

Efficacy and Safety of Oral Iron versus Intravenous Ferric Carboxymaltose in the Management of Anaemia During Pregnancy: A Prospective Comparative Study

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Abstract:

Background: Anaemia is one of the most common medical disorders during pregnancy, with iron deficiency being an important underlying cause. Oral iron remains widely used because of its accessibility and low cost; however, gastrointestinal adverse effects, prolonged treatment duration and suboptimal adherence can limit its effectiveness. Intravenous ferric carboxymaltose (FCM) permits rapid administration of a relatively large amount of iron and may be useful when rapid correction of anaemia is required.

Aim: To compare the efficacy and safety of oral iron and intravenous ferric carboxymaltose in pregnant women with iron-deficiency anaemia.

Methods: This prospective comparative randomized study included 200 pregnant women with iron-deficiency anaemia attending the Department of Obstetrics and Gynaecology, Government Satellite Hospital CHB, Jodhpur, over a two-year study period. Participants were allocated equally into two groups of 100 each. Group A received oral ferrous sulphate, whereas Group B received intravenous ferric carboxymaltose. Haemoglobin and iron indices were assessed at baseline and during follow-up. Treatment adherence, adverse events and maternal and neonatal outcomes were also evaluated.

Results: Baseline mean haemoglobin was comparable between the oral iron and FCM groups (8.72 ± 0.71 vs 8.69 ± 0.74 g/dL; $p=0.764$). At 4 weeks, mean haemoglobin increased to 10.02 ± 0.82 g/dL in the oral iron group and 10.71 ± 0.79 g/dL in the FCM group. At 8 weeks, the corresponding values were 10.86 ± 0.76 and 11.47 ± 0.68 g/dL, respectively. The mean increase in haemoglobin at 8 weeks was significantly greater with FCM than with oral iron (2.78 ± 0.91 vs 2.14 ± 0.88 g/dL; $p<0.001$). Serum ferritin also increased significantly more in the FCM group. At 8 weeks, haemoglobin ≥ 11 g/dL was achieved in 82.0% of women receiving FCM compared with 61.0% receiving oral iron ($p=0.001$). Treatment adherence was significantly higher with FCM. Gastrointestinal adverse effects were more frequent with oral iron, whereas only mild transient adverse events were reported following FCM. No severe hypersensitivity reaction was observed. Maternal and neonatal outcomes were comparable between groups.

Conclusion: Intravenous ferric carboxymaltose was associated with a greater and faster improvement in haemoglobin and iron stores than oral iron and was well tolerated. FCM may therefore be considered an effective alternative for selected pregnant women with iron-deficiency anaemia, particularly when rapid correction or improved treatment adherence is clinically desirable.

Keywords: Pregnancy; Anaemia; Iron-Deficiency Anaemia; Ferric Carboxymaltose; Oral Iron; Haemoglobin; Ferritin; Maternal Safety.

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Introduction

Anaemia during pregnancy remains an important maternal health problem. Iron deficiency is a major contributor to anaemia during pregnancy because maternal iron requirements increase substantially to support expansion of maternal red-cell mass,

placental development and fetal growth. The World Health Organization (WHO) published updated haemoglobin thresholds for defining anaemia in 2024, emphasizing the importance of appropriate

haemoglobin measurement and population-specific interpretation. [1]

WHO recommends daily iron and folic acid supplementation during pregnancy as a preventive strategy, with 30–60 mg of elemental iron and 400 µg of folic acid recommended for pregnant women. However, women with established iron-deficiency anaemia require therapeutic iron replacement rather than prophylactic supplementation alone. [2]

Oral iron, particularly ferrous sulphate, remains an established treatment because of its low cost, availability and established efficacy. Nevertheless, gastrointestinal adverse effects including nausea, abdominal discomfort and constipation can reduce treatment adherence. Guidelines also recognize intravenous iron as an important treatment option in selected women, particularly when oral iron is poorly tolerated, ineffective or when rapid correction is required. [3]

Intravenous iron preparations allow iron to bypass gastrointestinal absorption and permit more rapid replenishment of iron stores. Ferric carboxymaltose is particularly useful because relatively large doses can be administered in a single or limited number of infusions. Evidence from systematic reviews has demonstrated higher haemoglobin concentrations following intravenous iron compared with oral iron in several pregnancy populations. [4,5,6]

The FER-ASAP randomized trial directly compared FCM with oral ferrous sulphate in 252 pregnant women with iron-deficiency anaemia. Anaemia correction to haemoglobin ≥ 11.0 g/dL occurred in 84% of women receiving FCM compared with 70% receiving oral ferrous sulphate, and gastrointestinal adverse events were more frequent with oral therapy. [7]

Indian evidence has also supported the efficacy of FCM. Chawla et al. conducted a randomized controlled trial involving 362 pregnant women and reported a greater haemoglobin rise with FCM than with oral ferrous sulphate, without major safety concerns. [8]

More recent randomized evidence has further clarified the role of FCM. The IVON trial in Nigeria found no significant difference in anaemia prevalence at 36 weeks between FCM and oral iron, although FCM substantially reduced iron deficiency and was considered safe. [9] Similarly, the REVAMP trial in Malawi demonstrated important improvements in iron status with FCM, although not every maternal or neonatal endpoint differed significantly. [10]

Conversely, a 2025 randomized trial of FCM in women with anaemia during late pregnancy found a significantly lower prevalence of anaemia before childbirth among women receiving FCM than

among those receiving standard oral iron, without a difference in birth weight or serious infusion-related adverse events. [11] These findings suggest that the benefit of FCM may be particularly relevant when the time available for oral treatment is limited.

