

MORPHOLOGICAL FEATURES OF THE UMBILICAL CORD VESSELS AT THE DELIVERY, IN SUDANESE NEONATES

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ABSTRACT

Objective: This study was aim to describe the morphological features of the cord vessels at the birth.

Materials and methods: 980 umbilical cords of single birth Sudanese neonates, of normal vaginal deliveries were studied, with mother age ranged between 18 to 45 years and parity from 1 to 8 children. The study was carried out in the department of Obstetrics and Gynecology, Omdurman Maternity Hospital, Sudan, 2017. The cords were cut about 5 centimeters from the baby abdominal wall using scissor; the parts of the cords from the cut end to the placental insertion were dissected using the anatomical dissection tools and method, their blood were delivered from surrounding tissues and studied; the study includes; gross observation of the cord vessels. For general histology, two cm. of cord tissue was studied, using natural historical stains and methods. Special stains, Masson's Trichrome, Van Gieson and Verhoff's were used to clarify the connectives tissues within the cord.

Results and conclusion: the single umbilical artery were about 1.2%, more common in male, the ratio of male-to-female was about 2:1, and it was found associated with spina bifida and hydrocephalus. the relation between cord vessels after dissection showed that; in some cords arteries and vein were course together in a parallel fashions, vein centrally with arteries peripherally, some showed vein run predominantly straight with arteries coiled around it, while other showed arteries and vein course together in a helical fashion in a one-to-one relationship. Moreover the cord vessels don't run close each other like the rest of the blood vessels in the body, they were found separated by a wide tissues structure of Wharton's jelly without branches elements, and the after the umbilical vein was found surrounded by a special sheath. It is concluding that, the highly condensed tissue around the vein, it helps to maintenance the vein and preventing it from occlusion; because the vein is fewer coils and under tensile force of the fetal mobility. Our recommendation that; studding morphological features the cord vessels is significantly important, because their relations play an essential role in fetal intrauterine survival.

KEY WORDS: Morphological Features, Umbilical Cord Vessels, At Delivery.

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INTRODUCTION

Usually there are two arteries present together with one vein in the human umbilical cord. The vein carries blood and nutrients to the baby from the placenta and the arteries carry blood from

the fetus to the placenta. Sometimes, only one umbilical artery is present, in a condition called single umbilical artery. This condition can indicate possible chromosomal problems, while many babies with single umbilical artery are

develop fine and born with no apparent problems [1-3]. The relationship between the vein and arteries inside the cord is varies, normally the arteries wrap around the vein; the variations include the arteries that run together, or separated with each artery lateral to the vein, other variations is arteries wind around the vein while the vein remains central in the cord. This is sometimes referred to as spiraled arteries, but helical is the preferred term the vein can be parallel the arteries in a helical configuration, or can wind around the arteries. The variation may imply effects which can alter blood supply to the fetus [4,5].

In the fetus, the umbilical arteries run into the anterior abdominal wall and continue into the internal iliac arteries that supply the hind limbs. The vein goes all the way to the fetus's liver, where it splits into two parts; part supplies blood to the hepatic portal vein, which supplies blood to the liver, while the other, which is known as the ductus venosus, supplies 80% of the blood to the human body, allowing oxygen and other vital nutrients to circulate throughout the fetus [3]. Inside the placenta, the umbilical arteries connect with each other at a distance of approximately 5 mm from the cord insertion [6].

Subsequently, they branch into chorionic arteries or intraplacental fetal arteries. Umbilical cord blood vessel is without branches, this is unique compared to the large blood vessels of the adult body, the aorta and vena cava. In addition, the umbilical vein sometimes bunches up on itself, creating the appearance of a false knot or of multiple varicosities; these spaces can acts like quiet pools of blood that can clot and predispose to a thrombo-embolism in the fetus. The clot can break free and enter the fetal circulation or can obstruct cord blood flow. The umbilical arteries can develop similar pockets called aneurysms. These bulges in the arterial wall can rupture and lead to fetal hemorrhages in the uterus [7,8].

