CORRELATION BETWEEN PLACENTA AND UMBILICAL CORD MORPHPLOGY AND PERINATAL OUTCOME IN SINGLETON DELIVERIES AT TERM IN A NIGERIAN TERTIARY HEALTH CENTRE

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ABSTRACT

Context: The ability of the fetus to grow and thrive in-utero depends on a number of factors of which the placenta is a contributor. The umbilical cord is an essential organ connecting the fetus to the placenta and a healthy placenta is essential for good perinatal outcome.

Objectives: The study aims at determining the relationship between the morphology of the placenta and umbilical cord and perinatal outcome in singleton deliveries at term in a Nigerian hospital.

Study design: This is a cross-sectional study involving the analysis of placentae and umbilical cords of three hundred and five neonates delivered in the Federal Medical Centre, Owo who met the inclusion criteria. Immediately after each delivery, the umbilical cord was clamped and severed five centimetres from its attachment to the neonate. The rest of the umbilical cord from the cut end to its insertion on the placenta was measured in centimetres and five centimetres of the umbilical cord attached to the neonate was added to get the entire length of the umbilical cord. Other parameters involving the morphology of the umbilical cord and placentae were also noted.

Outcome measures: Correlation between the morphological parameters of the umbilical cord, placenta and the neonatal factors such as Apgar scores, birth weight, length of the baby, admission into Neonatal Intensive Care Unit and its indication were determined.

Results: Three hundred and five women had their babies' placentae and umbilical cords examined and also had other records complete. There were 270 umbilical cords out of the 305 recruited with normal coiling index range of 0.17-0.20 coils per centimetres giving an incidence of 88.5%. There was a positive correlation between birth weight and placenta weight (r = 0.466; p value <**0.001**); there was also a positive correlation between birth length and umbilical cord length (r = 0.130; p value <**0.024**); likewise there was a positive correlation between umbilical cord coiling index and some parameters of assessing perinatal outcome like the Apgar scores at first and fifth minute (r = 0.137; p value **0.024** and r = 0.84; p value 0.167 respectively) while it had a negative correlation with birth weight (r = -0.130;p = **0.024**) .

Conclusion: The findings from this study contribute significantly to knowledge and have also helped to establish the correlation between the intrauterine and extrauterine wellbeing.

INTRODUCTION

The well being of the fetus is affected by many factors and a healthy placenta is an important factor in producing a healthy baby[1,2]. The placenta is an

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organ that connects the developing fetus to the uterine wall to allow nutrient uptake, waste elimination and gas exchange via the mother's blood supply. The placenta is a complex multifunctional organ of mainly fetal origin with varying roles during fetal growth[3].

The placenta also provides endocrine functions, immune support and a special circulatory system to the developing fetus[4]. It separates the maternal and fetal circulation i.e the syncytiotrophoblast exposes the placenta to the maternal circulation and the fetal vascular endothelium is in contact with fetal blood[5].

The placenta comprises a large number of functional units called villi which contain branched terminals of the fetal circulation allowing transfer of metabolic products.

The placenta averages 22cm (9 inches) in diameter and 2-2.5cm (0.8-1inch) in thickness, with the centre being the thickest and the edges being the thinnest. It weighs 400-600g[3]. It has a dark reddish blue or crimson colour and is discoid in shape. Vessels branch out over the surface of the placenta and further divide to form a network covered by a thin layer of cells. This results in the formation of villous tree structures. On the maternal side, these villous tree structures are grouped into lobules[6].

The fetal surface of a full term placenta is shiny, grey and consists of large opaque blood vessels distributed on the dense opalescent surface of the thickened chorion. The maternal surface has the dark red colour of venous blood.

The placenta is classified as chorioallantoic since it is vascularized by vessels homologous with allantoic vessels of lower mammals and haemo-chorial because of the nature of placenta membranes. It uses about a third of all the oxygen and glucose supplied to the maternal blood and the rate of protein synthesis is higher in the placenta than the liver[7].

During pregnancy, a range of problems may occur that could lead to fetal abnormalities and death. Although these problems could arise from a variety of sources including chromosome and genetic disorders of the fetus (e.g. Down's syndrome), maternal illnesses (e.g. pre-eclampsia), maternal behavior (e.g smoking habit) and environmental factors (e.g. exposure to radiation); the most important of these is placental abnormalities[3]. Information on placental size, shape, consistency, completeness of the placenta, presence of accessory lobes, placental infarcts, haemorrhage or tumors may be important in the care of both the mother and infant[3].

