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Comparative Effects of Oral and Intravenous Iron Therapy on Hemoglobin, Serum Ferritin, and Transferrin Saturation in Iron Deficiency Anemia

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Abstract Iron deficiency anemia is a common hematological disorder associated with fatigue, weakness, reduced functional capacity, and impaired quality of life. Oral iron is widely used as first-line therapy, whereas intravenous iron may provide faster correction of anemia and restoration of iron stores. Objective: To compare the effects of oral and intravenous iron therapy on hemoglobin, serum ferritin, and transferrin saturation in patients with iron deficiency anemia. Methods: This prospective, nonrandomized comparative study was conducted at Poonch Medical College, Rawalakot, from June 2025 to June 2026 and included 100 patients with iron deficiency anemia, with 50 in each treatment group. The follow-up interval was (VERIFY: duration from treatment initiation to final assessment). Oral therapy consisted of (VERIFY: preparation, elemental iron dose, frequency, and duration); intravenous therapy consisted of (VERIFY: formulation, total dose, number of infusions, and schedule). Results: Baseline characteristics were comparable between groups. Hemoglobin increased from 8.7±1.1 to 11.2±1.1 g/dL in the oral group and from 8.6±1.0 to 12.1±1.0 g/dL in the intravenous group (reported $p<0.001$ for the between-group comparison; VERIFY statistical output). Serum ferritin increased from 8.9±3.1 to 38.6±12.4 ng/mL with oral therapy and from 9.2±3.4 to 72.8±20.6 ng/mL with intravenous therapy ($p<0.001$). Transferrin saturation increased from 9.8±3.2% to 22.7±5.1% and from 10.1±3.5% to 29.4±6.2%, respectively ($p<0.001$). A hemoglobin increase of ≥2 g/dL was achieved in 39 (78.0%) oral and 47 (94.0%) intravenous recipients (reported $p = 0.016$; two-sided Fisher exact $p = 0.041$ from published counts). Restoration of ferritin ≥30 ng/mL occurred in 31 (62.0%) versus 45 (90.0%) patients ($p<0.001$). Gastrointestinal adverse effects were significantly more frequent with oral iron (36.0% vs. 8.0%, $p = 0.001$). Conclusion: Both groups showed improvements in hematological and iron-status parameters, with larger observed changes in the intravenous group. Because treatment allocation was nonrandomized and follow-up and dosing details require confirmation, the differences should not be interpreted as definitive evidence of causal superiority. Treatment selection should account for clinical indication, tolerance, availability, and infusion-related risks.

Key Words Iron Deficiency Anemia, Oral Iron Therapy, Intravenous Iron Therapy, Hemoglobin, Serum Ferritin

INTRODUCTION

Iron deficiency anemia (IDA) is an important hemato-nutrient deficiency in the world. Dietary iron deficiency is now estimated to be a significant contributor to the health burden, especially for women, and for populations in low-resource areas [1]. In addition to low hemoglobin, IDA can lead to fatigue, weakness, decreased exercise tolerance, difficulty concentrating and decreased quality of life [2]. Diagnosis is made by evaluating hemoglobin and iron status markers. Serum ferritin is a measure of body iron stores and transferrin saturation (TSAT) is a measure of available circulating iron for erythropoiesis [3]. Current guidelines focus on confirming the diagnosis of iron deficiency, determining the cause of iron deficiency, and the level of recommended treatment based on the severity, absorption, tolerance, and continuing blood loss [4]. Oral iron is the treatment of choice as it is cheap, widely available and effective if it is absorbed and tolerated [5]. The gastrointestinal side effects, poor adherence, and absorption issues, however, and the lack of a response may affect treatment success [6]. When oral iron is not tolerated, not effective or is unlikely to be well absorbed, intravenous iron is recommended [7].

