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Research Article

Revisiting the placental bed: a syndrome approach

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ABSTRACT

Background: The apt way to reduce Neonatal mortality is to identify the antenatal factors, which ascertain the uterine milieu and nutrient bioavailability. Hence this study was conducted to outline the relation between preeclampsia, Abruption, prematurity and resultant perinatal mortality and morbidity in a tertiary feto maternal care centre.
Methods: This prospective study was carried out on 1800 deliveries in the Department of Obstetrics and Gynecology at Saveetha Medical College and hospital, Chennai, India between 1 October 2012 and 30 September 2013.
Results: During the study period, 100 (5.55%) pregnancies resulted in Low birth weight neonates out of total 1800 pregnancies. There were 70 diagnosed patients of Pregnancy induced Hypertension by International Society for the Study of Hypertension in Pregnancy criteria. There were no intrauterine deaths. There were 6 cases of grade 1 abruption. Out of 100 low birth weight infants, 46 were preterm births. There were 54 cases of Intrauterine Growth retardation. Out of 100 low birth babies (<2000 gms) 93 survived beyond four weeks of life.
Conclusions: The concept of junctional zone myometrium is not new. The term "Placental bed" was coined in 1958 for the modified endometrium and junctional zone myometrium of pregnancy. The lack of physiological transformation of spiral arteries at this feto maternal interphase has been postulated in the pathogenesis of preeclampsia, intrauterine growth retardation, spontaneous abortion, placental abruption and preterm labour. The damage of fetal tertiary stem villus from the jetting blood in the intervillous space could have led to preterm births, intrauterine growth retardation and neonatal mortality in our patients.

Keywords: Placental bed, Maternal factors, Low birth weight, Neonatal mortality

INTRODUCTION

Uterine Blood Flow and placental oxygen and nutrient transfer to the fetus may be compromised in a variety of maternal vascular diseases like pregnancy induced hypertension, Intra uterine infection, renal disease, chronic hypertension, multiple pregnancy and abnormal umbilical cord placental insertion.[1] The transfer of Oxygen across the maternal fetal interface is dictated by the Fick's Equation.

The volume of oxygen transfer is calculated as cm^3/min/Hg = (Villous surface area + capillary surface area) X K/2 X Mean Mth (the Harmonic mean thickness of the villous membrane which includes the trophoblast, the villous stroma and the endothelium of fetal capillaries) where K is the Krogh's diffusion coefficient.[2] The villous membrane thickness gradually decreases as gestation advances. In addition, the apical and basal membranes of syncytiotrophoblast are richly endowed with amino acid and other ATP dependent transporters involved in active transport and maintenance of ionic hemostasis. The syncytiotrophoblast produces large

quantities of both steroid and peptide hormones. Human placental Lactogen is secreted reaching 1 gm/day near term. Syncytiotrophoblasts contain a large amount of mitochondria, which are the primary source of oxygen free radicals and may be the cause of preeclampsia.[3]

Preeclampsia, Abruption, preterm labour and fetal growth restriction are major causes of perinatal mortality and morbidity. All have been implicated due to impaired spiral artery remodelling and nutrient transfer due to the disorders of placental bed. The apt way to reduce Neonatal mortality is to identify the antenatal factors, which ascertain the uterine milieu and nutrient bioavailability. Hence this study was conducted to outline the relation between preeclampsia, Abruption, prematurity and resultant perinatal mortality and morbidity in a tertiary feto maternal care centre.

