

**A CASE REPORT**

# Sodium Polystyrene Sulfonate (SPS): Sorbitol-induced Colonic Necrosis

by Mohamad Erfani, Yougandhar Akula, Touraj Zolfaghari, Hilary I. Hertan

**Sodium polystyrene sulfonate (SPS) is a cation exchange resin which primarily acts in the colon. It is usually administered with an osmotic laxative (e.g. sorbitol), orally or as a retention enema, to treat hyperkalemia. SPS-sorbitol use has been implicated in damage to different parts of the gastrointestinal (GI) tract. Adverse GI reactions include anorexia, nausea, vomiting, constipation, fecal impaction, intestinal obstruction and intestinal necrosis (rare). We present an uncommon case of ulceration with necrosis of the ascending colon following multiple oral SPS-sorbitol administrations.**

## CASE REPORT

**A** 70-year-old woman was admitted for evaluation of suprapubic abdominal pain and dysuria for 4 weeks. There was no associated nausea, vomiting, abdominal distension, diarrhea, constipation, melena or hematochezia with her presentation. Her medical history was significant for hypertension, chronic renal insufficiency, diabetes, congestive heart failure and bipolar disorder. On admission, her vital signs were stable and her abdominal examination was benign. Initial laboratory results suggested pre-renal azotemia, urinary tract infection, hyperkalemia (potassium = 6.4 mEq/L) and microcytic anemia. During the course of admission, she received five oral doses of

SPS-sorbitol as a part of treatment for hyperkalemia. She subsequently developed a new onset lower abdominal pain one day after the last dose. CT scan of the abdomen and pelvis showed no acute pathology.

Upper endoscopy and colonoscopy were performed; a 5 cm erythematous, raised, solitary ulcer was seen in the ascending colon (Figure 1). Biopsy showed acute colitis, ulceration, necrosis, and dark purple SPS crystals within the inflammatory exudates in the submucosa (Figure 2). The clinical, colonoscopic and pathologic findings were consistent with sorbitol induced colitis.

## DISCUSSION

SPS was first produced in 1935 as a sodium potassium exchange resin. It is a benzene, diethenyl-polymer, with ethenylbenzene, sulfonated, and sodium salt (Figure 3). Since SPS approval in the United States in 1958, very few cases of SPS-sorbitol damage to the GI tract have been published [11]. The first case of colonic necrosis, after administration of an SPS-sorbitol enema, was reported in a uremic patient in 1987 [1]. To date, 25 cases of intestinal necrosis due to SPS-

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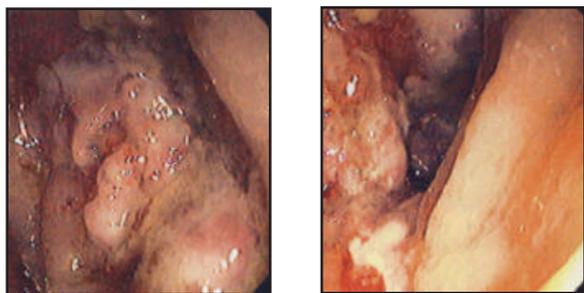
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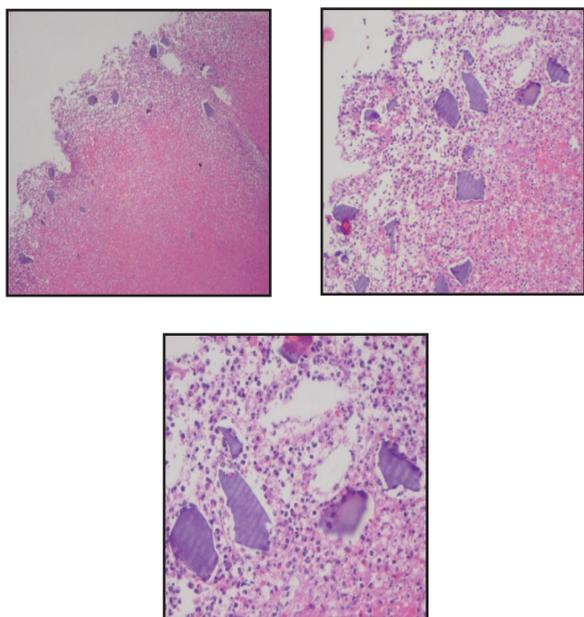
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**Figure 1.** Focal area of severe colitis and ulceration due to SPS-sorbitol.

sorbitol has been reported [3]. The actual incidence of GI complications following SPS-sorbitol use is unknown; however it is higher in patients with uremia and in post transplant patients. Studies by Rogers et al. and Gerstmann et al. showed the incidence of intestinal necrosis were 0.27% and 1.8% in uremic and post-operative patients, respectively [6,17]. Wootton et al. reported colonic complications in 6% of renal transplant patients following SPS-sorbitol enemas [16].

SPS has an *in vitro* exchange capacity of approximately 3.1 mEq (*in vivo* approximately 1 mEq) of potassium per gram. The sodium content is approximately 100 mg (4.1 mEq) per gram of the SPS. It is



**Figure 2.** Dark purple crystal of sodium polystyrene sulfonate (SPS).

synthesized in sodium phase, but it has a higher affinity for potassium and can be used either orally or rectally to treat hyperkalemia. When used orally sodium ions in the SPS-sorbitol are exchanged for hydrogen ions in stomach, and, later when it passes through the intestine, the hydrogen ions are replaced by potassium. The majority of this exchange takes place in the large intestine thus serum potassium is expected to be lowered within hours to days [2,3,11].

