Acute Kidney Injury in a Patient on High-dose Glucocorticoid Therapy

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Case Description
A 23-year-old woman with history of SLE (arthralgias, oral ulcers, + anti-nuclear antibodies, + anti-Sm antibody, + dsDNA antibody, and hypocomplementemia) on methotrexate presented with 4 days of nausea, vomiting, and abdominal pain. She was found to have acute necrotizing pancreatitis. An autoimmune etiology was favored, so she was pulsed with 1 g of solumedrol daily for 4 days, followed by prednisone 125 mg twice a day. Hospital course was complicated by disseminated intravascular coagulation requiring multiple transfusions, shock requiring vasopressor support, thrombocytopenia, AKI requiring continuous renal replacement therapy, and acute hypercapnic/hypoxemic respiratory failure requiring intubation and mechanical ventilation, followed by extracorporeal membrane oxygenation cannulation 6 days later. The patient later developed massive pancreatic hemorrhage complicated by abdominal compartment syndrome and died on the 63rd hospital day. An autopsy was undertaken per request of the next of kin.

Post-mortem examination confirmed severe necrotizing and hemorrhagic pancreatitis. Interestingly, several viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of plasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of plasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus. Sections of viable pancreatic islet and acinar cells contained glassy basophilic intranuclear and smaller intracytoplasmic inclusions which showed strong immunohistochemical positivity for cytomegalovirus.

In these areas, Grocott’s methenamine silver stain again showed numerous fungal elements, morphologically consistent with *Aspergillus* (Figure 1C). The uninvolved cortex showed mild acute tubular injury and unremarkable glomeruli. Sections of the liver and spleen showed increased macrophages with abundant foamy cytoplasm containing erythrocytes and leukocytes, suggestive of hemophagocytosis; however, the patient’s pre-mortem H-score was 1%(1).

Causes of cortical infarction of the kidney include thromboembolic phenomena and structural, vasoactive, and inflammatory vascular diseases. However, the cortical infarcts in this case were rimmed by granulomatous inflammation. Etiologic considerations for granulomatous inflammation of the kidneys include allergic/drug-induced interstitial nephritis (particularly secondary to anticonvulsants), sarcoidosis, and infection (2). Granulomas may also be seen accompanying necrotizing and crescentic glomerulonephritis and/or necrotizing arteritis in the setting of ANCA-mediated glomerulonephritis, particularly in the setting of granulomatosis with polyangiitis. The granulomas in drug-induced acute interstitial nephritis and sarcoidosis are typically noncaseating/non-necrotizing, whereas the presence of necrosis should prompt evaluation for infectious etiologies, particularly fungi and acid-fast bacilli.

*Aspergillus* species are ubiquitous molds that can cause atopic disease (allergic bronchopulmonary aspergillosis) in immunocompetent hosts. Invasive aspergillosis is an opportunistic infection that causes necrotizing pneumonia. Angioinvasion results in hematogenous spread to other organs, including the skin, brain, liver, and kidneys. Risk factors for invasive disease include severe or prolonged neutropenia, high-dose glucocorticoid therapy, and solid organ transplantation (3). Mortality rates as high as 88% have been reported (4).

Teaching Points
- Causes of cortical infarction include thromboembolic phenomena and structural, vasoactive, and inflammatory vascular diseases.
When necrosis/infarction is associated with granulomatous inflammation, infectious etiologies (particularly fungi and acid-fast bacilli) should be carefully excluded.

High-dose glucocorticoid therapy is a risk factor for invasive aspergillosis, a potentially multisystem disease that can involve the kidney.

Disclosures
D. Santoriello reports honoraria from American Society of Nephrology. The remaining author has nothing to disclose.

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Author Contributions
L. DiFranza was responsible for data curation, investigation, and wrote the original draft; and D. Santoriello conceptualized the study, was responsible for methodology, and reviewed and edited the manuscript.

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**Figure 1. | Kidney post-mortem findings.** (A) Sections of wedge-shaped, pale areas of renal cortex showed coagulative necrosis of all three renal compartments (glomerular, tubulointerstitial, and vascular), consistent with cortical infarction. The perimeter of the infarcted areas (arrows) was basophilic at low power (hematoxylin and eosin, original magnification, ×2). (B) High-power examination of the perimeter of the infarcted cortex showed inflammation by small lymphocytes, epithelioid histiocytes, and numerous multinucleated giant cells (arrows), consistent with granulomatous inflammation (hematoxylin and eosin, original magnification, ×200). (C) Narrow, septated hyphae with dichotomous acute angle (45°), morphologically consistent with *Aspergillus*, were identified in the areas of renal cortical infarction as well as in some blood vessel walls (not shown) (Grocott’s methenamine silver stain, original magnification, ×400).