The wall of the umbilical vessels contains mixture of smooth muscles cells and elastic fibers, which contribute to a rapid constriction and contraction of the umbilical vessels after the birth when the cord is tied off. The muscles cells are arranged into; an outer circular layer and an inner irregularly loosely arranged layer

embedded in abundant ground substance staining metachromatic [9-10].

MATERIALS AND METHODS

980 umbilical cords of both sexes of single birth were studied; the cord samples were randomly collected, from the department of Obstetrics and Gynecology, Omdurman Maternity Hospital, Sudan, 2017, which is a main reference Maternity Hospital in Sudan. All cords obtained were of full term looked healthy neonates of normal vaginal deliveries, of mother age ranged between 18 to 45 years and parity from 1 to 8 children. After the delivery the cords were cut about 5 centimeters from the baby abdominal wall using scissor; the part of the cords from the cut end to the placental insertion was taken. The specimens were placed in plastic container and storage at room temperature then studied. The cords were dissected, using the anatomical dissection tools and method, and their blood were delivered from surrounding tissues then studied. The study includes; gross observation of the vessels, their number, position, and relationship within the cord.

For histological examination, approximately two cm. of cord tissue was taken from each cord before the dissection, and then fixed in 10% neutral buffered formaldehyde. The tissue was dehydrated with alcohol, cleaned in chloroform and embedded in paraffin wax. Sections is cut at 5 μ m thick, using leica rotary microtome (Leica Germany), and stained with Hematoxylin and Eosin (H&E) stains for routine cord histological structures [12]. Special stains Masson's Trichrome, Van Gieson and Verhoff's stains also were used to clarify the connective tissues fibers within the umbilical cord [12,13]. The data were entered to computer software programs and analyzed using Statistical Package for Social Science version 16 (SPSS, V16. Aromonk, NY: IBM Corp, USA).

RESULTS

Out of 980 umbilical cords, 576 (58.8%) were of male neonates and 404 (41.2%) were of female neonates. of all specimens, 968(98.8%) cords showed three vessels (two arteries and one vein), (Fig.1A), and 12(1.2%) cords were showed two vessels, one artery one vein (single umbilical artery) (SUA), (Fig. 1B), of them 8 were males

cords and 4 were females cords. The ratio of male-to-female of single umbilical cords was about 2:1, and two babies of them were showed congenital abnormalities, spina bifida associated with hydrocephalus.

The dissected umbilical cords specimens showed that; the arteries and vein were course together in a parallel fashions, the vein centrally and the arteries peripherally (Fig. 2), other showed vein is run predominantly straight with arteries coiled around the vein (Fig. 3), and some showed, arteries and vein course together in a helical fashion in a one-to-one relationship (Fig. 4). The umbilical arteries were found distinctly smaller in size than the vein, and being circular, oval, or dumb-bell in shape, the vein was found surrounded by a special sheath, (Fig. 3 A, B), and are don't run close each other like the rest of the blood vessels in the body;

they are separated by a wide tissues structure of Wharton's jelly without branches elements, (Fig. 1 A,B and Fig. 2, A)

The histological results showed that; the connective tissue fibers appeared pink to back colored vary in thickness; after reacts by Verhoff's stain, (Fig. 5,6), and when stained by Masson's trichrome appeared blue to black colored highly condensed and concentrated close to the vein than arteries, forming sheath like structure (Fig 7). Van Gieson stain reacts with structures tunica media of the cord vessels, the connective tissue appeared blue red, while the smooth muscle appeared yellow, being thicker in artery than vein, and arranged into longitudinally orientated with a small groups of circular (Fig.7,8). Adventitia or vasa vasorum were not clearly visible in either arteries or veins

Fig. 1: cross sections of the umbilical cord showing blood vessels, A. cord with three vessels, B. cord with two vessels, 1-umbilical vein, 2- umbilical artery.



Fig. 2: umbilical cord shows blood vessels; A before dissection, B. after the dissection. 1- Umbilical vein, 2- umbilical artery.