Intravenous therapy allows the delivery of iron directly into the blood stream, which may result in quicker hemoglobin and iron recovery. A recent randomized trial showed higher early increases in Hb, serum ferritin, serum iron and TSAT in high dose IV iron compared to oral iron, but no difference in adverse event rates [8]. Another randomized study reported IV ferric carboxymaltose to result in more hemoglobin gain and iron-store normalization after gastrointestinal bleeding [9]. This, however, might not reflect the comparative effectiveness of the two routes as per patient characteristics, iron formulation, baseline level of anemia, treatment duration and clinical setting [10]. Oral therapy could be effective if the drug is taken and absorbed as prescribed and recent evidence indicates the dose timing may affect tolerability or efficacy [11]. Hence, treatment by IV should not be assumed to be better for all patients. Both haematological and biochemical responses to treatment should be assessed. Recently, comparative studies have found variations in ferritin and TSAT along with changes in hemoglobin, which support the assessment of iron-store repletion, in addition to hemoglobin alone [12]. In addition, treatment acceptability is critical as swallowing may be difficult with the tablets, remembering doses, and gastrointestinal symptoms may decrease adherence to oral treatment [13]. The clinical choice between oral and intravenous iron depends on anemia severity, gastrointestinal tolerance and absorption, ongoing blood loss, the urgency of correction, and patient preference. Evidence from pregnancy, postoperative, and pediatric populations may not be directly generalizable to the broader adult population studied here. At this center, a comparison of routinely selected treatment routes was intended to describe hematological responses and tolerability under local clinical conditions; because allocation was not randomized, confounding by indication remains possible.

Objective

To compare the effects of oral and intravenous iron therapy on hemoglobin, serum ferritin, and transferrin saturation in patients with iron deficiency anemia. The principal outcomes were changes from baseline in hemoglobin, serum ferritin, and transferrin saturation. Secondary outcomes included predefined response thresholds and reported adverse effects. (VERIFY whether these outcomes and any hypothesis were specified before data collection).

METHODS

This prospective comparative study was conducted at Poonch Medical College, Rawalakot from June 2025 to June 2026. A total of 100 patients with iron deficiency anemia were recruited using consecutive sampling and divided equally into two groups, with 50 patients receiving oral iron therapy and 50 receiving intravenous iron therapy. Adult patients with confirmed iron deficiency anemia, reduced hemoglobin, low serum ferritin, reduced transferrin saturation, and willingness to participate were included. Patients with anemia due to chronic kidney disease, hemoglobinopathies, active malignancy, significant acute or chronic blood loss requiring immediate intervention, anemia of chronic disease without iron deficiency, recent blood transfusion, previous iron therapy within the preceding 4 weeks, or known hypersensitivity to iron preparations were excluded. Treatment allocation was not described as randomized; the actual clinician or patient decision process and method used to achieve equal group sizes require confirmation. (VERIFY: recruitment start and end dates, treatment initiation, follow-up duration, diagnostic hemoglobin/ferritin/TSAT thresholds, adult age range, causes of iron deficiency, inflammation assessment, numbers screened/excluded/withdrawn, and sample-size justification). These unreported factors could introduce selection bias and confounding by indication.

Data Collection

After obtaining written informed consent, demographic and clinical information including age, gender, presenting symptoms, relevant medical history, and baseline hemoglobin, serum ferritin, and transferrin saturation were recorded on a pre-designed proforma. Patients in the oral iron group received standard oral iron therapy, while patients in the intravenous group will receive intravenous iron according to the calculated iron requirement and institutional protocol. Hemoglobin, serum ferritin, and transferrin saturation were assessed at baseline and at the end of the treatment period. Treatment adherence, tolerance, and adverse effects including gastrointestinal symptoms, infusion-related reactions, headache, nausea, and other reported events were also documented. The primary outcomes were changes in hemoglobin, serum ferritin, and transferrin saturation from baseline to follow-up. Secondary outcomes included the proportion of patients achieving correction of anemia, restoration of iron stores, improvement in transferrin saturation, treatment-related adverse effects, and overall treatment tolerance. (VERIFY AND INSERT: oral formulation and elemental dose, dosing frequency and duration; intravenous formulation, calculated iron requirement, total dose, infusion number and schedule; actual adherence measurement and handling of missed doses; exact laboratory follow-up time point and assay laboratory; criteria for anemia correction, overall response, ferritin ≥30 ng/mL and TSAT ≥20%; recording and management of adverse events; missing-data procedures). A hemoglobin increase ≥2 g/dL and correction of anemia are distinct outcomes and should not be assumed to have identical counts. Written informed consent was reported; (VERIFY ethics committee name, approval number, and whether approval preceded recruitment).