Safety remains an important consideration when intravenous iron is administered during pregnancy. Although serious hypersensitivity reactions are uncommon, FCM has been associated with hypophosphataemia. A recent international consensus statement indicates that most post-FCM hypophosphataemia is asymptomatic and transient, while monitoring should be considered in patients at increased risk or those receiving repeated high-dose courses. [12]

Therefore, the present study was undertaken to compare the efficacy and safety of oral iron with intravenous FCM in pregnant women with iron-deficiency anaemia attending a tertiary-care obstetric centre.

Aim and Objectives

Aim: To compare the efficacy and safety of oral iron versus intravenous ferric carboxymaltose in pregnant women with iron-deficiency anaemia.

Objectives

1. To compare the change in haemoglobin concentration between the oral iron and FCM groups.
2. To compare changes in serum ferritin between the two treatment groups.
3. To compare the proportion of women achieving correction of anaemia.
4. To compare treatment adherence between the two groups.
5. To compare the frequency and pattern of treatment-related adverse events.
6. To compare maternal and neonatal outcomes between the treatment groups.

Materials and Methods

Study design: This was a prospective, comparative, randomized controlled study conducted to compare the efficacy and safety of oral ferrous sulphate with intravenous ferric carboxymaltose (FCM) in pregnant women with iron-deficiency anaemia.

Study setting: The study was conducted in the Department of Obstetrics and Gynaecology, Government Satellite Hospital CHB, Jodhpur, Rajasthan, India.

Study duration: The study was conducted over a period of two years, from January 2023 to December 2024.

Study population: Pregnant women attending the antenatal outpatient department or admitted to the obstetric unit during the study period were screened

for eligibility. Women fulfilling the predefined eligibility criteria and diagnosed with iron-deficiency anaemia were recruited after obtaining written informed consent.

Sample size and randomization: A total of 200 eligible pregnant women were enrolled and allocated in a 1:1 ratio into two treatment groups, with 100 participants in each group:

1. **Group A (n=100):** Oral ferrous sulphate
2. **Group B (n=100):** Intravenous ferric carboxymaltose

Randomization was performed using a computer-generated randomization sequence after confirmation of eligibility and completion of baseline assessment. Allocation concealment was maintained until treatment assignment.

Because the routes and modes of administration of the two interventions differed, blinding of participants and treating clinicians was not feasible.

Inclusion Criteria

Pregnant women were eligible if they fulfilled all of the following criteria:

1. Age 18–40 years.
2. Singleton viable pregnancy.
3. Gestational age between 20 and 32 completed weeks at enrolment.
4. Haemoglobin concentration <11.0 g/dL according to the study eligibility protocol.
5. Serum ferritin <30 ng/mL.
6. Transferrin saturation $<20\%$.
7. No evidence of another predominant cause of anaemia.
8. Willingness to participate in the study.
9. Provision of written informed consent.

Exclusion Criteria

Women were excluded if they had any of the following:

1. Severe anaemia requiring immediate blood transfusion or urgent stabilization.
2. Known haemoglobinopathy or inherited red-cell disorder.
3. Vitamin B12 or folate deficiency as the predominant cause of anaemia.
4. Active significant bleeding.
5. Significant renal or hepatic disease likely to affect treatment response or safety.
6. Active infection or inflammatory disease likely to substantially affect interpretation of serum ferritin.
7. Known hypersensitivity to ferric carboxymaltose or other intravenous iron preparations.
8. Previous serious reaction to parenteral iron.
9. Multiple pregnancy.

10. Obstetric or medical conditions requiring immediate delivery.
11. Previous intravenous iron therapy during the current pregnancy.
12. Blood transfusion during the preceding 4 weeks.
13. Inability or unwillingness to comply with scheduled follow-up.

Baseline Assessment: A detailed medical, obstetric and treatment history was obtained at enrolment. Clinical examination was performed for all participants.

The following variables were recorded:

1. Age
2. Gestational age
3. Gravidity and parity
4. Body mass index
5. Previous history of anaemia
6. Previous oral iron therapy
7. Relevant medical history
8. Relevant obstetric history
9. Concomitant medications

Baseline laboratory investigations included:

1. Complete blood count
2. Haemoglobin concentration
3. Mean corpuscular volume
4. Mean corpuscular haemoglobin
5. Mean corpuscular haemoglobin concentration
6. Red-cell distribution width
7. Serum ferritin
8. Serum iron
9. Total iron-binding capacity
10. Transferrin saturation
11. Peripheral blood smear
12. Serum vitamin B12
13. Serum folate

Additional investigations were performed when clinically indicated to exclude other causes of anaemia.

Definition of iron-deficiency anaemia: For the purpose of the present study, iron-deficiency anaemia was defined according to the study protocol as haemoglobin concentration <11.0 g/dL in combination with serum ferritin <30 ng/mL and transferrin saturation $<20\%$, in the absence of another predominant cause of anaemia.

Treatment protocol

Group A: Oral ferrous sulphate

Participants randomized to Group A received oral ferrous sulphate equivalent to 60 mg of elemental iron once daily.

The medication was administered orally and treatment was continued for 8 weeks, unless treatment was discontinued because of intolerance,

delivery, treatment failure or another clinical indication.

Participants were instructed regarding appropriate administration of oral iron and were advised to maintain an appropriate interval between iron and calcium-containing supplements.

