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Original Article

Comparative histomophometric differences between umbilical cords from normal and pre-eclamptic pregnancies

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ABSTRACT

Introduction: To study and compare the histomorphometric parameters of umbilical cord and its vessels in normal and pre-eclamptic pregnancies.
Material and methods: One hundred umbilical cords, fifty each of normotensive and pre-eclamptic pregnancies were studied. Various histomorphometric parameters were measured with the help of vernier scale and ocular micrometer.
Results: In the present study, mean cord area was $43.45 \pm 9.26\ mm^2$, mean jelly area was $37.55 \pm 9.94\ mm^2$ and total vessels area was $5.90 \pm 1.91\ mm^2$ in control group. Whereas, in pre-eclamptic group, mean cord area was $34.85 \pm 11.78\ mm^2$, mean jelly area was $27.32 \pm 11.41\ mm^2$ and total vessels area was $7.51 \pm 3.25\ mm^2$. Mean wall thickness of the vein was $378.8 \pm 113.65\ \mu m$ and vein area was $2.38 \pm 1.01\ mm^2$ in control group. In pre-eclamptic group, mean wall thickness of vein was $307.2 \pm 107.15\ \mu m$ and vein area was $3.97 \pm 4.32\ mm^2$. Total cord area, jelly area and wall thickness of vein were significantly lower in pre-eclamptic group. Total vessels area and vein area were significantly higher in pre-eclamptic group.
Discussion: Umbilical cords in pre-eclampsia shows significant structural changes, including decrease in cord area, jelly area and umbilical arterial area, whereas increase in total vessels area and vein area. These differences are due to adaptation of the umbilical cord under the altered hemodynamic conditions in pre-eclampsia. Morphological modifications of the umbilical vessels directly influence the fetal blood stream, which impact upon fetal development. So, prenatal monitoring of the feto-placental circulation may reduce the postnatal complications in pre-eclamptic pregnancies.

1. Introduction

Umbilical cord is the only organ of the fetus that dies when life begins. It is the life-line connection between the fetus and mother for the supply of oxygen, nutrients and transfer of waste materials; and is necessary for the growth and development of the fetus.[1] Umbilical cord is mostly assessed for the impedance of the umbilical arteries to blood flow in the fetus with developmental abnormalities.[2] In view of this, abnormalities associated with umbilical cord would have adverse effects on the perinatal outcome.[3]

Pregnancy associated complications like hypertension or gestational diabetes are reflected in the umbilical cord and its vessels in a significant way both macroscopically and microscopically.[4,5] Pre-eclampsia is a common pregnancy associated pathological syndrome which is characterized by generalized edema, hypertension and proteinuria presenting after 20th week of gestation. It complicates about 6–20% of all pregnancies and is the major cause of maternal and neonatal death in developing countries. It also represents as the most important cause of intrauterine growth retardation, premature delivery, low birth weight, perinatal mortality. Prediction of preeclampsia is very difficult in early pregnancy. Some epidemiological factors associated with pre-eclampsia include nulliparity, previous pre-eclampsia, family history, obesity, diabetes mellitus, multi-fetal pregnancies, age of mother (<18 years and >35 years) and previous renal diseases.[6] Preeclampsia is associated with increased vascular resistance and decreased uteroplacental perfusion that results in fetal hypoxia and intrauterine growth retardation.[7,8]

Morphologically, cross section of umbilical cord comprises two umbilical arteries and one vein continuous with the vascular

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architecture of the placenta. Histologically, the umbilical cord in normal pregnancies shows well defined single layer of squamoid amniotic epithelium on the surface. Deep to epithelium, umbilical cord contains mucoid connective tissue known as Wharton's jelly within which umbilical vessels are embedded. The vessels are lined by a continuous single layer of flattened and elongated endothelial cells. Umbilical arteries do not possess an internal elastic lamina. The media of artery is thick, showing an inner layer of longitudinal smooth muscle cells (SMCs) and an outer layer of crossing spiraled SMCs. The vein has an internal elastic lamina and possesses a thinner muscular coat with single layer of circular SMCs. The umbilical arteries showed varying degrees of contraction, and often possess triangular, stellate or sickle shaped lumen. However, the vein was usually not so strongly contracted, and its lumen was comparatively patent. Umbilical vessels are not supplied by vasa vasorum and depend on their own oxygen supply; making them more vulnerable to hemodynamic changes.[9] Histological appearance of the umbilical cord vessels in pre-eclamptic group is nearly normal with varying degree of hypoplastic vessel wall. Edema due to the increase in fluid between the cells causes separation between the muscle cells. The morphological modifications of the umbilical cord in preeclampsia indicates some important postnatal and fetal hemodynamic deficiencies.[4,10]

The aim of the present study was to compare the morphological changes in umbilical cord and its vessels in normotensive and pre-eclamptic pregnancies on histological basis.