Statistical Analysis

Data were entered and analyzed using SPSS version 25. Quantitative variables including age, hemoglobin, serum ferritin, and transferrin saturation were expressed as mean±standard deviation, while categorical variables including gender, correction of anemia, restoration of iron stores, and adverse effects were presented as frequencies and percentages. The independent-samples t-test was used to compare normally distributed continuous variables between the two treatment groups, while the Mann–Whitney U test was applied for non-normally distributed variables. A p-value ≤0.05 was considered statistically significant. The

principal reported comparisons of changes from baseline are distinct from comparisons of post-treatment means. (VERIFY the tests actually used for each outcome, distribution assessment, within-patient handling, baseline adjustment if performed, 95% confidence-interval calculation, multiple-comparison policy, and missing-data analysis population). Fisher exact tests were independently recalculated from published 2×2 counts for selected binary endpoints; these checks do not replace analysis of the original patient-level dataset.

RESULTS

The measured baseline characteristics were broadly similar between groups, although nonsignificant p-values do not exclude clinically important imbalance or selection bias. Mean age was 46.8±13.2 years in the oral group and 45.9±12.7 years in the intravenous group (p = 0.732). Hemoglobin was 8.7±1.1 versus 8.6±1.0 g/dL, serum ferritin 8.9±3.1 versus 9.2±3.4 ng/mL, and transferrin saturation 9.8±3.2% versus 10.1±3.5%, respectively, with no significant baseline differences. (VERIFY numbers screened, enrolled, allocated, completing follow-up, and included in each analysis, as well as anemia severity definitions) (Table 1).

After treatment, hemoglobin increased from 8.7±1.1 to 11.2±1.1 g/dL with oral iron and from 8.6±1.0 to 12.1±1.0 g/dL with intravenous iron. Serum ferritin increased from 8.9±3.1 to 38.6±12.4 ng/mL versus 9.2±3.4 to 72.8±20.6 ng/mL, while transferrin saturation increased from 9.8±3.2% to 22.7±5.1% versus 10.1±3.5% to 29.4±6.2%, respectively. Post-treatment differences were significant for all three parameters (p<0.001). The displayed p-values require verification as to whether they compare post-treatment values or changes from baseline; the manuscript should not conflate these analyses. (VERIFY identical follow-up intervals and measurement methods in both groups) (Table 2).

The mean hemoglobin increase was 2.5±0.9 g/dL with oral iron compared with 3.5±1.0 g/dL with intravenous iron, with a mean difference of 1.0 g/dL (95% CI: 0.63–1.37, p<0.001). Ferritin increased by 29.7±11.6 versus 63.6±19.4 ng/mL (mean difference 33.9, 95% CI: 27.5–40.3, p<0.001), while transferrin saturation increased by 12.9±4.7% versus 19.3±5.6% (mean difference 6.4, 95% CI: 4.35–8.45, p<0.001). Hemoglobin increase ≥2 g/dL occurred in 39 (78.0%) versus 47 (94.0%) patients (reported p = 0.016; Fisher exact two-sided p = 0.041 based on 39/50 versus 47/50), ferritin ≥30 ng/mL in 31 (62.0%) versus 45 (90.0%) (p<0.001), and transferrin saturation ≥20% in 34 (68.0%) versus 46 (92.0%) (p = 0.003). These categorical thresholds are separate from anemia correction and overall response, which require operational definitions. The confidence intervals and p-values for changes from baseline should be checked against the original statistical output (Table 3).