Routine antenatal supplementation, including folic acid, was continued according to institutional practice.

Group B: Intravenous ferric carboxymaltose

Participants randomized to Group B received 1000 mg of elemental iron as ferric carboxymaltose by intravenous infusion as a single treatment dose.

The infusion was administered in a monitored clinical setting by trained medical personnel, with appropriate facilities available for recognition and management of acute hypersensitivity reactions.

Participants were monitored during and following administration for infusion-related adverse events, including hypersensitivity reactions, hypotension, dizziness, headache, nausea and local infusion-site reactions.

A 1000-mg single-dose FCM regimen has been used in pregnancy studies, including an Indian randomized trial comparing FCM with oral ferrous sulphate.

Concomitant Treatment: Routine antenatal supplementation, including folic acid, was continued in both treatment groups according to institutional practice.

Additional therapeutic iron preparations were not routinely administered during the study treatment period unless clinically indicated. Any additional iron therapy, blood transfusion or treatment modification was documented.

Follow-up: Participants were assessed at baseline and subsequently at 2, 4 and 8 weeks.

At each follow-up visit, clinical assessment was performed and participants were questioned regarding treatment adherence, adverse events and any intervening medical or obstetric events.

Haemoglobin concentration was assessed at baseline, 2 weeks, 4 weeks and 8 weeks.

Serum ferritin and transferrin saturation were assessed at baseline and at 8 weeks.

Participants were followed until delivery for assessment of maternal and neonatal outcomes.

Assessment of treatment adherence: For participants receiving oral iron, adherence was assessed using tablet counts and participant medication records.

The percentage adherence was calculated as:

Adherence (%) = (number of tablets consumed / number of tablets prescribed) × 100.

Adherence of $\geq 80\%$ was considered good adherence, while adherence of $< 80\%$ was considered poor adherence.

For participants receiving FCM, treatment completion was documented based on administration of the scheduled intravenous dose.

Outcome Measures

Primary Outcome: The primary efficacy outcome was the change in haemoglobin concentration from baseline to 8 weeks.

Secondary Outcomes

Secondary outcomes included:

- Change in haemoglobin concentration at 2, 4 and 8 weeks.
- Change in serum ferritin from baseline to 8 weeks.
- Change in transferrin saturation.
- Proportion of participants achieving haemoglobin ≥ 11 g/dL at 8 weeks.
- Proportion of participants achieving an increase in haemoglobin of ≥ 2 g/dL.
- Treatment adherence.
- Requirement for additional iron therapy.
- Requirement for blood transfusion.
- Frequency and severity of treatment-related adverse events.
- Maternal outcomes.
- Neonatal outcomes.

Safety Assessment: All adverse events occurring during treatment and follow-up were recorded.

For oral iron, particular attention was paid to gastrointestinal adverse effects, including:

1. Nausea
2. Vomiting
3. Constipation
4. Abdominal discomfort
5. Diarrhoea
6. Dyspeptic symptoms

For FCM, the following events were specifically monitored:

- Headache
- Dizziness
- Nausea
- Hypotension
- Infusion-site reactions
- Flushing
- Hypersensitivity reactions
- Other clinically relevant infusion-related events

Adverse events were documented with respect to their severity, duration, management and temporal relationship to treatment.

Any serious adverse event or severe hypersensitivity reaction was managed according to institutional emergency protocols.

Serum phosphate was assessed when clinically indicated, particularly in participants receiving repeated FCM administration or those with clinical features suggestive of hypophosphataemia. Hypophosphataemia is a recognized adverse effect of FCM and should be considered in safety assessment.

Maternal Outcomes: Maternal outcomes assessed at delivery included:

1. Gestational age at delivery
2. Preterm delivery
3. Mode of delivery
4. Requirement for blood transfusion
5. Significant postpartum haemorrhage
6. Maternal complications related to treatment

Preterm delivery was defined as delivery before 37 completed weeks of gestation.

Neonatal Outcomes: Neonatal outcomes included:

1. Birth weight
2. Low birth weight
3. NICU admission
4. Apgar score at 1 and 5 minutes, where available
5. Major neonatal complications

Low birth weight was defined as birth weight <2.5 kg.

Statistical Analysis: Data were entered into a computerized database and analysed using appropriate statistical software.

Continuous variables were expressed as mean $\pm$ standard deviation (SD) for normally distributed data and as median with interquartile range when

appropriate. Categorical variables were expressed as frequencies and percentages.

Normality of continuous variables was assessed before selection of the appropriate statistical test.

Between-group comparisons of continuous variables were performed using the independent-samples t test for normally distributed variables and the Mann–Whitney U test for non-normally distributed variables.

Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate.

Changes in haemoglobin and other laboratory parameters measured repeatedly during follow-up were analysed using an appropriate repeated-measures model, with treatment group, time and group-by-time interaction considered where applicable.

Within-group changes were assessed using paired statistical methods where appropriate.

The proportions of participants achieving predefined treatment-response thresholds were compared between groups using the chi-square test or Fisher's exact test.

All statistical tests were two-sided, and a p value <0.05 was considered statistically significant.

Results

Baseline characteristics: A total of 200 pregnant women were included in the study, with 100 participants allocated to each treatment group.

The mean age was 26.9 ± 4.2 years in the oral iron group and 27.2 ± 4.4 years in the FCM group ($p=0.624$). Mean gestational age at enrolment was 23.8 ± 4.6 weeks and 24.1 ± 4.5 weeks, respectively ($p=0.641$).

