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Comprehensive Morphological Study of the Umbilical Cord in Physiologically Proceeding Pregnancy

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Abstract A characteristic feature of both the umbilical artery and the umbilical vein is a well-developed muscular membrane. It's The thickness of the muscular membrane of the umbilical vein is 0.45 mm, the average diameter of the vein is on average 1.62 mm, the Carnegan index is 0.27.

Keywords Physiological pregnancy, Umbilical cord, Fetus

1. Introduction

During the formation of the functional system mother-placenta-fetus, all other provisional organs undergo changes. The umbilical cord is an independent element of this system, while performing important functions aimed at the development of a healthy fetus [1]. The blood vessels passing through the umbilical cord are the main section of the entire fetoplacental blood circulation system. It should be noted that the blood vessels of the umbilical cord have no innervation, and their length contributes to the complication of the structure of the entire vascular network, variability of the wall parameters, structural transformations of the Vartan jelly located around [2,3]. Ultimately, all this can affect the suppression of the entire fetoplacental blood circulation, and cause the development of pathology in the fetus [4].

2. Material and Methods

Based on the above, we conducted a set of morphological studies of umbilical cords obtained during term births (38-40 weeks) in women of different ages, which proceeded without visible clinical complications. The organometric study of the umbilical cord included: determining the frequency of its attachment site to the placenta, measuring its total length (from the beginning of the fetal segment to the umbilical cord stump, 1 cm from the attachment site to the placenta), weight (m, grams), average umbilical cord diameter (AUD), and calculating its specific gravity or the so-called linear mass unit (LMU - m/l, g/cm.

For histological examination with light microscopy, several pieces measuring 1x1 cm were cut from different umbilical cord segments (fetal, central and placental), the sections were stained with hematoxylin and eosin, according to van Gieson.

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3. Results and Their Discussion

The following umbilical cord parameters were determined: the diameter and thickness of the membranes of its vessels, in particular the muscular one, the Carnegan index (the ratio of the thickness of the muscular membrane to the diameter of the vessel lumen), as well as the relative proportion of the integumentary amniotic epithelium, Wharton's jelly condition.

Determining the Carnegan index is very important when examining the umbilical cord. As mentioned above, this index is an indicator of the ratio of the thickness of the muscular membrane to the diameter of the vessel lumen. Finding the Carnegan index gives an idea of the contractility of a given vessel, i.e., the nature of the reaction to vasoconstrictor impulses.

After the placenta has been discharged and the stapler has been applied, an average of 38-45 cm of umbilical cord remains. To exclude sections of the umbilical cord with artifical changes, pieces of an average of 2.05-5 cm are cut off from the fetal and placental ends. As a result, an umbilical cord of 30-37 cm in length (an average of 34.52±2.45 cm) remains for morphological studies. As our studies have shown, the umbilical cord is a twisted cord with an average total length of 36.7±2.84 cm. The average umbilical cord weight in full-term physiological pregnancies was 21.42±3.16 grams. However, determining only the umbilical cord weight does not provide reliable information. In our opinion, it would be more objective to determine the unit of linear mass (ULM) or the so-called specific gravity of the umbilical cord, as opposed to simply the total umbilical cord weight, since it reflects individual variations in its length. ULM is the ratio of the total organ weight to the total length - M/L (g/cm). In our case, it was 0.63±0.05; the average umbilical cord diameter (AUD) was 0.9±0.05 cm. As our studies have

shown, this indicator reliably characterizes the degree of Wharton's jelly swelling, the degree of vascular plethora, congestion, etc.

We then examined various forms of umbilical cord attachment to the placental disk. Depending on the location of the umbilical cord attachment, various variants of the placenta shape are formed. With a central attachment of the umbilical cord, the placenta is round or oval, the branching of the vessels has a star-shaped form (46%), and the vessels depart evenly, centrifugally over the entire surface of the placenta. With a paracentral (lateral) attachment of the umbilical cord, the placenta is oval, somewhat elongated in shape with a scattered type of vascular branching (24%). However, in this case, an asymmetry in the length of the vascular branches is noted. In the case of a membrane or marginal attachment of the umbilical cord to the placenta, the vessels have a fan-shaped branching form, the placenta itself in most cases has the appearance of an elongated disk. Histologically, the umbilical cord along its entire length in full-term physiological pregnancy shows a significant predominance of the stromal component over the vascular one, especially in the fetal part.

The vessels of the umbilical cord are represented by two arteries and one vein located in the center of the umbilical cord.

The umbilical arteries are represented by two arteries of the muscular type, the wall of which consists of two muscular layers: the internal longitudinal (which forms 3-4 thickenings on the cross section) and the external looser circularly oriented bundles. The lumen of the umbilical arteries is very narrow. As our studies have shown, on average, the diameter of the umbilical arteries is 5.1 ± 0.6 mm, the total cross-sectional area of the umbilical artery is on average 2.51 ± 0.13 mm2. At the same time, the Carnegan index was 35.32 ± 0.85. the thickness of the arterial wall is 0.16 mm, the average diameter of the vessel lumen is on average 0.55 mm, the Carnegan index is - 0.29 mm.

As our studies have shown, the course of the arteries is not the same everywhere along their entire length. A distinctive feature is the presence of anastomoses in the placental area at a distance of 1.5-2.0 cm from the place of attachment of the umbilical cord.

The umbilical vein belongs to the vessels of the elasto-muscular type, the diameter of which is on average 9.4 + 0.08 mm. Analyzing the data on the values of the diameter of the umbilical vein, it was found that in the fetal-placental direction there is a sharp narrowing of the umbilical vein. The total area of the umbilical vein is 3.31±0.13 mm2, the Carnegan index was 6.3±0.89, which is 6 times less than in the umbilical arteries. The thickness of the muscular layer of the umbilical vein is 0.45 mm, the average diameter of the vein is 1.62 mm, the Carnegan index is 0.27. During the observation, we identified a polymorphism of morphological changes in the umbilical cord and its tissue structures during timely delivery after uncomplicated gestation. Thus, in 22% of cases, there is a sharp plethora of the umbilical vein along its entire length against the background of alternating spasmodic and dilated areas of the umbilical arteries. In 18% of cases, massive areas of hemorrhage in Wharton's jelly were detected, macroscopically they look like hematomas of various sizes. Most often, a similar picture was observed in the fetal portion of the umbilical cord. In 10% of all cases, pronounced edema of the stroma of Wharton's jelly is noted against the background of plethora of the vein, in the wall of which the muscle fibers are strongly loosened. All this led to an increase in the diameter of the umbilical cord.

4. Conclusions

A characteristic feature of both the umbilical artery and the umbilical vein is a well-developed muscular membrane. Its Thickness of the muscular membrane of the umbilical vein is 0.45 mm, the average diameter of the vein is on average 1.62 mm, the Carnegan index is 0.27.

Spiral tortuosity of the course of the umbilical vessels, which has a certain hydrodynamic significance. The data obtained sufficiently characterize the wide adaptive capabilities of the umbilical vessels.

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