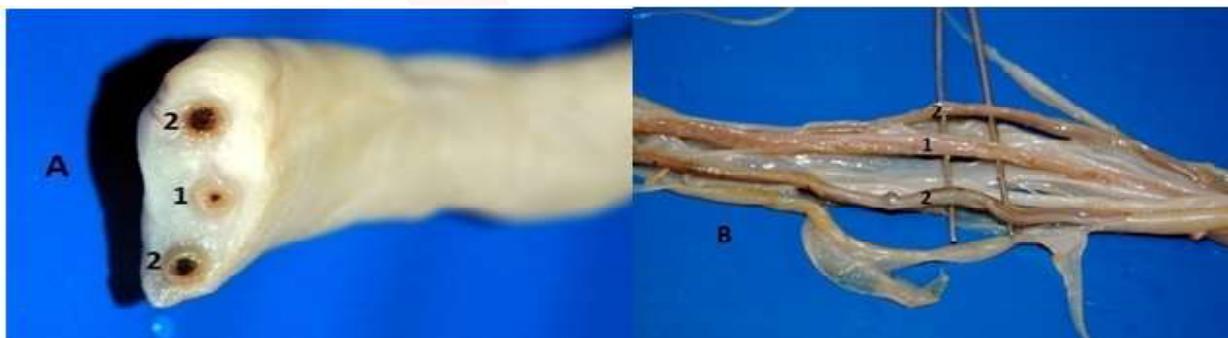


Fig. 3: A. B. dissection cords showing sheath around the umbilical vein. 1- umbilical vein, 2-umbilical artery, 3-outer covering of the umbilical cord and 4- sheath around the umbilical vein.



Fig. 4: A dissection cord showing relationship between blood vessels. B. cross section showing blood vessels lying in triangular manner. 1-umbilical vein, 2-umbilical artery).



Fig. 5: shows normal histological features of umbilical cord. (H and E stains, lens 60X). 1. lumen of the blood vessels, 2. blood cells, 3. tunica media, 4. Tissue of Wharton's jelly - arrow showing cells and fibers as condensation around blood vessels. UA-umbilical artery, UV- umbilical veins.

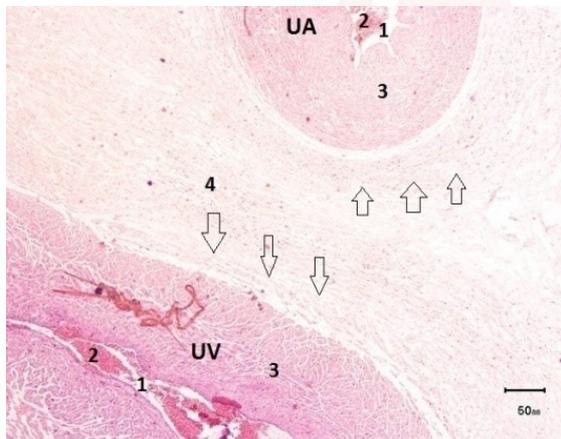


Fig. 6: Shows normal histological features of the umbilical cord, Verhoff's stain, lens 40X.

1. lumen of the blood vessels, arrow shows intima, 2- tunica media, pink colored in 2 showing elastic fibers within the tunica media, 3-collagenous fibers condensed around cord blood vessel.

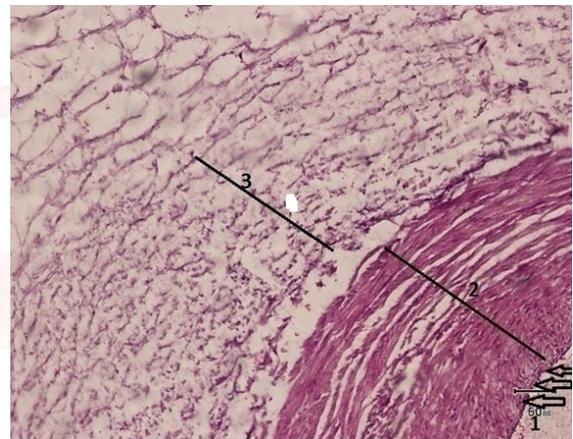


Fig. 7: Shows normal histological features of human umbilical cord ((H and E stains, lens 40X) A. Umbilical vein, B. umbilical artery. 1-Circular muscle in wall of cord blood vessel, 2- Longitudinal muscle in wall of cord blood vessel and 3-cells of Wharton's jelly condense around cord blood vessel (Arrow showing tunica intima)