The baseline demographic and clinical characteristics were comparable between the two treatment groups, as shown in Table 1.

Table 1: Baseline characteristics of study participants

Variable	Oral iron (n=100)	FCM (n=100)	p value
Age, years	26.9 ± 4.2	27.2 ± 4.4	0.624
Gestational age, weeks	23.8 ± 4.6	24.1 ± 4.5	0.641
BMI, kg/m ²	23.7 ± 3.1	23.9 ± 3.2	0.658
Primigravida	54 (54.0%)	51 (51.0%)	0.671
Multigravida	46 (46.0%)	49 (49.0%)	—
Previous anaemia	37 (37.0%)	40 (40.0%)	0.663
Previous oral iron use	31 (31.0%)	29 (29.0%)	0.751

Baseline Haematological Parameters: Baseline haemoglobin concentration was comparable between the two groups, with mean values of 8.72 ± 0.71 g/dL in the oral iron group and 8.69 ± 0.74 g/dL in the FCM group ($p=0.764$).

Similarly, baseline MCV, MCH, serum ferritin and transferrin saturation were comparable between the treatment groups (Table 2).

Table 2: Baseline laboratory parameters

Parameter	Oral iron	FCM	p value
Haemoglobin, g/dL	8.72 ± 0.71	8.69 ± 0.74	0.764
MCV, fL	76.4 ± 6.8	75.9 ± 7.1	0.607
MCH, pg	24.8 ± 2.7	24.5 ± 2.9	0.452
Serum ferritin, ng/mL	11.8 ± 5.2	11.5 ± 5.0	0.681
Transferrin saturation, %	11.2 ± 3.6	11.0 ± 3.4	0.694

Change in Haemoglobin: Both treatment groups demonstrated a progressive increase in haemoglobin during follow-up (Table 3).

At 2 weeks, mean haemoglobin increased to 9.31 ± 0.75 g/dL in the oral iron group and 9.72 ± 0.77 g/dL in the FCM group.

At 4 weeks, mean haemoglobin was 10.02 ± 0.82 g/dL in the oral iron group and 10.71 ± 0.79 g/dL in the FCM group.

At 8 weeks, mean haemoglobin reached 10.86 ± 0.76 g/dL in the oral iron group compared with 11.47 ± 0.68 g/dL in the FCM group. The between-group difference was statistically significant ($p < 0.001$).

The mean haemoglobin rise from baseline to 8 weeks was 2.14 ± 0.88 g/dL with oral iron and 2.78 ± 0.91 g/dL with FCM, representing a significantly greater increase with FCM ($p < 0.001$). These findings are summarized in Table 3 and can be visually presented in Figure 1.

Table 3: Haemoglobin concentration during follow-up

Time point	Oral iron	FCM	p value
Baseline	8.72 ± 0.71	8.69 ± 0.74	0.764
2 weeks	9.31 ± 0.75	9.72 ± 0.77	<0.001
4 weeks	10.02 ± 0.82	10.71 ± 0.79	<0.001
8 weeks	10.86 ± 0.76	11.47 ± 0.68	<0.001
Mean rise at 8 weeks	2.14 ± 0.88	2.78 ± 0.91	<0.001

Figure 1. Mean haemoglobin concentration at baseline, 2, 4 and 8 weeks in the oral iron and FCM groups.

Serum ferritin response: Serum ferritin increased substantially in both treatment groups during follow-up (Table 4).

In the oral iron group, mean serum ferritin increased from 11.8 ± 5.2 ng/mL at baseline to 35.4 ± 14.8

ng/mL at 8 weeks. In the FCM group, it increased from 11.5 ± 5.0 ng/mL to 58.7 ± 19.6 ng/mL.

The mean increase in serum ferritin was 23.6 ± 14.9 ng/mL with oral iron compared with 47.2 ± 18.3 ng/mL with FCM. The increase was significantly greater in the FCM group ($p < 0.001$). The comparative ferritin response is presented in Table 4 and Figure 2.

Table 4: Serum ferritin during follow-up

Time point	Oral iron	FCM	p value
Baseline	11.8 ± 5.2	11.5 ± 5.0	0.681
8 weeks	35.4 ± 14.8	58.7 ± 19.6	<0.001
Mean increase	23.6 ± 14.9	47.2 ± 18.3	<0.001

Figure 2. Mean serum ferritin concentration at baseline and 8 weeks in the oral iron and FCM groups.

Correction of Anaemia: At 8 weeks, 82 (82.0%) women receiving FCM achieved a haemoglobin concentration of ≥11 g/dL compared with 61 (61.0%) women receiving oral iron. This difference was statistically significant ($\chi^2 = 10.82$, $p = 0.001$).

An increase in haemoglobin of ≥2 g/dL was observed in 78 (78.0%) women in the FCM group

compared with 57 (57.0%) women in the oral iron group ($p = 0.003$).

The requirement for additional iron therapy was significantly lower among women receiving FCM (7.0% vs 18.0%; $p = 0.014$). Although blood transfusion was numerically less frequent in the FCM group, the difference was not statistically significant ($p = 0.174$). The findings are summarized in Table 5 and illustrated in Figure 3.

Table 5: Haematological response at 8 weeks

Outcome	Oral iron (n=100)	FCM (n=100)	p value
Hb ≥ 11 g/dL	61 (61.0%)	82 (82.0%)	0.001
Hb increase ≥ 2 g/dL	57 (57.0%)	78 (78.0%)	0.003
Required additional iron	18 (18.0%)	7 (7.0%)	0.014
Required blood transfusion	4 (4.0%)	1 (1.0%)	0.174

Figure 3. Comparison of haematological response and treatment requirements at 8 weeks between the oral iron and FCM groups.