SPS was initially administered as a suspension in water which could cause concretion of the crystalline resin, as SPS passes through the intestine slowly, and binds to calcium. This may cause severe constipation, fecal impaction, bezoars, intestinal obstruction and perforation [2,4,13]. To overcome these complications, SPS is now mixed with hypertonic sorbitol which acts as a cathartic agent to induce osmotic diarrhea.

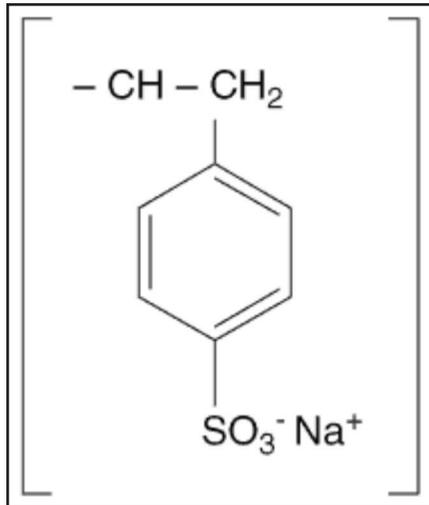
The exact mechanism by which SPS-sorbitol induces intestinal necrosis is unknown. Hypovolemia, hyperreninemia, elevated prostaglandin production, and localized colonic mesenteric vasospasm have all been suggested as possible mechanisms of necrosis. A study in a rat model has shown that sorbitol is, in fact, the cause of the intestinal necrosis [1].

Although upper GI tract complications have been described, the majority of the SPS-sorbitol related GI side effects were reported to involve the colon [1,3,8,13,17]. These complications include gastric or duodenal ulcers, GI bleeding, perforated colonic ulcers, ischemic colitis, and cytomegalovirus infection [7]. Rashid et al. recorded mucosal damage in the esophagus, stomach and duodenum in 3 of the 15 patients they studied. Simultaneous occurrence of antral ulcers and ileocecal perforation has been described in a patient who received SPS-sorbitol in both oral and rectal routes [18]. The overall clinical outcome of the lower GI tract injuries is worse than those of the upper GI tract. Lower GI tract lesions have a tendency to develop transmural necrosis, requiring surgical intervention [2].

### PATHOGENESIS

The evidence supporting the theory that sorbitol is the cause of GI complications comes from Lillemoie et al. experiments on Sprague-Dawley rats [1]. Enemas con-





**Figure 3.** Sodium polystyrene sulfonate structural formula.

taining saline alone, SPS alone, sorbitol alone and SPS-sorbitol solutions were administered to uremic and non uremic rats. The rats which received sorbitol or SPS-sorbitol enemas showed colonic necrosis while the rats on non-sorbitol enema regimens did not have any colonic damage. This effect was even more profound in uremic rats. After receiving sorbitol containing enemas, all the uremic rats died compared to no death in non-uremic rats.

The precise mechanism by which sorbitol causes colonic damage is unknown. The suggested risk factors include uremia, immunosuppression, hypovolemia, postoperative setting, hypotension after hemodialysis, and peripheral vascular disease [7].

Sorbitol can result in colonic damage due to (1) mesenteric ischemia secondary to elevated rennin levels (as seen in renal insufficiency) (2) vascular shunting and colonic ischemia secondary to osmotic load of sorbitol [1,13] and finally (3) direct toxic damage of concentrated sorbitol enema to the colonic mucosa. Decreased colonic motility, due to postoperative ileus or administration of opiates increases the duration of drug contact with the intestinal mucosa and the susceptibility to intestinal necrosis.

Histological examinations of the affected segments of the GI tract demonstrate dark purple crystals of SPS. They are useful histologic clue to the possibility of SPS-sorbitol administration and do not con-

tribute to the damage to the GI tract [11]. Microscopically, the crystals of SPS appear similar to cholestyramine therefore medication history should be sought [7,13]. On acid fast staining SPS crystals are more maroon while cholestyramine crystals are pinker. The spectrum of pathological findings induced by sorbitol includes ulcers, pseudomembranes, transmural necrosis, and characteristic findings of ischemic bowel, in the absence of large vessel disease [1,2,7,13,17]. These changes are not unique to sorbitol. In patients with pseudomembranes, *C. difficile* infection needs to be considered in the differential diagnosis [2,13].

### CLINICAL FEATURES

The most common presentation of patients with SPS-sorbitol induced GI tract injury is abdominal pain followed by distention and GI bleeding. Symptoms usually begin 3 to 11 hours after SPS-sorbitol administration although it could occur several days after ingestion [3,9].

Each gram of SPS-sorbitol resin takes up approximately 0.65 mmol of potassium *in vitro* but this amount is highly variable *in vivo* [21,22,24]. 30 gm of SPS can potentially eliminate up to 120 meq of potassium, but this degree of exchange does not occur at the sodium and potassium concentrations found in the GI tract. In addition, a small portion of SPS resin binds to intraluminal calcium and magnesium. Other factors that determine the amount of potassium elimination include serum glucose, patient's diet, and use of other potassium lowering agents.

### CONCLUSION

Intestinal necrosis following SPS-sorbitol administration is a rare clinical condition that may have a significant morbidity and mortality. SPS-sorbitol should be used with caution, especially in the postoperative setting, in uremic or ill patients. Any new onset abdominal pain, change in character of abdominal pain or GI bleeding after SPS-sorbitol administration needs to be thoroughly evaluated. When clinically indicated other measures to treat hyperkalemia should be considered instead of SPS-sorbitol. Physicians need to be aware of SPS-sorbitol GI side effects while managing hyperkalemia. ■





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