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Original Research Article

Effect of maternal blood transfusion versus maternal parenteral iron therapy on fetal vascular adaptation: an observational study in a tertiary care hospital in North India

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ABSTRACT

Background: Maternal anemia, particularly with haemoglobin levels below 7g/dl, is associated with significant fetal hemodynamic adaptations that may impact perinatal outcomes. This study aimed to evaluate the effects of maternal anemia on fetal doppler indices and assess changes after treatment with blood transfusion versus parenteral iron therapy.
Methods: A prospective study was conducted over a period of 12 months at GMC Srinagar, including 80 pregnant women (32-36 weeks gestation) with severe anemia (Hb<7g/dl). Participants were divided into two groups: Group 1 (blood transfusion) and Group 2 (parenteral iron therapy). Hematological parameters and fetal doppler indices (umbilical artery resistive index [UA RI] and middle cerebral artery resistive index [MCA RI]) were measured at admission, two weeks, and four weeks post-treatment. Statistical analysis was performed using SPSS Version 20.0.
Results: At baseline, Group 1 had significantly lower hemoglobin (5.69±0.54g/dl) than Group 2 (6.46±0.29g/dl, p<0.001). Post-treatment, Hb levels improved to 8.18±0.33g/dl (Group 1) and 8.05±0.22g/dl (Group 2, p=0.116), with a greater increase in Group 1 (2.48±0.77g/dl vs. 1.59±0.18g/dl, p<0.001). Doppler indices showed a significant reduction in UA RI and an increase in MCA RI in both groups (p<0.001).
Conclusions: Both blood transfusion and parenteral iron therapy effectively improved maternal hematological status and fetal doppler parameters. However, blood transfusion led to a faster correction of anemia. Regular doppler monitoring allows for timely assessment of fetal adaptation and intervention, improving perinatal outcomes.

Keywords: Maternal anemia, Doppler ultrasound, Blood transfusion, Parenteral iron therapy, Fetal hemodynamics

INTRODUCTION

Throughout pregnancy, anaemia is one of the most prevalent medical conditions. It is a major problem in low socio econimic, in addition to numerous other negative consequences on the mother and the foetus, it plays a major role in the high rate of maternal mortality. A reduction in red cell haemoglobin concentration with respect to age, sex, and geographic characteristics is known as anaemia. Approximately 50% of pregnant women worldwide suffer from anaemia, which is a significant global and reproductive health concern.[1] According to WHO estimations, the prevalence of anaemia during pregnancy ranges from 8.3% to 23% in industrialised nations and from 53.8% to 90.2% in underdeveloped nations.[2] Foetal blood flow is redistributed as a result of severe maternal anaemia, which lowers the oxygen supply to the developing foetus. Foetal adaptations to oxygen deprivation are largely influenced by the brain-sparing reflex, which occurs when foetal hypoxaemia causes foetal blood flow to become centrally distributed in order to maintain cerebral oxygenation. The ratio of the cerebral resistance index (CRI) to the umbilical resistance index (URI) determines the distribution of foetal blood flow (between the placenta and cerebral area).[3] UA doppler is most frequently employed to track and time the delivery of the foetus that has been impaired by FGR.[4] Other consequences on the foetus include prematurity, increased new born death/perinatal mortality, congenital deformity, stillbirth, IUGR, preterm and intra uterine fatalities.

Colour doppler ultrasound provides a convenient and effective method to assess the hemodynamic status of fetal circulation in relation to fetal hypoxia and thereby facilitates the monitoring of the fetus, prediction of adverse outcome and thus a timely intervention to improve the survival prognosis of the fetus5. Fetal and uteroplacental blood flow doppler velocity waveforms are considered as one of the standards non-invasive diagnostic measures to study the physiological and pathological changes in fetomaternal circulation during pregnancy.[6]

Aims and objectives

To study the effect of maternal anaemia on fetal Doppler indices and the changes in the same after correction of anaemia, in patients given blood transfusion versus patients receiving parenteral iron.