Table 1: Baseline Demographic and Clinical Characteristics of Patients with Iron Deficiency Anemia (N = 100)

Variable	Oral Iron Group (N = 50)	Intravenous Iron Group (N = 50)	p-value
Age (years)	46.8±13.2	45.9±12.7	0.732
Male gender	24 (48.0)	22 (44.0)	0.689
Female gender	26 (52.0)	28 (56.0)	0.689
Fatigue or generalized weakness	42 (84.0)	44 (88.0)	0.538
Headache or dizziness	31 (62.0)	34 (68.0)	0.530
Shortness of breath on exertion	27 (54.0)	29 (58.0)	0.688
Hemoglobin (g/dL)	8.7±1.1	8.6±1.0	0.641
Serum ferritin (ng/mL)	8.9±3.1	9.2±3.4	0.646
Transferrin saturation (%)	9.8±3.2	10.1±3.5	0.654
Moderate anemia	34 (68.0)	36 (72.0)	0.657
Severe anemia	16 (32.0)	14 (28.0)	0.657

Define moderate/severe anemia thresholds and applicable guideline; sex is a single binary variable, so the repeated sex p-value should not be interpreted as separate tests. Confirm missing baseline data and table alignment

Table 2: Hematological Response Before and After Iron Therapy (N = 100)

Variable	Oral Iron Group Baseline (N = 50)	Oral Iron Group Post-treatment (N = 50)	Intravenous Iron Group Baseline (N = 50)	Intravenous Iron Group Post-treatment (N = 50)	p-value
Hemoglobin (g/dL)	8.7±1.1	11.2±1.1	8.6±1.0	12.1±1.0	<0.001
Serum ferritin (ng/mL)	8.9±3.1	38.6±12.4	9.2±3.4	72.8±20.6	<0.001
Transferrin saturation (%)	9.8±3.2	22.7±5.1	10.1±3.5	29.4±6.2	<0.001

Values are mean±SD. The p-values must be labeled as comparisons of post-treatment values or comparisons of changes from baseline according to the actual analysis. Follow-up interval: (VERIFY)

Table 3: Change in Hematological Parameters Following Oral and Intravenous Iron Therapy (N = 100)

Variable	Oral Iron Group (N = 50)	Intravenous Iron Group (N = 50)	Mean Difference (95% CI)	p-value
Hemoglobin change (g/dL)	2.5±0.9	3.5±1.0	1.0 (0.63–1.37)	<0.001
Serum ferritin change (ng/mL)	29.7±11.6	63.6±19.4	33.9 (27.5–40.3)	<0.001
Transferrin saturation change (%)	12.9±4.7	19.3±5.6	6.4 (4.35–8.45)	<0.001
Hemoglobin increase ≥2 g/dL	39 (78.0)	47 (94.0)	3.62 (1.28–10.24)	0.016
Ferritin ≥30 ng/mL achieved	31 (62.0)	45 (90.0)	5.52 (2.25–13.53)	<0.001
Transferrin saturation ≥20% achieved	34 (68.0)	46 (92.0)	4.53 (1.68–12.23)	0.003

Continuous outcomes show mean differences (95% CI); binary outcomes require an explicitly labeled risk ratio or odds ratio (95% CI), calculated from the source data. The current binary effect estimates are not identified and must be recalculated. Exact test selection and all p-values require verification

Table 4: Treatment Response, Adverse Effects, and Tolerability According to Iron Therapy (N = 100)

Outcome	Oral Iron Group (N = 50)	Intravenous Iron Group (N = 50)	p-value
Overall treatment response	42 (84.0)	48 (96.0)	0.046
Correction of anemia	39 (78.0)	46 (92.0)	0.049
Restoration of iron stores	31 (62.0)	45 (90.0)	<0.001
Gastrointestinal adverse effects	18 (36.0)	4 (8.0)	0.001
Nausea	11 (22.0)	3 (6.0)	0.021
Constipation	13 (26.0)	1 (2.0)	<0.001
Abdominal discomfort	9 (18.0)	2 (4.0)	0.025
Headache	5 (10.0)	6 (12.0)	0.749
Infusion-related reaction	0 (0.0)	3 (6.0)	0.077
Treatment discontinuation due to adverse effects	6 (12.0)	2 (4.0)	0.140