Treatment Adherence: Treatment adherence was significantly higher in the FCM group (Table 6).

Mean treatment adherence was $78.6 \pm 13.4\%$ in the oral iron group compared with $98.0 \pm 4.1\%$ in the FCM group ($p < 0.001$).

Good adherence ($\geq 80\%$) was observed in 63 (63.0%) women receiving oral iron compared with 98 (98.0%) women receiving FCM ($p < 0.001$). Conversely, poor adherence ($< 80\%$) was more frequent in the oral iron group (37.0% vs 2.0%).

The marked difference in adherence between the two treatment strategies is shown in Figure 4.

Table 6: Treatment adherence

Variable	Oral iron	FCM	p value
Mean adherence	$78.6 \pm 13.4\%$	$98.0 \pm 4.1\%$	< 0.001
Good adherence $\geq 80\%$	63 (63.0%)	98 (98.0%)	< 0.001
Poor adherence $< 80\%$	37 (37.0%)	2 (2.0%)	—

Figure 4. Treatment adherence in the oral iron and FCM groups.

Treatment-related Adverse Effects: Treatment-related adverse effects were reported in 28 (28.0%) women in the oral iron group compared with 11 (11.0%) women in the FCM group ($p = 0.003$).

Gastrointestinal adverse effects were more frequent among women receiving oral iron. Nausea occurred in 12.0%, constipation in 10.0%, and abdominal discomfort in 8.0% of women in the oral iron group.

In comparison, these events were uncommon in the FCM group.

Among women receiving FCM, headache was reported in 4.0%, dizziness in 3.0%, and infusion-site reaction in 2.0%. No severe hypersensitivity reaction was observed in either group.

The distribution of treatment-related adverse events is presented in Table 7 and Figure 5.

Table 7: Treatment-related adverse effects

Adverse event	Oral iron n (%)	FCM n (%)	p value
Any adverse event	28 (28.0%)	11 (11.0%)	0.003
Nausea	12 (12.0%)	1 (1.0%)	0.002
Constipation	10 (10.0%)	0	0.001
Abdominal discomfort	8 (8.0%)	1 (1.0%)	0.018
Headache	3 (3.0%)	4 (4.0%)	0.721
Dizziness	2 (2.0%)	3 (3.0%)	0.651
Infusion-site reaction	0	2 (2.0%)	0.156
Severe hypersensitivity	0	0	—

Figure 5. Comparison of treatment-related adverse events between the oral iron and FCM groups.

Maternal and Neonatal Outcomes: Maternal and neonatal outcomes were broadly comparable between the two treatment groups (Table 8).

Mean gestational age at delivery was 38.1 ± 1.5 weeks in the oral iron group and 38.3 ± 1.4 weeks in the FCM group ($p = 0.326$). Mean birth weight was 2.91 ± 0.42 kg and 2.98 ± 0.40 kg, respectively ($p = 0.224$).

Preterm delivery occurred in 9.0% of women in the oral iron group and 6.0% in the FCM group ($p = 0.438$). Caesarean delivery occurred in 47.0% and 43.0%, respectively ($p = 0.571$). Low birth weight was observed in 14.0% and 10.0% of neonates ($p = 0.383$), while NICU admission occurred in 8.0% and 6.0%, respectively ($p = 0.576$).

None of the assessed maternal or neonatal outcomes differed significantly between groups. These findings are summarized in Table 8 and illustrated in Figure 6.

Table 8: Maternal and neonatal outcomes

Outcome	Oral iron	FCM	p value
Gestational age at delivery, weeks	38.1 $\pm$ 1.5	38.3 $\pm$ 1.4	0.326
Preterm delivery	9 (9.0%)	6 (6.0%)	0.438
Caesarean delivery	47 (47.0%)	43 (43.0%)	0.571
Birth weight, kg	2.91 $\pm$ 0.42	2.98 $\pm$ 0.40	0.224
Low birth weight	14 (14.0%)	10 (10.0%)	0.383
NICU admission	8 (8.0%)	6 (6.0%)	0.576

Figure 6. Comparison of selected maternal and neonatal outcomes between the oral iron and FCM groups.