To improve the perinatal morbidity and mortality by adequate and timely correction of maternal anaemia.

METHODS

This prospective study was conducted in the Postgraduate Department of Obstetrics and Gynecology, Government Medical College, Srinagar, over a period of 12 months (January 2021 to January 2022).

Inclusion criteria

Pregnant women (32–36 weeks) with Hb <7g/dl, singleton, normal structural ultrasound parameters.

Exclusion criteria

Recent blood transfusion, antepartum hemorrhage, multiple gestation, GDM, PIH, heart disease, congenital anomalies, chronic medical disorders, IUD, Rh incompatibility, hemoglobinopathies, and anemia of chronic disease.

The study included 80 pregnant women between 32–36 weeks of gestation with hemoglobin levels below 7 g/dl. Based on the treatment received, participants were categorized into two groups: Group 1 (Those who were severely anemic and near to term were given blood transfusion) and Group 2 (Those who were far from term and moderately anemic were given parenteral iron therapy). Also, the patients who did not agree to undergo a blood transfusion or refused to arrange the same were given iron therapy as ours is a low resource hospital and due to supply constraints it relies mostly on blood donations from the attending family and friends of the patient. A comprehensive clinical assessment was conducted including history-taking, physical examination and laboratory investigations. Maternal venous blood samples were analysed for haemoglobin, LFT, KFT, RBS, MCV, MCH, MCHC, serum iron levels and peripheral blood film. Obstetric ultrasonography and Doppler studies of the umbilical and fetal middle cerebral arteries were performed at admission and repeated at two- and four-weeks post-treatment. Iron therapy was administered using iron sucrose or ferric carboxymaltose, with dosage calculated based on the formula:

Total iron dosage = Body weight × (Target Hb – present Hb in g/dl) × 2.4 + (500–1000 mg).

Blood transfusions were sourced from a model blood bank adhering to stringent screening and storage protocols. Doppler studies were conducted using the Mindray DC-70 color doppler system with a 3–5 Hz curvilinear probe. Monitoring was carried out per standardized hospital protocols.

Statistical analysis

Data were recorded in SPSS Version 20.0 (SPSS Inc., Chicago, USA). Continuous variables were expressed as Mean±SD and categorical variables as percentages. The independent t-test or Mann-Whitney U-test was used for continuous variables, while Chi-square or Fisher's exact test was applied for categorical data. A p-value <0.05 was considered statistically significant.

RESULTS

This study analyzed 80 pregnant women between 32–36 weeks of gestation with severe anemia (Hb <7g/dl), categorized into two groups: Group 1 (blood transfusion) and Group 2 (parenteral iron therapy). The mean age of participants in Group 1 was 30.3±5.73 years, and in Group 2, it was 30.3±5.73 years, with no statistically significant difference (p=0.913). Similarly, mean parity was 1.9 in Group 1 and 1.5 in Group 2 (P=0.246). The gestational age at admission was 33.6±1.76 weeks in Group 1 and 32.9±1.87 weeks in Group 2, which was not statistically significant. Socioeconomic status varied between groups: Group 1: 40% lower class, 27.5% upper-lower class, 17.5% lower-middle class, 15% upper-middle class, 2.5% upper class. Group 2: 37.5% lower class, 22.5% upper-lower class, 17.5% lower-middle class, 22.5% upper-middle class, 5% upper class. At admission, mean hemoglobin (Hb) levels were significantly lower in Group 1 (5.69±0.54g/dl) than in Group 2 (6.46±0.29g/dl) (p<0.001). Post-treatment, the mean Hb levels increased to 8.18±0.33g/dl in Group 1 and 8.05±0.22g/dl in Group 2, with no significant difference (p=0.116). However, the change in Hb levels was significantly greater in Group 1 (2.48±0.77g/dl) compared to Group 2 (1.59±0.18g/dl, p<0.001).

Table 1: Demographic parameters in two study groups.