The umbilical cord develops from the extra embryonic mesoderm and becomes the channel for blood vessels, through which all exchanges and other activities of the mother and the fetus via the placenta are carried out. It is a cylindrical structure made up of a single layer of amniotic epithelium within which are two arteries and one vein embedded in a gelatinous Wharton's jelly which consists mainly of mucopolysaccharides[8].

At term the normal umbilical cord is about 55-65 cm in length[9] with a diameter of 2.0-2.5cm which normally inserts centrally or eccentrically on the fetal side of the placenta. It provides the means by which oxygen, carbon dioxide, steroids and other products are carried to and from the fetus. It also allows free movement of the fetus within the uterus and protects the umbilical blood vessels from mechanical injury[10,11]. Due to its peculiar role of being the link between the placenta and the fetus, any abnormality of this cord be it in length, the amount of Wharton's jelly, the number of vessels or its amniotic epithelium may lead to abnormal fetal outcome[12]. Short umbilical cords (i.e<40cm) are associated with neuropathic diseases, prolonged second stage of labour, cord rupture and placenta abruption[3]. In contrast, long cords (i.e>70cm) which are usually due to hyper-kinesis are associated with cord thromboses, entanglement and

torsion[3]. Thus abnormalities in cord length associated with intrauterine factors could lead to abnormalities that are only detected later in life[12]. This study aimed to relate the gross morphologies of the placenta and the umbilical cord with neonatal outcomes.

MATERIALS & METHODS

The study population consisted of three hundred and five pregnant women who consented to participate in the study and had live singleton fetuses at term during the period of study.

Inclusion criteria:

1. Singleton deliveries at term irrespective of mode of delivery

Exclusion criteria:

1. Multiple pregnancies
2. Previously diagnosed intrauterine fetal deaths
3. Preterm deliveries (i.e< 37weeks) or prolonged pregnancies (> 42weeks) gestations.
4. Patients who had their placentae manually removed.

All eligible women were informed about the study using the patient information sheet and were appropriately counseled.Patients who cannot read or write English had their questionnaires interpreted to them via trained interpreters.

All eligible women who gave informed written consent were recruited for this study which was carried out by the researcher and two other registrars, one from each firm. This was to reduce inter observer error as much as possible. Measuring tapes, a weighing scale and other materials like latex gloves were provided for the study.

STANDARD OPERATING PROCEDURES

First stage of labour was monitored with the use of partograph, fetal stethoscope, sonicaid and cardiotocogramwhen indicated. When in second stage of labour, the patients were encouraged to bear down with each uterine contraction to effect delivery of the neonate. Immediately after delivery, the umbilical cord will be clamped about 5cm from its attachment to the abdomen of the neonate and the neonate was handed over to the paediatrician for apgar scoring. Paediatricians were present at all deliveries of the study subjects. The third stage of labour was actively managed.

Immediately after removal of the placenta, the number of umbilical cord coils, length, width, knot(s) and blood vessels were noted promptly before the cord starts to untwist. The five centimeters of the umbilical cord attached to the neonate was added to obtain the entire length of the umbilical cord. The placenta was weighed using a weighing scale and subsequent examination of the placenta was done under running water,universal safety precautions were observed in all these steps. Patients who had their placentae manually removed were excluded because the gross architecture of the placenta may have been distorted.

For patients who had to undergo abdominal delivery, the examination of the placentae and the umbilical cords will follow the same manner. The generally accepted method of assessing the degree of the umbilical cord coiling was by calculation of the umbilical coiling index (UCI) defined as the number of complete (360-degree) coils per centimeter length of cord. Using this criterion, normal UCI was 0.2 in the postpartum setting following examination of the delivered placenta and umbilical cord (pUCI). Undercoiled or hypocoiled cords were defined as those with UCI $<10^{th}$ percentile of the normal and overcoiled or hypercoiled cords as those with UCI > 90^{th} percentile.

RESULTS

The findings from this study revealed that 270 (88.5%) umbilical cord had normal umbilical cord coiling index during the period when this study was conducted. Majority of this umbilical cords had between 10 to 12 helices, two hundred and seventy one of these umbilical cord inserted centrally on the placenta. The average umbilical cord length was 51.50 ± SD 6.67 centimetres. There were 2 arteries and 1vein in each of 304 umbilical cord examined, only one had a single umbilical artery and the birth weight of the baby with a single umbilical artery in it cord was 2.05kilograms.The average placenta weight was 0.61 ± SD 0.10 kilograms, there were 15 placenta abnormalities noted with hyperplacentation accounting for eleven of them.

