the arterial diameter (Figure 3B).

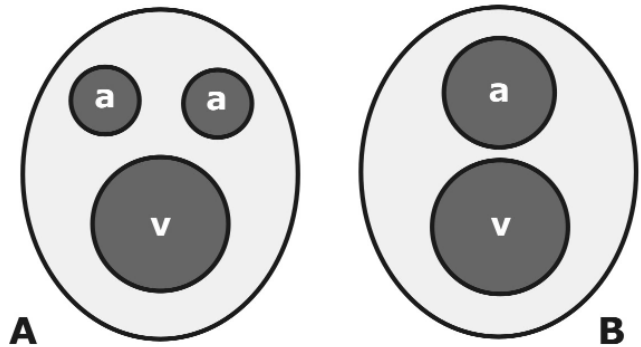


Figure 3. Schematic representation of the umbilical cord transvers section. **A:** a normal three-vessel cord. a: umbilical artery, v: umbilical vein. **B:** a two-vessel cord

The differences between number of cotyledon and hypercoiling of the cord ($p < 0.001$) and the differences between APGAR scores (first and five minute) were statistically significant (Table I). Moreover, there were significant correlations between hypercoiling of the cord, and abortion and APGAR scores (first minute).

Table I. Correlations among the parameters

Parameters		Number of cotyledons	Hypercoiling of the cord	Apgar scores (first minute)
Abortion	τ	0.377	0.171	0.095
	p	<0.001	<0.001	0.065
Number of cotyledons	τ		0.250	0.026
	p		<0.001	0.634
Hypercoiling of the cord	τ	0.250		0.001
	p	<0.001		<0.001
Apgar scores (first minute)	τ	-0.029	0.113	0.244
	p	0.579	0.045	0.968

τ : correlation coefficient

Discussion

The human placenta is initially labyrinthine as the early villous stems are formed, but becomes secondarily villous with the development of generation of terminal villi. The expelled placenta is a flattened discoidal mass with an approximately circular or oval outline (3).

Approximately 30% of multiple gestations are monozygous and 70% are dizygous. All dizygous twins have dichorionic-diamniotic placentas. The separate dichorionic placentas may occasionally be fused. Monozygous pregnancies may have dichorionic-diamniotic (30%). Frequency of monozygous varies from 1 in 30 births in Nigeria to 1 in 150 births in Japan (4). We found that 1 out of 259 placenta was monochorionic monoamniotic twin placenta and 1 out of 259 was dichorionic diamniotic twin placenta.

Macroscopically, fetal surface of placenta is smooth, shiny and transparent. The umbilical cord is usually attached near the center of the fetal surface. The maternal surface is finely granular and mapped into some 15-30 lobes by a series of fissures or grooves. The lobes are often somewhat loosely termed cotyledons (3). We observed 8-20 lobes. Cotyledons were counted from maternal surface in order to evaluate their contribution to oxygenization and function of the placenta.

The normal human umbilical cord measures approximately 55 cm at term. At term a cord shorter than 35 cm or longer than 85 cm is considered to be abnormal. Both short and long cords may be associated with intrauterine problems. A cord less than about 32 cm may increase the likelihood of placental abruption. Long cords may increase the probability of cord entanglement, prolapse and true knot development (5). In our study, the length of umbilical cord was 57.13 ± 9.08 cm (range 22-76 cm).

Less commonly, but with potentially devastating consequences, the umbilical cord can become knotted. If the knot is loose, fetal circulation is maintained.

However, if the knot is tightened, for example at the time of fetal descent through the birth canal, the tightening knot can occlude the circulation between the placenta and fetus, resulting in an intrauterine demise (5). We observed that 2 out of 259 placentas were consisting of knotted umbilical cords.

In 1992, Naeye has reported that approximately 1% of all umbilical cords contain only one artery rather than the normal two (6). In 1995, Persutte and Hobbins have found that this value was 2.0% (7). Fetuses with single umbilical artery had significantly more chromosomal and other congenital anomalies (7). In our study we found that 2 out of 259 (0.8%) placentas have only one artery. The umbilical cord typically contains two arteries and a single vein. If only one artery and one vein are grossly visible, the fetal anomaly rate is nearly 50 percent (8). These anomalies may affect the cardiovascular, genitourinary or gastrointestinal systems, and others as well (9,10).

The average diameter of human umbilical cord was reported as 1.5 cm and the average circumference was separately reported as 3.6 cm after birth (1). The umbilical vein and artery have been measured before and after birth. At term, the typical umbilical cord is in a diameter of 2.0 to 2.5 cm (11). We measured external diameters of these vessels as in Reynold's study (12). We found that the external diameter of umbilical artery was 2.48 ± 0.38 mm and the external diameter of umbilical vein was 2.97 ± 0.49 mm.

Most umbilical cords show a twist. This coiling probably provides greater strength while retaining necessary flexibility. Presumably, this coiling arises because the longer umbilical vein twists around the umbilical arteries. The only twist-associated process which seems relevant to stillbirth is the absence of any coiling. Various series have shown frequencies of 10-18% for untwisted cords in stillborns. This does not mean that lack of twisting is the cause of intrauterine death. In fact, no one has any idea what the sequence of events is in connecting untwisted cords and stillbirth (2,13,14). We found significant differences between the number of cotyledon and hypercoiling of the cord ($p < 0.001$). However, in 1997, Dado et al. reported no statistically significant difference in umbilical venous flow between coiled and non-coiled cords when external compression, twisting and longitudinal stretching were applied to the cord segments (15). Published series of umbilical cord coiling range from 0.19 to 0.44 coils/cm (16-20).

In 2000, Machin et al. reported abnormally coiled cords among 1329 cases (20). Twenty one percent of cords were overcoiled. Principal clinical correlations

found in overcoiled cords were fetal demise (37%), fetal intolerance to labor (14%), intrauterine growth retardation (10%), and chorioamnionitis (10%). Abnormal cord coiling was associated with thrombosis of chorionic plate vessels, umbilical venous thrombosis, and cord stenosis (20).

The normal umbilical cord coiling index (UCI) is 0.17 (+/-0.009) spirals completed per cm. Abnormal cord coiling, i.e. UCI <10th centile (<0.07) or >90th centile (>0.30) is associated with adverse pregnancy outcome (21). We found that the distribution of umbilical cord coiling index in 259 placentas was 0.18 ± 0.1 per cm and hypercoiling of the cord was 0.34 ± 0.38 (10.8%).

In our study, noticeably, the differences between the number of cotyledon and hypercoiling of the cord and the differences between other parameters were statistically notable.

Finally, hypercoiling of the cord, hypocoiling of the cord, abnormal cord insertion, knotted of the cord or long umbilical cord and oligohydramnios may lead to hypoxia or death of the fetus. Besides, small diameter of umbilical arteries and vein can decrease in oxygen and nutrition transfer capacity between the fetus and placenta.

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