Parameter		Group 1 (blood transfusion)	Group 2 (iron therapy)	P value
Mean age (years)		30.3±5.73	30.3±5.73	0.913
Mean gestational age (weeks)		33.60±1.76	32.90±1.87	0.883
Socioeconomic class	Upper	2.5%	5.0%	<0.001
	Upper middle	15.0%	22.5%	0.886
	Lower middle	17.5%	17.5%	
	Upper lower	27.5%	22.5%	
	Lower	40.0	37.5%	

Table 2: Haematology parameters in two study groups.

Parameter	Group 1 (blood transfusion)	Group 2 (iron therapy)	P value
Hb at admission (g/dl)	5.69±0.54	6.46±0.29	<0.001
Hb post-treatment (g/dl) (2 weeks)	8.18±0.33	8.05±0.22	0.116
Change in Hb (g/dl)	2.48±0.77	1.59±0.18	<0.001

Table 3: Mean corpuscular volume (MCV) in two study groups.

Parameter	Group 1 (blood transfusion)	Group 2 (iron therapy)	P value
MCV at admission (fL)	71.90±3.95	78.98±1.24	<0.001
MCV post-treatment (fL) (2 weeks)	78.19±2.44	83.35±1.85	<0.001
Change in MCV (fL)	6.28±2.49	4.37±1.85	<0.001

Table 4: Doppler findings.

Doppler parameter	Group 1 (blood transfusion)	Group 2 (iron therapy)	P value
UA RI at admission	0.692±0.060	0.641±0.028	<0.001
UA RI post-treatment (2 weeks)	0.657±0.050	0.631±0.025	<0.001
MCA RI at admission	0.690±0.041	0.733±0.031	<0.001
MCA RI post-treatment (2 weeks)	0.770±0.054	0.742±0.028	<0.001

Mean corpuscular volume (MCV) was significantly lower in Group 1 (71.90±3.95 fL) than in Group 2 (78.98±1.24 fL, p<0.001). After treatment, MCV levels improved significantly in both groups, reaching 78.19±2.44 fL (Group 1) and 83.35±1.85 fL (Group 2). The change in MCV was greater in Group 1 (6.28±2.49 fL) than in Group 2 (4.37±1.85 fL, p<0.001).

Similar trends were observed for MCH and MCHC, with significant improvement post-treatment. Umbilical Artery Resistive Index (UA RI) was significantly higher in Group 1 (0.692±0.060) than Group 2 (0.641±0.028, p<0.001) at admission. Post-treatment, UA RI decreased significantly in both groups (Group 1: 0.657±0.050, Group 2: 0.631±0.025, p<0.001). Middle Cerebral Artery Resistive Index (MCA RI) was lower in Group 1 (0.690±0.041) than in Group 2 (0.733±0.031, p<0.001) at admission. After treatment, MCA RI increased significantly in Group 1 (0.770±0.054) compared to Group 2 (0.742±0.028, p<0.001).

The cerebroplacental ratio (C/U Ratio) remained above 1.1 throughout pregnancy in both groups. At admission, the mean C/U ratio was 1.140±0.045 (Group 1) and 1.141±0.028 (Group 2). After treatment, the ratio increased slightly (Group 1: 1.170, Group 2: 1.153), with a statistically significant difference (P=0.016). In summary, blood transfusion resulted in a significantly higher increase in hemoglobin levels than iron therapy (p<0.001). Doppler parameters showed improved placental circulation in both groups, with more pronounced improvement in Group 1 and both treatment modalities were effective, but blood transfusion led to faster hematological correction.