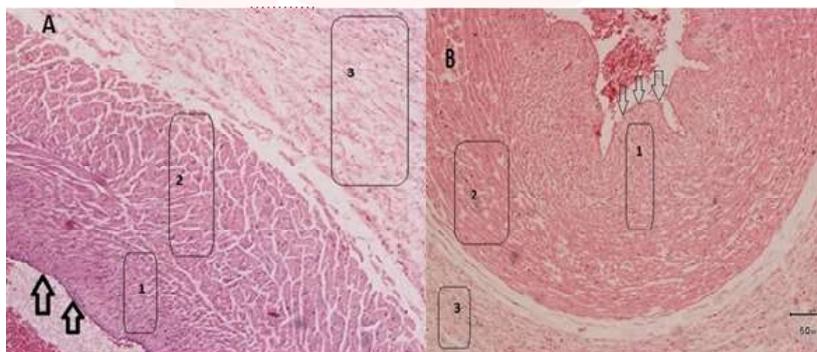
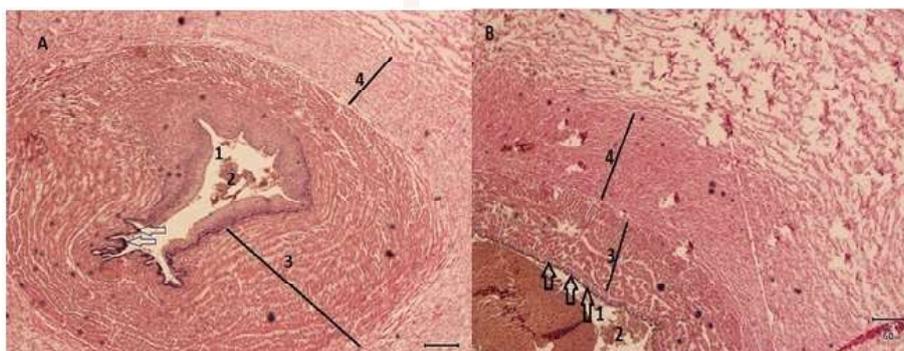


Fig. 8: shows normal histological features of human umbilical cord (Van Gieson stain, using lens 40X).

A. Umbilical artery, B. Umbilical vein. 1- lumen of the blood vessels- arrow showing tunica intima, 2-blood cells, 3- tunica media, 4- cells of Wharton's, jelly condensed around cord blood vessels



DISCUSSION

Normally the cord has three vessels two arteries and one vein, absence of one umbilical artery is rare, in condition known single umbilical artery (SUA). Detection of a SUA can be done by several methods, before birth by ultrasound or after birth following examination of the placenta. The exact cause of SUA is unknown Bourke et al [14], in (1993), and Ghatersamni [2], in (2007), they suggested that it occurs due to primary agenesis or secondary atrophy of one artery in the early stages of embryonic life. In (1995), Abuhamad et al [15]. found that the umbilical artery more commonly absence on the left side; a similar finding was described by Ghatersamni et al [2], in (2007), these is in contrast to results of Blazer et al [16], in (1997) and Fukada et al [17]. in (1998), they did not find such difference. The present work failed to determine the side of missing artery, because Abuhamad et al. [15]. In (1995), Ghatersamni et al [2]. in 2007 and Rajit Narayan in (2015)[18]. They did their works prenatal ultrasographically and they were able to scan fetal abdominal wall, scanning the fetal abdominal wall before the delivery can help for detection the missing artery, while the present work done postnatal. Bourke et al [14], in (1993) and Geipel et al [19], in (2000), they studied cord blood vessels prenatally, found that the incidence of SUA occurs in about 1% of deliveries; which common in females than in males babies, the SUA in the present study was about 1.2% of deliveries, this is consistent with the available data from examination of the umbilical cord before delivery. The congenital anomaly which associated with incidence of SUA was greatly different and may be influenced by, race, geographical and socioeconomic factors. The studies of the Nyberg et al [20], in (1991), Gornall et al [21], in (2003), Mu et al [22], in (2008) and Dane et al [23], in (2009), showed that the presence of SUA may be related to a variety of congenital anomalies of the major organ systems as well as to chromosomal defects and low birth weight. The present study showed two cases of nervous system abnormalities; spina bifida associated with hydrocephalus. Umbilical cord with four vessel is rare, and been reported by Heifetz [24], (1984), in conjoined twins, the present study

