Delayed Hypersensitivity Reaction to Iron Salts: From Diagnosis to Desensitization

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Iron deficiency anemia (IDA) is a global public health problem because of its association with malnutrition and multiple medical conditions and the fact that it severely compromises the quality of life of affected patients [1]. IDA is highly prevalent in women of reproductive age, reaching 32.8% worldwide [2].

Iron treatment is considered a safe procedure, although adverse events, while rare, do occur. Cases of severe allergic reactions following iron administration have been reported [1-3]; of these, 25% result from iron hypersensitivity. One in every 5 million doses of intravenous iron administered is estimated to produce allergic reactions, most of which are immediate. The risk of anaphylaxis following intravenous iron treatment, rapid drug desensitization [7] is 1 in 200 000 patients treated with high-molecular-weight iron dextran experienced carboxymaltose. The symptoms subsided in 4 days without medication.

The patient was referred to the allergy department. A skin prick test (SPT) with iron carboxymaltose was performed 8 months after the reaction, and immediate and delayed readings (96 hours) yielded negative results. Intradermal testing was not performed because of the high risk of residual skin lesions. The referring physicians confirmed that iron carboxymaltose was mandatory because of malnutrition and intolerance to oral iron therapy. We assessed the management risks, and the patient signed the informed consent document. After assessment of risk, a drug provocation test (DPT) was performed with iron carboxymaltose, and no immediate reactions were reported. Three days later, the patient developed fever, nausea, diarrhea, and myalgia. She was prescribed oral prednisone (30 mg), cetirizine (10 mg), and paracetamol (1000 mg), and her symptoms resolved after 24 hours. Administration of iron carboxymaltose was contraindicated. Given the worsening of the IDA and the need for iron therapy, we decided to seek an alternative with iron sucrose. SPT with iron sucrose and immediate and delayed readings yielded negative results. DPT with iron sucrose was performed. Four hours after administration, the patient developed fever and generalized arthralgia.

In an attempt to determine the mechanism underlying this reaction, we performed a lymphocyte transformation test (LTT) with iron carboxymaltose and iron sucrose 2 months later. Peripheral blood mononuclear cells were isolated from whole blood using LymphoPrep gradient centrifugation. Briefly, 200 µL of cell suspensions (106 cells/mL) in AIM V Medium was added to each culture-plate well and stimulated with iron carboxymaltose and iron sucrose (20 µg/µL, 2 µg/µL, 0.2 µg/µL, 0.02 µg/µL, and 0.002 µg/µL). Dynabeads (Thermo Fisher Scientific; CD3/CD28 [1 µL/well]) were used as a positive control. Nonstimulated cells were used as a negative control. Cultures were performed in triplicate and incubated for 4 days at 37°C in an atmosphere of 5% CO2/95% air. On day 4, the culture plates were centrifuged and 100 µL of each well was replaced by fresh AIM-V medium containing 10 µCi of 3H-thymidine (3H). On day 6, cells were harvested using a vacuum manifold, and incorporation of radioactivity into DNA was measured using a liquid scintillation counter. The result is expressed as the stimulation index (SI), which is the relationship between the mean of triplicate dpm of the drug-stimulated cultures and the mean of triplicate dpm of the negative controls.

An SI of 2 to 3 is generally considered weakly positive. SI ≥3 was considered a positive response in our evaluation [4-6]. The reading was positive at a concentration of 0.02 µg/µL and 0.002 µg/µL of iron sucrose and 20 µg/µL, 2 µg/µL, and 0.2 µg/µL of iron carboxymaltose. An LTT with iron sucrose and iron carboxymaltose in 3 healthy controls revealed no proliferative responses (Figure). Since the patient was in need of intravenous iron treatment, rapid drug desensitization [7] was performed, with no breakthrough or delayed reactions (See Supplementary table).

Most reported hypersensitivity reactions (HSRs) to iron salts are immediate, and 1 in 200 000 patients treated with high-molecular-weight iron dextran experienced
anaphylaxis. Many of the patients with an HSR to an iron salt preparation tolerated a different preparation in a rechallenge. Delayed reactions are rare, with only 11 cases reported [8]. Tolerance to an alternative iron formulation was achieved by rechallenge in 2 of the 11 patients. These cases were descriptive, with no allergy work-up. In the present case, the patient experienced a delayed reaction to iron carboxymaltose. Skin tests were negative in the late reading, and diagnosis was confirmed by means of a DPT. The patient presented another delayed reaction during rechallenge with iron sucrose. In cases of confirmed HSR where the patient must take a specific treatment, desensitization is an effective and safe alternative. In the present case, the patient tolerated desensitization to iron sucrose with no breakthrough or late reactions. LTT is currently the most frequently used test for the diagnosis of T cell–mediated hypersensitivity, especially in delayed hypersensitivity reactions to β-lactams and anticonvulsants [4]. To our knowledge, LTT has not been used in the diagnosis of HSR to iron salts. Here, we demonstrate that LTT could prove useful for elucidating the mechanism underlying delayed HSR to iron salts. Nevertheless, further research is needed to evaluate the role of LTT in the diagnosis of this reaction.

To our knowledge, this is the first case of type IV HSR to iron carboxymaltose and iron sucrose to be confirmed with positive DPT and LTT and successfully managed with desensitization. This case shows the LTT to be a promising new tool for the diagnosis of T cell–mediated HSR to iron preparations.

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Conflicts of Interest
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References
An Atypical Case of Idiopathic Nonhistaminergic Angioedema With Anti-C1-INH Antibodies

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Recurrent angioedema without wheals can be hereditary or acquired. While the most common form of hereditary angioedema (HAE) is caused by deficiency of C1 esterase inhibitor (C1-INH-HAE), HAE can also occur with normal plasma levels of C1-INH owing to mutations in gene coding for coagulation factor XII, angiopoietin 1, plasminogen, kininogen 1, myoferlin, and heparan sulfate-glucosamine 3-O-sulfotransferase 6. HAE with an unidentified genetic cause is defined as HAE of unknown origin [1].

Acquired angioedema (AAE) includes idiopathic histaminergic AAE (IH-AAE), idiopathic nonhistaminergic AAE (InH-AAE), AAE related to angiotensin-converting enzyme inhibitors (ACEI-AAE), and AAE with C1-inhibitor deficiency (C1-INH-AAE) [2].

C1-INH-AAE is a rare disease characterized by cutaneous swellings, edema of the gastrointestinal mucosa, and life-threatening laryngeal edema [3]. Symptoms first appear after the fourth decade of life in 90% of patients, and a family history of angioedema is absent.

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