Figures

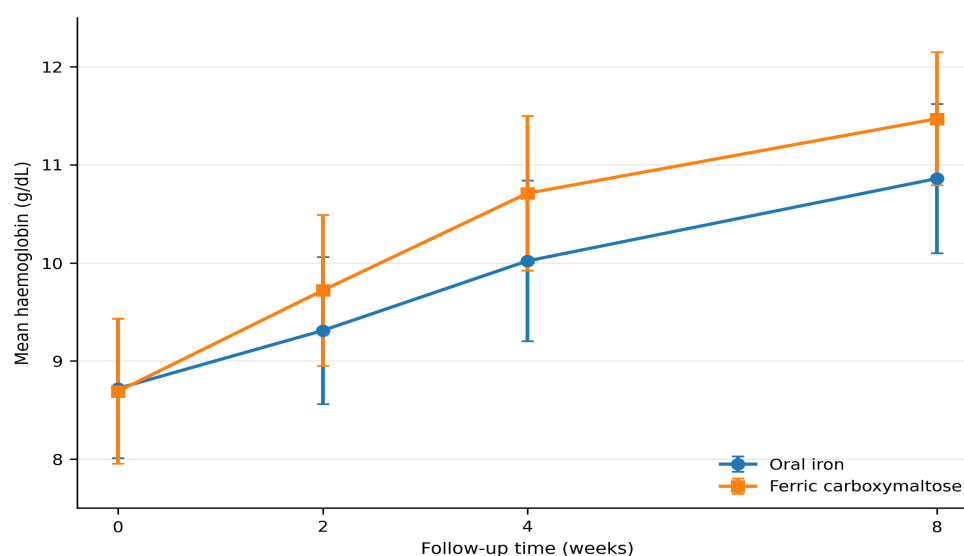


Figure 1: Mean haemoglobin concentration at baseline, 2, 4 and 8 weeks in the oral iron and ferric carboxymaltose groups. Error bars represent standard deviations.

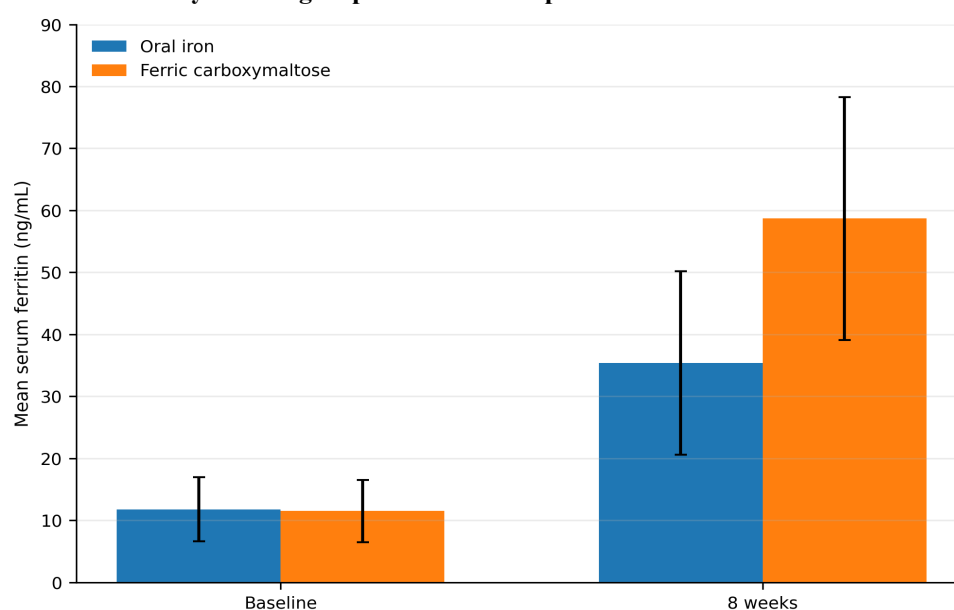


Figure 2: Mean serum ferritin concentration at baseline and 8 weeks in the oral iron and ferric carboxymaltose groups. Error bars represent standard deviations.

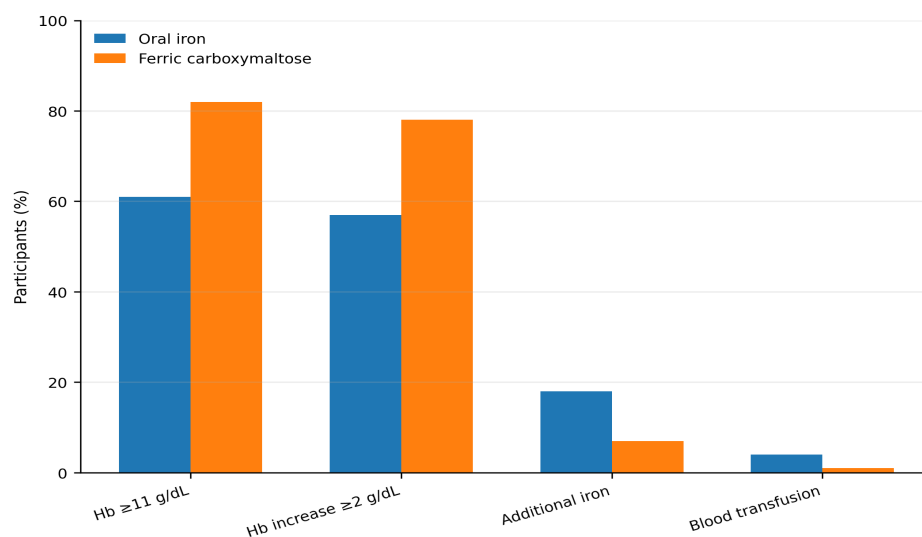


Figure 3: Comparison of haematological response and treatment requirements at 8 weeks between the oral iron and ferric carboxymaltose groups.