2. Material and methods

The study was carried out in the Department of Anatomy, Gandhi Medical College, Bhopal (M.P). One hundred umbilical cords were collected from pregnant women who delivered in Sultania Zanana Hospital associated to Department of Obstetrics and Gynaecology, G.M.C. Bhopal, after informed consent and due permission from institutional ethics committee. Women were diagnosed with preeclampsia if they had systolic BP ≥140 mmHg and diastolic BP ≥90 mmHg measured on two or more occasions at least 4 h apart after 20th week of gestation with proteinuria. Proteinuria was considered present when there was a urine dipstick value of at least 1+ (>30 mg/dl) on two separate occasions at least 6 h apart. On this basis, subjects were divided into two groups. Group I consisted of umbilical cords obtained from normal pregnant women (n = 50) with gestational age 37–40 weeks. Group II consisted of umbilical cords obtained from pre-eclamptic women (n = 50). Patients with essential hypertension, diabetes mellitus, anemia, renal disorders and other illness associated with pregnancy were excluded from study.

In all cases, segments of umbilical cord obtained at 2 cm distance from the placental side, of thickness of approximately 4–5 mm were routinely processed for paraffin embedding, sectioning and H & E staining. Two diameters from each histological section of umbilical cord were measured at right angle in x-axis and y-axis by using vernier scale on the stage of microscope. The diameters of blood vessels were measured by ocular micrometer in x-axis and y-axis [Figs. 1B, 2A]. Vessels wall thickness was measured by ocular micrometer which expresses the whole thickness of vessels wall, from the endothelium to the Wharton jelly.

Total cord area, Jelly area and total vessel area were calculated for each cord by the formulae given below:

(1) $A = \pi D_1 D_2/4$, where A is area, D_1 is diameter in x-axis and D_2 is diameter in y-axis.
(2) Total vessel area = (Total area of artery 1 + Total area of artery 2 + Total area of vein) in cross section.
(3) Jelly area = (Total umbilical cord area − Total vessels area) in cross section.

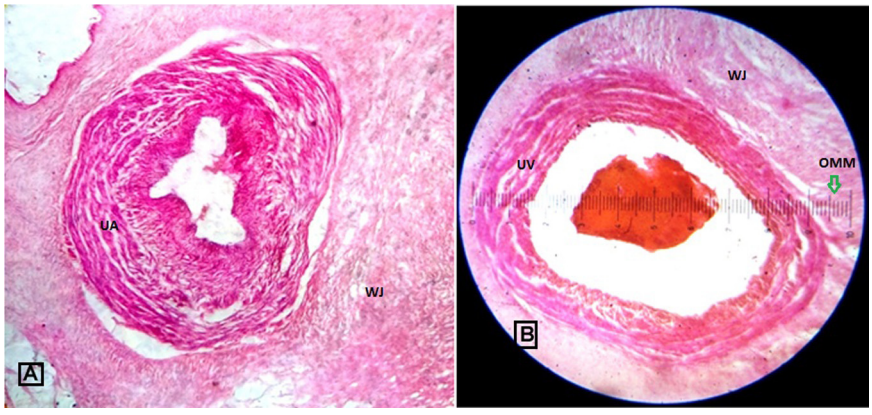

Fig. 1. Hematoxylin & eosin (H&E) staining of umbilical cord taken from normal pregnancy. (A) Umbilical artery (UA) embedded within Wharton's jelly (WJ, 100×). (B) Umbilical vein (UV) embedded within Wharton's jelly (WJ) with ocular micrometer (OMM, arrow, 100×).

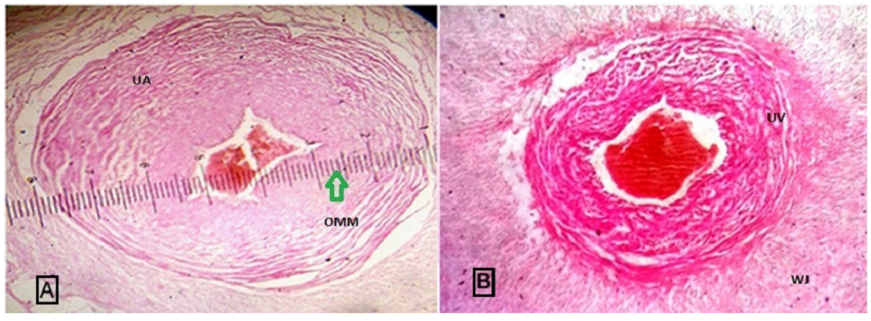

Fig. 2. Hematoxylin & eosin (H&E) staining of umbilical cord taken from pre-eclamptic pregnancy. (A) Umbilical artery (UA) with ocular micrometer (OMM, arrow, 100×). (B) Umbilical vein (UV) embedded within Wharton's jelly (WJ, 100×).