METHODS

This prospective study was carried out on 1800 deliveries in the Department of Obstetrics and Gynecology at Saveetha Medical College and hospital, Chennai, India between 1 October 2012 and 30 September 2013. Pregnancies with previous stillbirths, gestational diabetes and chronic pre pregnancy illness like renal, cardiac, hypertension were excluded. Detailed maternal factors like age, gestational age, parity, pre pregnancy body mass index, previous low birth weight, hemoglobin levels, Urinary tract infection and preeclampsia were recorded. Fetal Presentation, intra partum fetal hypoxia, premature rupture of membranes, instrumental delivery and placental problems like infarcts, retro placental calcifications, small placenta, and premature separation were noted. Preeclampsia was defined according to the guidelines of the International Society for the Study of Hypertension in Pregnancy. This requires two recordings of diastolic blood pressure of ≥90 mmHg at least 4 h apart in previously normotensive women, and proteinuria of 300 mg or more in 24 h, or two readings of at least + + on dipstick analysis of midstream or catheter urine specimens if no 24-h collection is available. In newborn, gestational age as calculated by Naegle's formula was confirmed according to the Ballard's modification of Dubowitz et al. The detailed account of postpartum events like Apgar score and resuscitation were recorded. The post natal course in the hospital including the presence of apnea, seizures, patent ductus arteriosus, intra ventricular hemorrhage, hyaline membrane disease, hyper bilirubinemia, necrotizing entro collitis, duration of oxygen therapy and ventilator support were noted. Statistical analysis was done using Fisher exact test.

RESULTS

During the study period, 100 (5.55%) pregnancies resulted in Low birth weight neonates out of total 1800 pregnancies. There were 70 diagnosed patients of pregnancy induced hypertension by international society for the study of hypertension in pregnancy criteria. There were no intrauterine deaths. There were 6 cases of grade 1 abruption. Out of 100 low birth weight infants, 46 were preterm births. There were 54 cases of intrauterine growth retardation. Out of 100 low birth babies (<2000gms) 93 survived beyond four weeks of life. In 2 neonates (28.6%) no maternal cause of mortality could be identified. Gestational age rather than weight is a predictor of neonatal mortality. Table 1 brings up the fact that presence of PIH as compared to absence confers a significant risk (18.18% v/s 3.85%) for low birth weight baby mortality ($p<0.05$). (Table 2) tells us that presence of abruptio placentae is a significant risk factor for Low birth weight mortality (25.00% v/s 4.55%). A preterm delivery was associated with significant risk for low birth weight mortality ($p<0.5$) as shown in (Table 3). While no term baby or a preterm baby above 2000 gms had neonatal death. There were 4 deaths in babies below 28 weeks, 2 deaths in babies 29-32 weeks and 1 death in babies 33-36 weeks. Table 4 tells us that the preterm AGA has a significant incidence of mortality as compared to preterm SGA and IUGR.

Table 1: Pregnancy Induced Hypertension and neonatal death (babies less than 2000gms).

Outcome	Not present (%)	Present (%)	Total
Death	3 (3.85)	4 (18.18)	7
Survival	5 (96.15)	18 (81.82)	93
Total	78 (78.00)	22 (22.00)	100

(P<0.05 significant)

Table 2: Placental Problems and neonatal death (babies less than 2000gms).

Outcome	Not present	Present	Total
Death	4 (4.55)	3(25)	7
Survival	84 (95.45)	9(75)	93
Total	88 (88.00)	12(12)	100

(P<0.05 significant)

Table 3: Low birth weight and neonatal death.

Outcome	<1000 gms	1000-1500 gms	1500-2000 gms	Total
Death	2 (28.57)	4 (14.81)	1 (1.52)	7
Survival	5 (71.43)	23 (85.19)	65 (98.48)	93
Total	7 (7.00)	27 (27.00)	66 (66.00)	100

(P<0.05 significant)

Table 4: Gestational age and neonatal death.

Outcome	<28 weeks	29-32 new weeks	33-36 weeks	Term	Total
Death	4 (50)	2 (7.69)	1 (2.17)	0	7
Survival	4 (50)	24 (92.31)	45 (97.83)	20 (100)	93
Total	8 (8)	26 (26.00)	46 (46.00)	20 (20)	100

