Radiopacity of sodium zirconium cyclosilicate on CT imaging

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Abstract

A patient who post-operatively develops hyperkalemia is treated with sodium zirconium cyclosilicate (Lokelma[®]), a novel agent used for the treatment of non-life-threatening hyperkalemia with reduced side effects as compared with its predecessors. On CT imaging of the chest, abdomen, and pelvis, a radiopaque fluid is noticed despite the patient not having received any oral or intravenous contrast nor any medications or supplements that may appear radiopaque. Based on previous CT imaging of zirconium-based tooth implants and their radiopaque appearance on images, it is hypothesized that the sodium zirconium cyclosilicate that the patient was administered is the explanation of the radiopacity on CT imaging. We performed an in-vitro experiment to confirm that Lokelma is radiopaque to support our hypothesis. It is important to fully understand the differential of what may cause different appearances on imaging as well as to eliminate potential sources of artifact prior to imaging, or alternatively, to potentially be able to use medications with known radiopaque properties as alternatives to contrast agents.

Keywords Sodium zirconium cyclosilicate · Lokelma · Radiopacity · Radiopaque · Imaging

Case report

A 69-year-old male with a past medical history of hypertension, GERD, and multiple hip replacements and revisions presented for an elective hip revision. Prior to the surgery, the patient's home medications included folic acid 1 mg daily, ranitidine 300 mg nightly, sennosides/docusate sodium 2 tablets twice daily, pantoprazole sodium 40 mg daily, metoprolol succinate 12.5 mg daily, aspirin 81 mg daily, melatonin 5 mg nightly as needed, and magnesium hydroxide/aluminum hydroxide/simethicone 30 mL as needed. The patient's last dose of his medications was at 9 PM the day before his surgery and had not taken any of his as needed medications including the magnesium hydroxide/aluminum hydroxide/simethicone in at least 48 h. The patient experienced an estimated blood loss of 1500 mL during surgery, and was admitted for monitoring post-operatively. Intraoperatively, he was resuscitated with 2 units of packed red blood cells and lactated ringer's solution. Post-operatively, the patient had a hemoglobin level of 7.8 mg/dL and was subsequently transfused 2 more units of packed red blood cells.

On subsequent lab analysis, the patient was found to have a number of laboratory derangements, including a potassium level of 7 mmol/L and creatinine of 3.1 mg/dL, which was confirmed with repeat bloodwork.

As part of hyperkalemia management, the patient was administered intravenous calcium gluconate, albuterol/ipratropium nebulizer, intravenous insulin with dextrose, and 5 g of sodium zirconium cyclosilicate (Lokelma[®]) orally.

The patient's anemia briefly improved to a hemoglobin of 11 before once again decreasing to 8.0 without an obvious source of bleeding. At this time, the patient was taken for a CT scan of the chest, abdomen, pelvis, and lower extremities, without oral or intravenous contrast, to assess for any occult bleeding. The CT scan showed post-operative changes of the left hip with air and fluid at the surgical site suggestive of possible hematoma or abscess formation. Of note, the CT scan also showed a distended stomach with a radiopaque fluid level (Figs. 1 and 2). The radiopaque fluid measured approximately 1100 Hounsfield units. Two days later, the patient underwent a CT of the pelvis, which showed a hyperattenuating collection in the ascending and descending colon, measuring approximately 900 Hounsfield units (Fig. 3). The patient had not been administered any oral or intravenous contrast for either CT scan nor had he consumed radiopaque supplements such as calcium, iron, or his home as needed medication magnesium hydroxide/

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Fig. 1 Hyperdense fluid in the stomach on CT imaging without oral or IV contrast

Fig. 3 Hyperdense fluid in the right colon on CT imaging without oral or IV contrast

Fig. 2 Scout image from abdomen and pelvis CT

aluminum hydroxide/simethicone. The only medication other than Lokelma[®] that the patient was administered by mouth was docusate sodium, which has been reported as not radiopaque on X-ray imaging [1]. We hypothesize that the radiopaque fluid level in the stomach represented layering of Lokelma[®] in the dependent portion of the stomach, and that the hyperattenuating collections in the colon 2 days later represented its transit through the GI tract.

Discussion

Lokelma[®] was FDA approved in May 2018 for treatment of non-life-threatening hyperkalemia and having preferable use as it has no reported adverse effects of intestinal necrosis [2]. The drug information pamphlet for Lokelma[®] in Europe and Japan notes “Sodium zirconium cyclosilicate may be opaque to X-rays. If the patient is having abdominal X-rays, radiographers should keep this in mind” [3]. In addition, one study mentions that Lokelma[®] may alter dual-energy X-ray absorptiometry (DXA) by altering measurements of bone mineral density and body composition phantom measurements which were both statistically significant [4]. There are no available (DXA) or abdominal X-ray images for the patient in this presentation. No previous studies have identified sodium zirconium cyclosilicate (Lokelma[®]) as radiopaque material on CT imaging. The use of this medication in this patient and subsequent imaging suggests that the powder suspension, much like zirconium-based tooth implants, appears radiopaque on imaging, as no other likely source of radiopaque material in the stomach could be identified, this may be mistaken for oral contrast or other radiopaque medications if not reported prior to imaging. Previous

Fig. 4 Sodium zirconium cyclosilicate mixed with 3 tablespoons of water in a plastic bag

studies of dental implants had noted that zirconium-based implants produced pronounced artifact when imaged with a CT scanner [5, 6]. Furthermore, the patient had not received any substances by mouth which are known to appear radiopaque on imaging including his home as needed medication, magnesium hydroxide/aluminum hydroxide/simethicone in at least 48 h prior to the CT imaging which further solidifies that the radiopaque substance is likely the administered sodium zirconium cyclosilicate [7, 8].

To support this hypothesis, the writers of this paper put 5 g of Lokelma mixed with 3 tablespoons of water in a plastic bag and scanned it with the same CT scanner that was used to scan the patient (Fig 4). It was found that the Hounsfield units in vitro ranged from 1040 to 1878 of which the lower end was similar to the Hounsfield units in the radiopaque substance found in the patient (Figs 5, 6, 7). In addition, the slightly lower Hounsfield units of the substance in the patient are thought to be secondary to dilution from water consumed by the patient as well as resorption at various stages during the substance's travel through the gastrointestinal system. The higher Hounsfield units in vitro are also thought to be due to layering of the sodium zirconium cyclosilicate in the plastic bag as well as there being no

Fig. 5 Sodium zirconium cyclosilicate CT scan with Hounsfield units

Fig. 6 Sodium zirconium cyclosilicate CT scan with Hounsfield units

Fig. 7 Sodium zirconium cyclosilicate CT scan with Hounsfield units

contribution of other tissues to the averaging of the Hounsfield units.

Multiple medications, supplements, and contrast materials may appear radiopaque on imaging so it is necessary to be able to elucidate the differential of what may have caused the appearance on imaging as well as to prevent administration when those materials may have caused unnecessary artifact preventing proper analysis of imaging. Conversely, it may be possible to use Lokelma® as an alternative to oral contrast when both a treatment to non-life threatening hypokalemia and CT imaging with oral contrast are indicated; however, further studies into the feasibility and utility of this practice are necessary.

Declarations

Informed consent Informed consent was obtained from all individual participants included in the study.

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