

Adverse Effects of Superactivated Charcoal Administered to Healthy Volunteers

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Abstract

Objectives: Activated charcoal is frequently administered to drug overdose patients, who may experience nausea and vomiting secondary to the drug overdose. Drinking a charcoal slurry orally may be difficult for them necessitating a gastric tube. The purpose of this study is to report the frequency of adverse effects from oral superactivated charcoal (SAC) given to healthy volunteers.

Methods: Healthy adult study subject volunteers were given a single 2000 mg (first 13 subjects) or 3000 mg (remaining 35 subjects) dose of acetaminophen. Subjects were randomized to receive no charcoal (ctrl) or 75 grams of SAC administered orally in a slurry 3 hours following the acetaminophen dose. The adverse effects of both groups were recorded and compared.

Results: There were 48 study subject runs. The mean age was 27.4 years (SD 6.5). SAC was administered to 24 subjects. Adverse effect rates were as follows (*one-tail $p < 0.05$): black stool* (SAC 22/24, ctrl 0), constipation or abdominal fullness* (SAC 12/24, ctrl 0), nausea* (SAC 5/24, ctrl 0), vomiting (SAC 2/24, ctrl 0), diarrhea (SAC 2/24, ctrl 0), anal irritation (SAC 2/24, ctrl 0), drowsiness/fatigue (SAC 2/24, ctrl 3/24), dizziness/lightheadedness (SAC 0, ctrl 1/24), headache (SAC 4/24, ctrl 0). 7 of 24 SAC subjects and 20 of 24 ctrl subjects experienced no adverse effects at all* (other than black stools for the SAC subjects). Acetaminophen may have been blunted some adverse effects. Two SAC subjects could not finish the charcoal. For the 22 subjects who finished the charcoal, SAC consumption took a mean of 10.9 minutes (SD 11.8, range 1 to 50 minutes). Thirteen subjects finished it in 7 minutes or less. Six subjects took 19 minutes or longer to finish it. The 12 heavier subjects (>71kg) completed SAC consumption significantly faster than the 12 lighter subjects (18.7 vs 7.8 minutes, $p = 0.04$, single sided). This comparison included the two subjects (both lighter) who did not finish SAC consumption, so this difference was no longer significant when these two subjects were removed.

Conclusions: Superactivated charcoal consumption is associated with significant adverse effects in some healthy volunteers, which may impede a drug overdose patient's ability to willingly drink charcoal slurry in a reasonable period of time.

Introduction

Activated charcoal is generally considered to be a safe and effective agent that is widely used in the treatment of toxic ingestions.¹⁻⁴ There are relatively few reports in the literature documenting complications associated with activated charcoal use. The majority of reported adverse effects secondary to activated charcoal use have been limited to aspiration of charcoal^{1,2,5-11}, emesis^{4,12-15}, gastrointestinal obstruction^{1,16-18}, and fluid and electrolyte imbalances^{1,19-22}. One of the most frequent adverse reactions, black discoloration of stools, is considered harmless²³.

Emesis rates following toxic ingestion and activated charcoal treatment have ranged from 7% to 30%.^{12-15,22} There has been minimal research to date indicating whether emesis following activated charcoal is an effect of the charcoal itself, or due to the emetic effects of the toxic overdose.

Activated charcoal is known to have a constipating effect²⁴ which rarely progresses to gastrointestinal obstruction. The cases of obstruction previously reported have predominantly been associated with multiple-dose activated charcoal with concurrent impaired peristalsis from toxic ingested agents, or therapeutic agents administered which are known to impair gastrointestinal mobility.^{1,2,16,17}

Since much of our knowledge of the adverse effects of activated charcoal has been obtained in the course of clinical treatment of toxic overdose patients, many of the reported adverse effects of charcoal may be attributed to the effects of the toxic overdose drug or concurrently administered therapeutic drugs. The frequency of adverse effects that may be attributed to activated charcoal alone is not known. The purpose of this study is to report the frequency of adverse effects from the administration of oral superactivated charcoal (SAC) given to healthy volunteers.

Methods

This study represents a sub-group analysis of a protocol to examine the effects of superactivated charcoal administration on acetaminophen serum levels. Forty-eight healthy adult volunteers were randomized to control or charcoal (SAC) groups. The study protocol is described elsewhere in which study subjects received 2000 mg or 3000 mg of acetaminophen²⁵.

Three hours after acetaminophen ingestion, participants randomized to the charcoal group ingested 75 g of superactivated charcoal as an aqueous slurry in 240 mL of apple juice. Study participants were given one hour to drink the charcoal slurry by any means, with any amount of water or apple juice. The time necessary to ingest the

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SAC was recorded, and failure to complete the ingestion was recorded as an adverse effect. The weight, age, and gender of each participant were recorded.

Participants were followed for one week, and asked to report any effects that could possibly be attributed to participation in the study.

Results

Participants ranged in age from 18 to 58 years and in weight from 43.2–111.4 Kg. There were 24 participants in each group, and while age was similar for both groups (SAC = 27.3 (SD=7.7) years; control = 27.4 (SD=5.2)), there was a significant difference in weight (SAC = 75.7 Kg (SD=16.2); control = 61.6 (SD=12.2); $p=0.0014$).