DISCUSSION

Maternal iron deficiency anemia is a significant global health concern, leading to adverse maternal and fetal outcomes. Our study evaluated the impact of blood transfusion versus parenteral iron therapy in anemic pregnant women, assessing various hematological and fetal doppler parameters. The demographic characteristics in our study showed no significant difference in age and gestational age between the two groups, aligning with the findings of Stefanovic et al, who reported similar maternal and gestational ages in moderately and severely anemic pregnant women.[7] Our study also found that severe anemia affected multiparous women more than primiparous women, possibly due to short interpregnancy intervals. These findings are consistent with Uche-Nwachi et al who reported a direct correlation between gravidity and anemia severity.[8] However, Stefanovic et al observed no significant difference between primiparous and multiparous women regarding anemia prevalence.[7] The hemoglobin (Hb) levels on admission were significantly lower in the blood transfusion group (5.69g/dl) than in the iron therapy group (6.46g/dl). Post-treatment, both groups showed improvement, but the increase was more significant in the transfusion group (2.48g/dl vs. 1.59g/dl; $p<0.001$). These findings align with Stefanovic et al, who reported a greater rise in Hb in severely anemic patients after treatment with blood transfusion. Red cell indices, including MCV, MCH, and MCHC, improved post-treatment.[7] On admission, MCV was significantly lower in group 1 (71.9 fL) compared to group 2 (78.98 fL), and post-treatment, the increase was more pronounced in the transfusion group (6.28 fL vs. 4.37 f; $p<0.001$). MCH also improved in both groups, but the increase was more in the iron therapy group (4.28 pg/cell vs. 2.52 pg/cell; $p<0.001$). Similarly, MCHC showed a more significant increase in group 2 (4.06 vs. 2.03; $p<0.001$). These results are supported by Tiwari et al who found a significant correlation between anemia severity and red cell indices improvement with iron therapy.[9] However, Hassan et al reported no significant correlation between Hb levels and red cell indices, contradicting our findings.[10]

The fetal doppler study showed that the umbilical artery resistive index (UA RI) significantly decreased in both groups after treatment ($p<0.001$), with a more pronounced decline in the transfusion group. These findings are consistent with Ghada et al who reported a significant decline in UA RI after anemia treatment, with the most considerable decline observed in the severe anemia group.[11] The middle cerebral artery resistive index (MCA RI) also increased significantly post-treatment in both groups ($p<0.001$), corroborating the findings of Stefanovic et al and Ancuta et al.[7,12] They concluded that cerebral vasodilation due to maternal anemia increased fetal cerebral blood flow, which normalized post-treatment. The cerebroplacental ratio (C/U ratio) was within normal limits on admission but increased significantly in both groups after treatment, with a greater increase in the transfusion group (0.030 vs. 0.012; $p=0.016$). These findings align with Stefanovic et al and Ancuta et al who reported an increased C/U ratio in anemic women post-treatment.[7,12] Ghada et al also found that the C/U ratio improved significantly after 10 days of treatment in all anemia severity groups.[11]

Our doppler study findings indicate that severe maternal anemia induces significant hemodynamic changes in fetal cerebral circulation. The post-treatment increases in cerebral resistance and decreases in umbilical artery resistance suggest that maternal anemia's pathological effects can be rapidly reversed, with blood transfusion demonstrating a quicker response than intravenous iron therapy. These findings are supported by Vyas et al.[13] Socioeconomic status analysis revealed that most patients in both groups belonged to the lower socioeconomic class, consistent with Singh et al who found that anemia was more prevalent among women from lower socioeconomic backgrounds.[14] However, our results contrast with Kaur et al who reported no significant difference in anemia prevalence based on socioeconomic status.[15] Despite maternal iron deficiency anemia being a widespread medical concern, studies evaluating iron supplementation's efficacy in preventing adverse pregnancy outcomes remain limited. Allen et al hypothesized that maternal anemia significantly reduces fetal oxygen supply, triggering fetal blood flow redistribution despite no evidence of placental insufficiency.[16] Our study highlights the impact of maternal anemia on both mother and fetus and demonstrates that treatment can reverse these physiological and pathological effects.

This single-center, nonrandomized study (allocation influenced by gestational age, anemia severity, and resource constraints) with a modest sample size (n=80) and short follow-up may introduce selection bias and limit the generalizability and causal inference of the findings.