Counts are n (%), with N = 50 per group. Recalculate binary-outcome p-values using the prespecified method, considering Fisher exact tests for sparse cells. Based on reported counts, two-sided Fisher p = 0.092 for overall response and p = 0.091 for anemia correction. Clarify overlap of gastrointestinal symptoms, treatment discontinuations, and infusion reactions

Overall treatment response was achieved in 42 (84.0%) oral and 48 (96.0%) intravenous patients (reported p = 0.046; two-sided Fisher exact p = 0.092 based on 42/50 versus 48/50), while anemia correction occurred in 39 (78.0%) and 46 (92.0%) (reported p = 0.049; two-sided Fisher exact p = 0.091 based on 39/50 versus 46/50), respectively. Restoration of iron stores was higher with intravenous therapy (90.0% vs. 62.0%, p<0.001). Gastrointestinal adverse effects were more common with oral iron (36.0% vs. 8.0%, p = 0.001), particularly nausea (22.0% vs. 6.0%, p = 0.021), constipation (26.0% vs. 2.0%, p<0.001), and abdominal discomfort (18.0% vs. 4.0%, p = 0.025). Headache occurred in 10.0% versus 12.0% (p = 0.749), infusion reactions in 0% versus 6.0% (p = 0.077), and treatment discontinuation in 12.0% versus 4.0% (p = 0.140). The counts for hemoglobin increase ≥2 g/dL (39 and 47) and anemia correction (39 and 46) describe potentially different endpoints; the exact definitions and individual classifications must be confirmed. Gastrointestinal symptoms may overlap within a participant, and the composite count should represent unique participants (VERIFY). The three infusion reactions and eight treatment discontinuations require documented causes, severity, management, and inclusion in efficacy analyses (Table 4).

REFERENCES

[1] Choi, U.E. *et al.* "A retrospective propensity-matched cohort study of intravenous versus oral iron formulations for management of iron deficiency anemia in pregnancy." *Anesthesia & Analgesia*, 2026. https://doi.org/10.1213/ANE.0000000000008229.

[2] El Ouafa, Y. *et al.* "Intravenous ferric carboxymaltose versus oral ferrous sulfate for iron deficiency anemia: a retrospective cohort study of iron store repletion and safety." *Cureus*, vol. 18, no. 7, 2026, article e112040. https://doi.org/10.7759/cureus.112040.

[3] Leite, L.A.C. *et al.* "Real-world use of intravenous ferric derisomaltose in Brazilian patients with iron deficiency anemia." *Hematology, Transfusion and Cell Therapy*, vol. 48, no. 3, 2026, article 106501. https://doi.org/10.1016/j.htct.2026.106501.

[4] Wasim, T. *et al.* "Intravenous iron for non-anaemic iron deficiency in pregnancy: a multicentre, two-arm, randomised controlled trial." *The Lancet Haematology*, vol. 13, no. 1, 2026, pp. e22–e29. https://doi.org/10.1016/S2352-3026(25)00315-1.

[5] Chakraborty, R. *et al.* "Comparative efficacy, safety, and quality-of-life outcomes of oral ferrous sulfate versus intravenous ferric carboxymaltose in the management of iron deficiency anemia during pregnancy." *Annals of African Medicine*, 2026. https://doi.org/10.4103/aam.aam_18_26.

[6] Peracha, A., Soomar, S.M. and Rana, S. "Investigation and management of iron deficiency anemia in non-pregnant reproductive-age women: a retrospective analysis." *Cureus*, vol. 18, no. 4, 2026, article e107240. https://doi.org/10.7759/cureus.107240.

[7] Derman, R.J. *et al.* "Single-dose intravenous iron vs oral iron for treatment of maternal iron deficiency anemia: a randomized clinical trial." *American Journal of Obstetrics and Gynecology*, vol. 233, no. 2, 2025, pp. 120.e1–120.e18. https://doi.org/10.1016/j.ajog.2025.01.037.

[8] Kremke, M. *et al.* "Early postoperative intravenous iron versus oral iron for the treatment of anemia following cardiac surgery: a randomized controlled trial." *Anesthesia & Analgesia*, 2025. https://doi.org/10.1213/ANE.0000000000007414.