Reported effects by group are shown in Table 1 (single sided probabilities are used). Black stools were present in 22 of 24 SAC subjects and none of the controls. Constipation/Abdominal Fullness was significantly greater in the SAC group ($p<0.001$). Nausea was significantly greater in the SAC group ($p=0.03$). Seven participants in the SAC group, and 20 in the control group reported no adverse effects (other than black stools) ($p<0.001$). Effects were not associated with age, sex, or weight in simple or multiple logistic regression models.

Reported Effect	SAC (%)	Control (%)
Constipation/Abdominal Fullness	12(46)	0
Nausea	5 (17)	0
Headache	4 (13)	0
Vomiting	2 (8)	0
Diarrhea	2 (8)	0
Anal Irritation	2 (8)	0
Unable to Complete	2 (8)	0
Drowsiness/Fatigue	2 (8)	3 (13)
Dizziness/Lightheadedness	0	1 (4)
No Adverse Effects	7(30)	20 (83)

Two subjects did not complete charcoal ingestion within one hour; one was able to ingest approximately one-fifth of the slurry, and one vomited while trying to ingest the SAC slurry. Of the 22 participants who completed SAC consumption, ingestion times averaged 10.9 minutes (SD = 11.8 minutes) and ranged from 1 minute to 50 minutes. Consumption time was not associated with age, sex, or gender in simple or multiple linear regression models. Thirteen subjects finished it in 7 minutes or less. Six subjects took 19 minutes or longer to finish it. The 12 heavier subjects (>71kg) completed SAC consumption significantly faster than the 12 lighter subjects (18.7 vs 7.8 minutes, $p=0.04$, single sided). This comparison included the two subjects (both lighter) who did not finish SAC consumption (consumption time of 60 minutes assigned to them), so this difference was no longer significant when these two subjects were removed.

Discussion

Activated charcoal is the therapy of choice for gastrointestinal decontamination for toxic ingestions²⁶. Although serious adverse effects such as bowel obstruction, electrolyte imbalances, and aspiration have been noted in the literature, these cases are rare^{12,19}. Additional research is needed to define the prevalence of risk factors

of the adverse effects of activated charcoal¹⁶.

Our study found a significantly greater number of adverse effects were noted in the charcoal group as compared with the control group. The adverse effects in our study were mild when compared with adverse effects previously reported in the literature. We had no incidents of pulmonary aspiration, gastrointestinal obstruction, or electrolyte imbalances requiring hospitalization.

One of the most common adverse effects of activated charcoal administration in overdose patients is emesis. However, the exact frequency of emesis of activated charcoal in overdose patients is very variable. Furthermore, some researchers believe that emesis in healthy volunteers is extremely uncommon¹⁶. Thus, one might infer that emesis is less attributable to the administration of the activated charcoal than it is attributable to adverse effects of the overdose drug which the activated charcoal is trying to remove. Our study showed that emesis rates in the healthy volunteers following charcoal ingestions were found to be 8% (2/24), compared with previous reports of 7% - 30% in intoxicated patients.

Overdose patients frequently experience nausea and vomiting secondary to drug overdose. Activated charcoal may be given orally if the patient is awake and cooperative or by nasogastric tube if the patient is uncooperative or unconscious. Because gastric decontamination loses its efficacy over time²⁷, if a patient has difficulty ingesting activated charcoal, nasogastric administration is usually considered. Thus, the time taken to ingest SAC may be significant in the outcome of an overdose patient. In our study, the ingestion time was affected by poor palatability, nausea, and emesis in the absence of a toxic ingestion. The presence or absence of adverse effects was not correlated with participants' weight, age, gender, or time of charcoal ingestion. However, heavier subjects were able to ingest the charcoal faster than the lighter subjects.

The main adverse effects reported by the charcoal group can be directly attributed to the charcoal ingestion. However, we did note some adverse effects that were likely not attributable to the charcoal ingestion. Several participants reported headaches, which have not previously been reported as adverse effects of charcoal ingestions. It is uncertain whether the adverse effects of drowsiness/fatigue and dizziness/lightheadedness were associated with either the charcoal or acetaminophen.

Ideally, a study investigating the adverse effects of activated charcoal should compare a charcoal group to a control group. However, since this study was originally designed to study the decontamination efficacy of charcoal, study subjects were also given acetaminophen which may adversely affect the validity of the study results. Acetaminophen, even in the 2 and 3 gram supranormal doses, is probably benign, but it must be acknowledged that acetaminophen may have added to the adverse effects or it may have suppressed some of the adverse effects because of its analgesic properties. However, the comparison of the two groups remains relatively valid since acetaminophen was given to study subjects in both groups.

Our sample size is small and may not be representative of the population. However, these results were significant and are likely to be seen in a larger sample size. Our study design did not allow for blinding of participants. Also, informed consent procedures may have introduced bias, as participants were aware of some possible adverse effects prior to the study.

In conclusion, superactivated charcoal consumption is associated with adverse effects in some healthy volunteers, which may impede a drug overdose patient's ability to willingly drink charcoal slurry in a reasonable period of time.

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