Two hundred and forty one (79%) had spontaneous vaginal delivery, while the rest had caesarean section. Out of the 305 babies one had congenital anomaly in the form of hypospadia. There were also eleven neonates admitted into the neonatal intensive care unit and the indications were birth asphyxia 7(63.6%), neonatal jaundice 3(27.2%) and one case of fetal macrosomia admitted for observation for metabolic disorders like hypoglycaemia and hypocalcaemia. Two hundred and eighty three babies had their birth weight in the range of 2.5kg and 4.0kg, the average birth weight was 3.23 ± 0.50 kilograms and the average baby's length was 49.75 ± 2.40 centimeters.

There was a positive correlation coefficient between birth weight and placenta weight ($r = 0.466$, $p < 0.001$); the baby's length and umbilical cord length ($r = 0.130$, $p < 0.024$) Likewise there was also a positive correlation coefficient between the normal umbilical cord coiling index and the Apgar Scores at the first and fifth minute respectively.($r = 0.137$, $p = 0.024$; $r = 0.084$, $p = 0.167$). There was however a negative correlation between the umbilical coiling index and birth weight ($r= -130$, $p= 0.024$)

DISCUSSION

There have been previous studies aimed at establishing the link between the intrauterine and extrauterine life; hence, it is believed that a healthy intrauterine state should culminate in a healthy extrauterine state provided other confounding variables that may alter these factors are limited to the barest minimum. As a need of filling this potential gap in knowledge, this study was conceived to re-establish that important link by exploring the gross morphology of the placenta and umbilical cord and correlating it to the perinatal outcome of newborns at term in the Federal Medical Centre, Owo, Ondo State. This is with the aim of contributing to the attainment of the Millenium Development Goals 4 and 5 using this readily accessible link.This study only involved gross examination of the placenta and umbilical cord as it relates to perinatal outcome in Federal Medical Centre, Owo. This limitation was expected because of the sociocultural beliefs of individuals in this locality, as the placenta is regarded as being linked to the destiny of the newborn, hence, efforts were made to ensure that it was collected and disposed by parents or relatives of the newborn and not the labour ward staff.

The mean birth weight obtained in this study was 3.20±0.50kg and this was found to be similar to the birth weights obtained from previous Nigerian studies despite the variance in region of the various study site [13,14]. The average birth weight for the male newborns in this study was also higher than the female newborns and this was in keeping with the existing knowledge. The weight of the placenta is used in the determination of the fetoplacental ratio because there is a relationship between the placenta weight and the weight of the baby[15,16]. This correlation was also verified in a Nigerian study by Mutihir et al in 2006 [16]. The weight of the placenta is said to give an idea of the amount of substance that

is exchanged between the mother and the fetus. The mean placenta weight obtained from this study was 611±104grams with a range of 350 to 1000 gram. Another Nigerian study obtained a range of 300 to 890 gram, with a mean of 590±82grams, this finding is similar to the finding of this study [15]. The weight of the placenta was found to have significant positive correlation with the birth weight of the baby ($r=0.466$, $p<0.001$). Lurie et al in 1999 found the mean placenta weight to be 613±123grams with a range of 319 to 1266 grams [17].

Comparing the various averages obtained above with that obtained from this present study it is observed that the average placenta weight appears to be similar to that obtained by Lurie et al though there are variations which could be attributed to some factors such as nutrition, genetics, sociodemographic and sociocultural factors[18,19]. Since the weight of the placenta correlated positively with the weight of the baby, it then implies that factors which directly affect the weight of the baby at birth will indirectly affect the weight of the placenta. According to Van den Broek et al in 2005 unfixed placentae that weigh more than 600 grams are pathologic, but more important may be the placenta fetal ratio. Chronic low uteroplacental blood flow is the most frequent cause of small placenta but often the fetal weight is affected so the ratio is normal[1]. The cause of placenta enlargement may be unknown but it is often revealed if the following are considered i.e. maternal diabetes, maternal anaemia, fetomaternal blood group incompatibility; fetal malformation especially of the lungs and alpha thalassemias. Some of these factors may be responsible for the placenta weight obtained in the present study and those obtained by Salafia and Vintziloes in 1999[9].

In the present study the minimum umbilical cord length was 29.5 cm and maximum 100cm with a mean of 51.5±6.67cm, this is similar to the 55 to 60 cm reported previously, [3] and to the 52.9±7.3cm reported in a previous Nigerian study by Mutihir et al in 2006 [16]. Cords less than 40cm were classified as short while those greater than 70cm were categorized as long. Umbilical cords of length up to 300cm have also been reported [18]. The prevalence of short cords in this present study was 4.9%, while that of long cord was 3.8%. This study also found that 91.3% of the umbilical cords examined fell within the range 40 to 70cm. This support the assertion that normal cord length should be in the range 40 to 70 cm . Although it is not fully understood what controls the cord length, various authors correlate cord length with fetal activity and movement. It is suggested that sufficient space in the amniotic cavity for movement and the tensile force applied to the umbilical cord during movements are two main factors that determine the cord length [3,20].