didn't found cord with four blood vessel.

The present study found a SUA was more common in males than females babies and was associated with multiparity and advanced maternal age. Similar finding was noted by Fujikura [25]. (1984), and Santillan et al [26], (2002), but Bourke et al [14], Geipel et al [22], (2000) and Marie et al Heifetz [7], (2009) found that the incidence of a SUA is more common in females than in males.

The umbilical vessels have two-way traffic; arteries carry blood pumped by the heart away from the fetus while the vein returns blood to the fetus from the placenta, and relationship between them is varies. Commonly the vein runs centrally with arteries in the periphery in three vessels cord, or the vein and artery course together in parallel fashion in two vessels cord. Moreover the cord vessels don't run close each other like the rest of the blood vessels in the body, separated by a wide tissues structure of the Wharton's jelly; without branches elements, this is unique compared to the large blood vessels of the adult body, the aorta and vena cava. but when the umbilical vein enter the fetus's liver, it splits into two, a part join liver while other part bypass the liver to join inferior vena cava [3].

The umbilical arteries were found distinctly smaller in size than the vein, and being circular, oval, or dumb-bell in shape. Indicative of tortuosity or helical twisting, the lumen of the umbilical arteries appeared irregular in shape. The present study found that the dominant tissues of the human umbilical cord vessels wall were smooth muscles. A similar finding was observed by Ernst et al [6], in (2013); he found that, the smooth muscles in inner layer runs with the vessel lengthwise, while the outer layer runs in circle ways. Contrary to the findings of Ernst et al [6], in (2013), the present study found that, inner layer runs in circle ways while the outer muscular layer runs with the vessel lengthwise. The arrangement of smooth muscles in wall of cord vessels in this study was found similar to arrangement the smooth muscles in wall of esophagus; this arrangement will allow the cord to shorten and elongate during fetal movements. Adventitia was not clearly seen either in wall of arteries or vein in this study, a similar observa-

tion was found by Meyer et al. [9], in (1978) and Gill & Jarjoura [10], in (1993). The dissected cord specimens in the present study showed a highly condensed tissue around the cord vessels especially the vein; this may help to maintenance vein wall; because the vein runs straight way under tensile forces neonatal movement, while the arteries run helically in nature which adapt the tensile force. The fetal heart cannot expand or work harder because it is surrounded by a fluid-filled lung. The fetus has to work against a larger column of fluid and tissue resistance at the placental end. This assist pump may be designed to help the fetus over difficult growth proportions which may exist at 20 weeks, 24 weeks, 28 weeks, and 32 weeks -times that are known for premature labor to appear (Collins [8], 2014).

The extra stress on the fetus may require that the cord be designed correctly so that it can have properties of an assist mechanism or pump.

This requires that the arteries surround the vein in the proper architecture. It is conclude that, the highly condensed tissue around the umbilical vein it well maintenance the vein wall and preventing from collapse or occlusion, because the vein runs straight under tensile force while the arteries are helical nature of arteries adapt the tensile force of the fetal mobility. Recommendation; studding the umbilical cord morphology before and after the devilry has great important, because it is play an essential role in fetal intrauterine survival, its abnormalities may affect blood flow and oxygen from the fetus to placenta.

Conflicts of Interests: None

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