DISCUSSION

The closest intimacy between fetus and mother occurs in the hemochorial placenta of primates where the semiallogenic fetal trophoblastic cells bathe in the maternal blood. A unique feature of all hemochorial placentation is decasualisation of uterine mucosa. The process of transformation of uterine endometrium to decidua (Latin decidere, to fall) includes epitheloid transformation of fibroblasts, matrix changes and infiltration with natural killer cells and macrophages.[4] The decidua not only secretes hormones and growth factors for implantation but also protects the uterus against excessive damage.[5] Superficial trophoblastic invasion in 9-12 weeks is confined to the decidua while the second wave of deep trophoblastic invasion at 20-24 weeks conquers the myometrium as well. The spiral arteries tunica media degenerates, they get plugged by intraluminal trophoblasts, the trophoblasts cells get incorporated into the vessel wall and finally a new endothelium is formed and tunica media thickens.[6,7] It is interesting to note that degradation of vascular smooth muscles of maternal spiral artery in decidua basalis (cf spiral arterioles in decidua parietalis) begins before the actual cellular interaction with fetal trophoblast.[8]

In recent literature the retrograde (antidromic=against the blood flow) migration of fetal cytotrophoblast cells towards the spiral artery walls in Junctional Zone (JZ) myometrium has been well established with immune histo chemical staining.[9] An alternative hypothesis is intra vasation of interstitial trophoblast in the vessel wall of spiral arteries.[10]In normal pregnancy this results in a significant increase in vessel diameter and as depicted by the Poiseuille Law (1840, Jean Louis Marie Poiseuille Resistance to blood flow = $8\eta l/\pi r^4$ where r is on an average 250µm. In a preclamptic pregnancy $\acute{R}= 8\eta l/\pi \acute{r}^4$ where $\acute{r}$ = 100µm. So a 60% reduction in vessel radius can result in 40-fold increase in vessel resistance. As resistance increases in preeclampsia pregnancies, the velocity of blood flowing also increases from 10 cm/sec to 1-2 m/s. This result in damage to inter villous space and tertiary stem villi. The blood flow in inter villous space needs to be low for two reasons. First the blood flow around the placental villi needs to be reduced, to facilitate gaseous exchange, especially as the two circulations are not arranged in a formal counter current way.[11] Second the inter villous pressure has to be kept low otherwise the floating tertiary villi will collapse and maternal fetal diffusional exchange will stop.[12] AV enturing effect is created in normal pregnancy and the villi are sprayed gently with maternal blood. It is pertinent to note that most blood entering the radial arteries traverses the uterus via the arterio venous shunts and only a small proportion enters the inter villous space at low pressure and velocity.[13] The high flow velocity in the inter villous space could have lead to the problems of abruption, prematurity, intrauterine growth retardation and neonatal death in our patients.

The concept of junctional zone myometrium is not new. The term “Placental bed” was coined in 1958 for the modified endometrium and junctional zone myometrium of pregnancy.[14] The lack of physiological transformation of spiral arteries at this feto maternal interphase has been postulated in the pathogenesis of preeclampsia, intrauterine growth retardation, spontaneous abortion, placental abruption and preterm labor.[15-25]

CONCLUSION

As gestation advances the amount of blood flowing through the common iliac arteries is pumped into the internal iliac arteries (increasing impedance with increasing gestation) and then into the uterine arteries (decreased impedance with increasing gestation).Only a partial amount of blood flowing through uterine arteries is pumped into the dilated spiral arteries and sprinkled (cf shot) over tertiary fetal stem villi in the inter villious space. Most blood increases uterine arterio venous circulation and helps in the development of uterine musculature and local milieu of gestation. The damage to placental bed may be ischemic or immunological. The extent of damage is decided by time, duration and extent of damage to the fetal stem villi bathing in inter villous space. The coevolution of fetal trophoblastic intravascular invasion and maternal spiral artery smooth muscle disintegration is also under the influence of genetic and nutritional factors. In teleological terms, this explains the varied clinical phenotypes of placental bed damage. A long preclinical course and the various adaptive mechanisms put forth by fetus and mother to circumvent the damage may decide the clinical picture. The damage of fetal tertiary stem villus from the jetting blood in inter villous space could have led to preterm births, intrauterine growth retardation and neonatal mortality in our patients.

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