In studying umbilical cord length as a correlate of perinatal outcome; this study shows that cord length correlate significantly with babies length at birth($r=0.130$,$p<0.024$). It is important to note that this positive correlation even though it is statistically significant, it does not have a very strong statistical relationship like that which occurs between the placenta weight and the birth weight of the baby as noted above. There was also a positive correlation between the umbilical cord length and the weight of the baby at birth($r=0.145$,$p=0.011$), this finding was also observed in a previous study by Wu et al and a Nigerian study by Adinma et al [21,22].

Another important finding obtained from this study was the positive statistical relationship between the birth weight and the birth length of the babies. ($r=0.498$, $p<0.001$)

The mean umbilical cord coiling index observed in this study was 0.19 ± 0.01 coils per cm, this means that on the average every one centimetre of a cord studied had 0.26 complete vascular coil around the Wharton's jelly; compared to 0.2 ± 0.01 coils per cm

reported by Ercal et al in 1996 [23], 0.21 ± 0.07 coils per cm by Strong et al in 1993 and 0.13 ± 0.08 coils per cm by Gupta et al in 2006[24,25]. A recent meta-analysis showed the normal coiling index to be 0.17 ± 0.009 coils per cm [26]; Rana et al in 1995 also showed it to be 0.19 ± 0.01 coils per cm [27]which is similar to what was observed in the present study.

In the present study 88.5% of the cords had UCI in the range of 0.17 -0.20 coils per cm, 3.6% had coiling index of < 0.17 and 7.8% had coiling index > 0.20 coils per cm this shows that a large majority of these cords were of normal coiling index. In two previous studies, it was observed that some of the umbilical cords were without coils, however, in this study none of the umbilical cord was without a coil; also this study shows that the was a positive correlation between umbilical cord coiling index and Apgar scores at the first and fifth minute (r=0.13,p=0.024; r=0.084, p=0.167) respectively. This is a pointer that the positive correlation at the first minute is statistically significant whereas the positive correlation at the fifth minute Apgar scoring is not statistically significant. This may be due to the fact that there are other confounding variables which may modify the scores obtained at the fifth minute. Some of these confounding variables could be other intrinsic factors like the state of maternal health, while the extrinsic factors could be due to the extent of resuscitation and other environmental factors.

The study showed a negative correlation between umbilical cord coiling index and birth weight (r = -0.13, p = 0.024) Table 8. This is in keeping with the findings from the study carried out by `Rana et al [27] which showed that hypercoiled umbilical cords were associated with low birth weights. Also Kashanian et al, [28] in his study showed that neonatal weight in normocoiled and hypocoiled cords were higher than that of hypercoiled cords.

Of the three hundred and five umbilical cord studied, one (0.33%) had a single umbilical artery and the baby weighed 2.05kg at term and this finding is in agreement with the study done by Hua et al who reported association of IUGR with single umbilical artery [29]. Cases of four and five vessel cord have also been reported in previous studies but this was not found in this study [30,31].

In Conclusion, this study shows the strong relationship between the placenta and the fetus suggesting that the wellbeing of the fetus is highly dependent on the placenta since it serves as a link between the mother and the developing fetus for nutritional support, excretory functions as well as immunological and hormonal support.

The study also showed a strong relationship between the umbilical cord parameters, the placenta and perinatal outcome at term amongst singletons in the Federal Medical Centre, Owo. The various observation made in this study were similar to those obtain in previous studies as highlighted previously. This shows that the placenta and the umbilical cord can be assessed even in the antenatal period to provide a hint about the state of the fetus. Taking an advantage of this link between the umbilical cord, placenta parameters and perinatal outcome; several investigation can be carried out during the antenatal period, this include the use of Doppler ultrasound to access the umbilical cord and placenta and using it as a measure of fetal health inutero. The gross and even histologic assessment of the placenta and umbilical cord can also help in accessing the health of the newborn with the aim of attaining the Millennium Development Goal 4 and also enhancing a general improvement in infant health.

The Recommendations include:

~ The immediate need to educate pregnant women and their relatives about the importance of placenta and umbilical cord examination by health care givers right from the antenatal period.

~Health education and awareness campaign should be done with the aim of changing the existing

cultural taboo. If this goal is achieved it could be an opportunity for a future study on the correlation of perinatal outcome with the histologic findings in the placenta and umbilical cord.

~ To train and retrain health care givers in public and private hospitals about the significance of the placenta, umbilical cord and perinatal outcome.

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