CONCLUSION

Our findings reinforce that maternal hemoglobin levels below 7 g/dl are significantly linked to notable fetal hemodynamic adaptations, necessitating treatment with either red blood cell transfusion or parenteral iron therapy. Regular monitoring of fetal umbilical and cerebral circulation using doppler ultrasound in anemic pregnancies enables the evaluation of fetal vascular responses, facilitates early detection of fetal complications, and contributes to better fetal outcomes.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Onoh R, Lawani O, Ezeonu P, Nkwo P, Onoh TJP, Ajah L. Predictors of anaemia in pregnancy among pregnant women accessing antenatal care in a poor resource setting in South Eastern Nigeria. Sahel Medical Journal. 2015;18(4):182-87.
2. Bruno B, Mclean E, Egli I, Cogswell M. World Prevalence of Anaemia 1993–2005. WHO Global Database on Anaemia, World Health Organisation, Geneva, Switzerland, 2008.
3. Gramellina D, Folli MC, Raboni S. Cerebral-umbilical Doppler ratio as predictor of adverseoutcome. Obstet Gynecol. 1992;79:416-20.

4. Royal College of Obstetricians and Gynaecologiets. Green-Top Guideline 31. The Investigation and Management of the Small-for-Gestational-Age Fetus. 2nd ed. London: RCOG, 2013.
5. Sumpaico WW, Leung KY, Malhotra N et al. Doppler evaluation in fetal hypoxia. Ultrasound in Obstetrics and Gynecology. 1991;252:500.
6. Kurmanavicius J, Florio I and Wisser J. Reference resistance indices of the umbilical, fetal middle cerebral and fetal uterine arteries at 24-42 weeks of gestation. Ultrasound Obstetrics and Gynecology. 1997;10:112-20.
7. Stefanovic M, Milosavljevic M, Radovic-Janosević D, Kutlesic R, Vukomanovic P. Maternal anemia and fetal cerebral hemodynamic response-doppler assessment. Medicine and Biology. 2005;12(2):93-6.
8. Uche-Nwachi EO, Odekunle A, Jacinto S, Burnett M, Clapperton M, David Y, et al. Anaemia in pregnancy: associations with parity, abortions and child spacing in primary healthcare clinic attendees in Trinidad and Tobago. Afr Health Sci. 2010;10(1): 66-70.
9. Tiwari M, Kotwal J, Kotwal A, Mishra P, Dutta V, Chopra S. Correlation of haemoglobin and red cell indices with serum ferritin in Indian women in second and third trimester of pregnancy. Med J Armed Forces India. 2013;69(1):31-6.
10. Hassan R, Abdullah W, Nik Hussain. Anaemia and iron status of Malay women attending an antenatal clinic in Kubang, Kerian, Kelantan, Malaysia. Southeast Asian J Trop Med Public Health. 2005;36(5):1304-7.
11. Ghada A, Abdel Moety MD, Yossra SA. Effect of maternal iron deficiency anemia on fetal cerebral hemodynamic response by doppler and APGAR score. Med J Cairo Univ. 2012;80(1):235-40.
12. Ancuta E, Ancuta C, Iordache C, Chirieac R. P07. 14: Predictive value of Doppler assessment for the fetal umbilical and cerebral hemodynamic response in anemic pregnancies. Ultrasound in Obstetrics & Gynecology. 2009;34.
13. Vyas S, Nicolaides K, Campbell S. Doppler examination of the middle cerebral artery in anemic foetuses. Am J Obstet Gynecol. 1990;162:10604.
14. Singh K, Fong YF and Arulkumaran S. Anaemia in pregnancy - a cross-sectional study in Singapore. European Journal of Clinical Nutrition. 1998;52:65-70.
15. Kaur M, Chauhan A, Mohammad Muntafa Rajput. Maternal Anaemia and Neonatal Outcome: A Prospective Study on Urban Pregnant Women. Journal of Clinical and Diagnostic Research 2015;9(12):QC04-QC08.
16. Allen LH. Anemia and iron deficiency: effects on pregnancy outcome. Am J Clin Nutr. 2000;71(5 Suppl):1280S-4S.

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