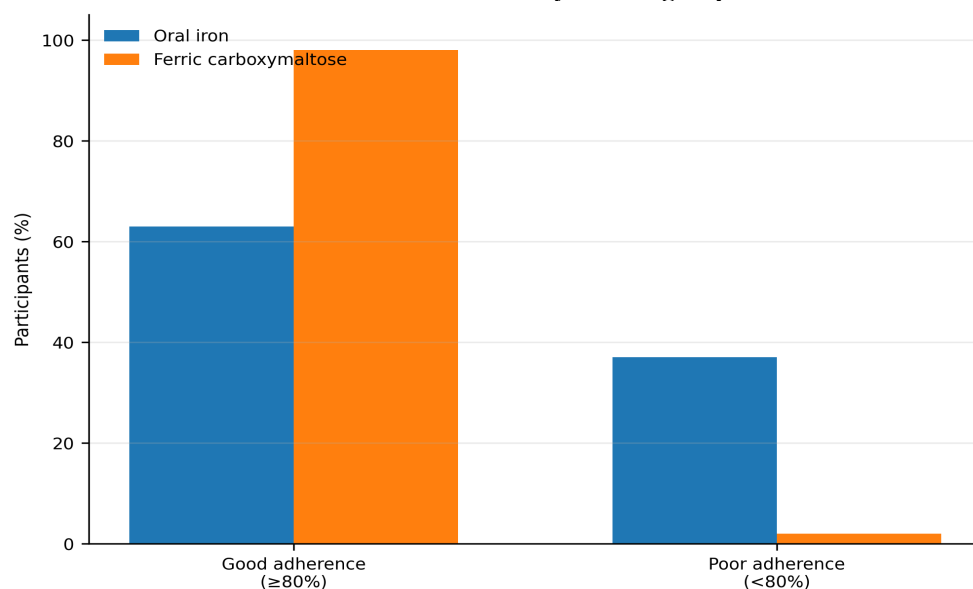


Figure 4: Treatment adherence in the oral iron and ferric carboxymaltose groups.

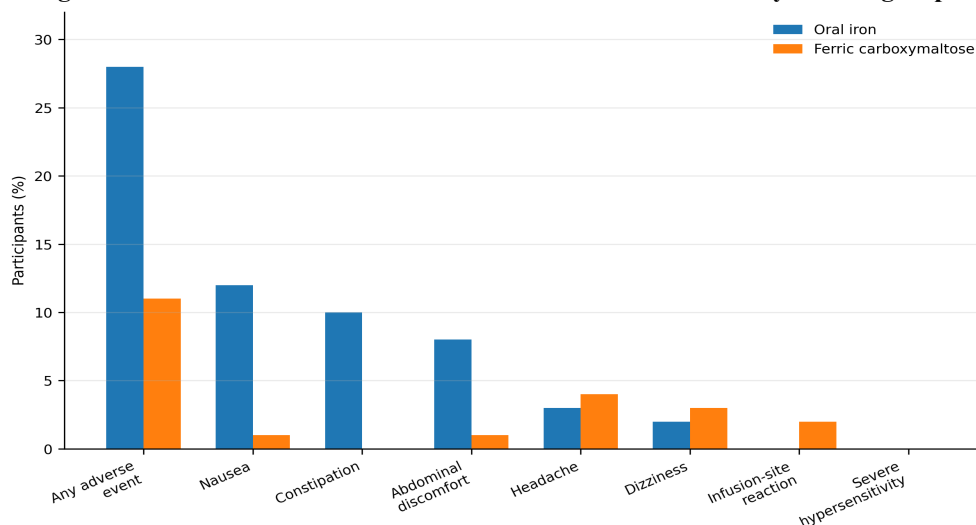


Figure 5: Comparison of treatment-related adverse events between the oral iron and ferric carboxymaltose groups.

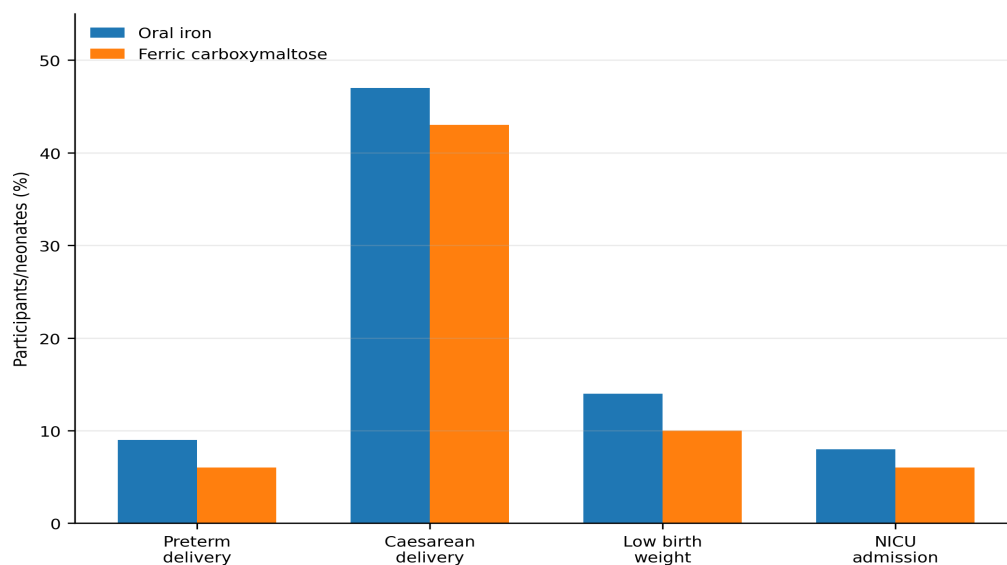


Figure 6: Comparison of selected maternal and neonatal outcomes between the oral iron and ferric carboxymaltose groups.

Discussion

The present study compared oral iron with intravenous ferric carboxymaltose for the treatment of iron-deficiency anaemia during pregnancy. The principal findings were that FCM produced a significantly greater increase in haemoglobin and serum ferritin, a higher proportion of women achieved the predefined haemoglobin target, treatment adherence was greater and gastrointestinal adverse effects were less frequent.