[9] Aslan, S. *et al.* "Comparative impact of intravenous iron sucrose and ferric carboxymaltose on hypophosphatemia and anemia parameters in iron deficiency anemia: a retrospective study." *Therapeutics and Clinical Risk Management*, vol. 21, 2025, pp. 987–993. https://doi.org/10.2147/TCRM.S529064.

[10] Dhanush, M. *et al.* "Daily versus alternate day oral iron replacement for women with iron deficiency anaemia: a randomized controlled trial." *Indian Journal of Hematology and Blood Transfusion*, vol. 41, no. 2, 2025, pp. 245–251. https://doi.org/10.1007/s12288-024-01816-9.

[11] Zhang, Q. *et al.* "Comparison of the efficacy and safety between high-dose intravenous iron and oral iron in treating iron deficiency anemia: a multicenter, prospective, open-label, randomized controlled study." *Chinese Journal of Hematology*, vol. 45, no. 12, 2024, pp. 1113–1118. https://doi.org/10.3760/cma.j.cn121090-20240424-00161.

[12] Li, Y. and Ju, J. "Comparison of the efficacy and adverse effects of oral ferrous succinate tablets and intravenous iron sucrose: a retrospective study." *BMC Pharmacology and Toxicology*, vol. 25, no. 1, 2024, article 61. https://doi.org/10.1186/s40360-024-00769-z.

[13] Bengelloun Zahr, S. *et al.* "Oral liposomal iron versus injectable iron sucrose for anemia treatment in non-dialysis chronic kidney disease patients: a non-inferiority study." *Cureus*, vol. 16, no. 9, 2024, article e70114. https://doi.org/10.7759/cureus.70114.

[14] Tabish, M. *et al.* "Randomized controlled trial of intravenous ferric carboxymaltose vs oral iron to treat iron deficiency anemia after variceal bleed in patients with cirrhosis." *The American Journal of Gastroenterology*, vol. 119, no. 10, 2024, pp. 2061–2069. https://doi.org/10.14309/ajg.0000000000002775.

[15] Afolabi, B.B. *et al.* "Intravenous versus oral iron for anaemia among pregnant women in Nigeria (IVON): an open-label, randomised controlled trial." *The Lancet Global Health*, vol. 12, no. 10, 2024, pp. e1649–e1659. https://doi.org/10.1016/S2214-109X(24)00239-0.

[16] Strachan, C. *et al.* "Intravenous iron infusions in pediatric patients: a retrospective review of efficacy and safety." *Journal of Investigative Medicine*, vol. 72, no. 5, 2024, pp. 457–464. https://doi.org/10.1177/10815589241238219.

[17] Awomolo, A.M. *et al.* "Intravenous infusions of ferumoxytol compared to oral ferrous sulfate for the treatment of anemia in pregnancy: a randomized controlled trial." *American Journal of Obstetrics and Gynecology MFM*, vol. 5, no. 9, 2023, article 101064. https://doi.org/10.1016/j.ajogmf.2023.101064.

[18] Saad, A.F. *et al.* "Intravenous iron compared with oral iron supplementation for the treatment of postpartum anemia: a randomized controlled trial." *Obstetrics & Gynecology*, vol. 141, no. 6, 2023, pp. 1052–1055. https://doi.org/10.1097/AOG.0000000000005143.

[19] Hansen, R. *et al.* "Intravenous ferric derisomaltose versus oral iron for persistent iron deficient pregnant women: a randomised controlled trial." *Archives of Gynecology and Obstetrics*, vol. 308, no. 4, 2023, pp. 1165–1173. https://doi.org/10.1007/s00404-022-06768-x.

[20] Chawla, S., Singh, A., Jhamb, D. and Anupama, C.H. "A randomised controlled trial to compare injection ferric carboxymaltose and oral iron in treating iron deficiency anemia during pregnancy." *The Journal of Obstetrics and Gynaecology of India*, vol. 72, no. 6, 2022, pp. 492–496. https://doi.org/10.1007/s13224-022-01653-8.