Baseline demographic and haematological characteristics were comparable between the two groups. Similar baseline values are important because differences in initial haemoglobin or iron status could otherwise influence the magnitude of treatment response.

The principal finding was the greater haemoglobin response following FCM. In the present study, the mean haemoglobin increase at 8 weeks was 2.78 g/dL with FCM compared with 2.14 g/dL with oral iron. This finding is consistent with the broader evidence that intravenous iron can produce a more rapid haematological response than oral iron in pregnancy. A systematic review and meta-analysis of randomized trials found higher haemoglobin concentrations at delivery following intravenous iron compared with oral iron. [5]

The findings are also consistent with the FER-ASAP randomized trial. Breymann et al. reported correction of anaemia to Hb ≥ 11.0 g/dL in 84% of women treated with FCM compared with 70% receiving oral ferrous sulphate. FCM also achieved correction more rapidly. [7] The direction of effect in the present study was similar, with 82% of women in the FCM group and 61% in the oral iron group achieving the predefined Hb target.

Indian evidence provides additional support. Chawla et al. reported a randomized comparison of FCM and oral ferrous sulphate involving 362 pregnant women. The mean haemoglobin increase was greater in the FCM group than in the oral iron group, while no major safety difference was observed. [8] The current findings are therefore broadly consistent with previously reported Indian experience.

The increase in serum ferritin was also substantially greater with FCM. This is biologically plausible because intravenous administration bypasses gastrointestinal absorption and allows rapid delivery of a large iron dose. Systematic reviews have similarly reported improved iron stores with intravenous iron compared with oral therapy. [4,5,6]

Treatment adherence was considerably higher in the FCM group. This finding is expected because FCM is administered under supervision, whereas oral iron requires regular daily intake over an extended period. Gastrointestinal intolerance can further compromise adherence to oral iron. The FER-ASAP trial similarly reported more gastrointestinal treatment-related events with oral ferrous sulphate. [7]

In the present study, gastrointestinal symptoms were the predominant adverse effects associated with oral iron, whereas only a small number of mild events were observed following FCM. These findings are broadly consistent with systematic reviews reporting fewer medication reactions with intravenous iron. [5]

Nevertheless, intravenous FCM should not be considered universally superior for every outcome. The IVON trial involving more than 1,000 pregnant women found no significant difference in anaemia prevalence at 36 weeks between FCM and oral iron, although FCM produced substantially better

correction of iron deficiency and was considered safe. [9]

Similarly, the REVAMP randomized trial in Malawi demonstrated improvements in haemoglobin and iron deficiency with FCM but did not show a significant improvement in every maternal or neonatal outcome. [10] These findings emphasize that improvement in haematological indices does not necessarily translate into differences in all pregnancy outcomes.

More recent evidence from the REVAMP-TT trial provides further support for FCM when anaemia is diagnosed late in pregnancy. In women treated during the third trimester, FCM significantly reduced anaemia before childbirth compared with standard oral therapy, without increasing serious adverse events or changing birth weight. [11] This is clinically relevant because the available time for oral therapy to correct anaemia becomes progressively shorter as pregnancy advances.

The maternal and neonatal outcomes in the present study did not differ significantly between groups. This finding is compatible with the broader literature, in which intravenous iron has not consistently demonstrated major differences in preterm birth, caesarean delivery or neonatal outcomes. The meta-analysis by Lewkowicz et al. found higher haemoglobin at delivery with intravenous iron but no significant difference in blood transfusion or caesarean delivery. [5]

The safety profile of FCM was favourable in the present study, with no severe hypersensitivity reaction. However, hypophosphataemia should remain an important consideration. A 2025 international consensus statement notes that FCM is associated with hypophosphataemia more frequently than some other intravenous iron preparations. Most cases are asymptomatic and transient, but patients at increased risk or those receiving repeated high-dose treatment may require phosphate monitoring. [12]

The findings should therefore be interpreted in the context of the individual patient's clinical situation. Oral iron remains an important treatment option, particularly when anaemia is mild, there is adequate time before delivery and treatment is tolerated. FCM may be particularly advantageous when rapid correction is desired, adherence to prolonged oral treatment is problematic, gastrointestinal intolerance is significant or oral therapy has produced an inadequate response.

The present study has the advantage of directly comparing two commonly used treatment strategies in the same obstetric population, with evaluation of both haematological efficacy and treatment tolerability.

Conclusion

In this prospective comparative study, intravenous ferric carboxymaltose produced a significantly greater improvement in haemoglobin and serum ferritin than oral iron among pregnant women with iron-deficiency anaemia.

A significantly greater proportion of women receiving FCM achieved the predefined haemoglobin target, and treatment adherence was substantially higher. Gastrointestinal adverse effects were more frequent with oral iron, whereas FCM was generally well tolerated and no severe hypersensitivity reaction was observed.

FCM may therefore represent an effective treatment option for selected pregnant women with iron-deficiency anaemia, particularly when rapid correction is required or oral iron is poorly tolerated or difficult to adhere to.

However, treatment choice should be individualized according to gestational age, severity of anaemia, iron status, previous response to oral therapy, tolerability, availability, cost and institutional protocols.

Limitations

1. The study was conducted at Government Satellite Hospital CHB, Jodhpur which may limit generalizability.
2. Blinding was difficult because oral and intravenous treatment modalities are readily distinguishable.
3. The follow-up period may not capture long-term maternal and infant outcomes.
4. The study did not evaluate cost-effectiveness.
5. FCM-associated hypophosphataemia requires consideration, particularly with repeated high-dose treatment.

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