

Effect of Adding Charcoal Capsule to Abdominal Ultrasound Preparation on Image Quality

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Abstract: Abdominal Ultra-sonography is playing a major role to diagnose patients referred from outpatient clinics, inpatient, and Emergency department. In recent decades, ultrasound modality became a corner stone in diagnosis of many acute or chronic abdominal diseases such as infections, inflammations, stones, and obstructions. The use of ultra-sonography as first choice by doctors all over the world became standard procedure. In routine abdominal ultrasound patient preparation such as fasting for 8 hours and having light meal the night before the exam is a common practice to avoid digestive motility and gases which are considered as the main causes of artifacts and image quality degradation.

Importance of this study: As patient preparation before abdominal ultrasound exam plays a major role to ensure better visualization of internal organs and pathologies by minimizing artifacts caused by abdominal gases that makes scanning process much easier to accomplish, but nevertheless abdominal gases in many patients still exist in large amount causing artifacts; for this reason it is important to search for new, safe, efficient, reliable and cost effective method to improve patient preparation by eliminating excessive abdominal gases.

Material & Method: Prospective Study on randomly selected sample size of 52 adult patients from different age groups and mixed gender based on inclusion criteria where no history of previous or current abdominal surgery. Pediatric, pregnant, abdominal surgery, bedridden, and patients with bowel obstruction were also excluded from this study. For accepted patients the routine upper abdominal ultrasound with usual preparation fasting instruction for 8 hours was followed, then same group of patients have been asked to come again after 48 hours for rescanning and instructed to follow the same standard routine preparation for abdominal ultrasound but, in addition they were asked to take one capsule of charcoal 8 hours before rescanning. Then we compared ultrasound image quality in abdominal region for the same patient before and after the modified preparation by focusing on pancreas images as a reference, the pancreas was divided into head, neck, body and tail.

Result: The total improvement in pancreas head region was 50%, In the pancreas neck the improvement in visualization was 32.5%, pancreas body visualization 57.45% and 32.5% in the pancreas tail region. A significant improvement was noticed in overweight, obese & extremely obese patients group by 57.2% while in underweight & normal weight group it was found that the improvement was 39.05%. The improvement among males 66.9% while 49.9% among female. The overall improvement in pancreas visualization was 63% among our study sample.

Conclusion: The result of our study suggest that the active charcoal can be used to reduce gastrointestinal gases is efficient, low cost, safe and ease of use to improve the visualization of routine adult abdominal ultrasound.

Key words: pancreas head, neck, body, male, female, active charcoal, improve.

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I. Introduction

Abdominal ultra-sonography is playing a major role to diagnose patients referred from outpatient clinics, inpatient, and Emergency department. In recent decades, ultrasound modality became a corner stone in diagnosis of many acute and chronic abdominal diseases such as infections, inflammations, stones, masses, fluid collection and obstructions. The use of ultra-sonography as first choice by doctors all over the world became standard procedure since it is available, safe and non invasive. In routine abdominal ultrasound patient preparation such as fasting for 8 hours and having light meal the night before the exam is a common practice to

avoid digestive motility and gases that may cause artifacts and degrade image quality. As patient preparation before abdominal ultrasound exam plays a major role to ensure better visualization of internal organs and pathologies by minimizing artifacts caused by abdominal gases that makes scanning process much easier to accomplish, but nevertheless abdominal gases in many patients still exist in large amount especially in pancreatic region causing artifacts for this reason it is important to evaluate a new, safe, efficient, reliable and cost effective method to improve patient preparation to eliminate excessive abdominal gases.

II. Literature Review

Ultrasound is a form of mechanical energy used in medical imaging. The ultrasound waves are produced by the transducer and can travel within the body and reflected back from different structures with different attenuation value then the image displayed on the monitor after processing and reconstruction process by the computer. Ultrasound exam is cheap and safe comparing to other modalities. It plays significant role to rule out many pathologies. All sonographers are suffering from challenging image artifacts caused by gases present in gastrointestinal tract. Usually these artifacts seen as a dirty shadowing and reverberation artifacts distal to gases which obscure underlying structure and degrade the image quality [1]. Factors cause excessive intestinal gas include Intestinal obstruction, motility disorder, infectious, irritable bowel syndrome, mal-absorption, psychological, dietary. Different drugs and agents are in the management of gas reduction such as beano, simethicone, and activated charcoal. Some studies supporting the use of charcoal in the treatment of intestinal gas and others do not [2]. "Activated charcoal is a highly adsorbent powder made from superheated, high surface area, porous particles produced by pyrolysis of organic material. Its extensive surface area is covered with a carbon-based network that also includes functional groups (eg, carbonyl, hydroxyl) that adsorb chemicals within minutes of contact, preventing gastrointestinal absorption and subsequent toxicity" [3]. Many diseases have been treated by Charcoal such as epilepsy, vertigo, and anthrax. Activated charcoal recently is used as an antidote for different poisons and anti-gas agent. A large doses of given Activated charcoal over long time has been demonstrated to be very safe and has no side effects [4]. The higher value of BMI, abdominal wall thickness and waist circumference are the main factors that can predict the presence of excessive intestinal gas which make poor visualization of the upper abdominal structures and demonstrating pathologies very difficult by ultrasound [5]. Ultrasound examination of the abdominal area requires a gall bladder to be full and as little gas in the gastrointestinal tract as possible. The Intestinal contents (gas and food particles) have a direct impact on diagnostic value of abdominal ultrasound since it can induce confusing shadows and inconclusive images. For all patients undergoing ultrasound examination, patients always instructed to be fasting for several hours prior to exam but mostly instructed to fast 8 hours for abdominal ultrasound examination, sometimes it might be required to fast as long as 12 hours to get full extended gall bladder otherwise it will be contracted and difficult to assess. In addition the fasting patients will have less gas in the duodenum & colon. Preparing the patient for two-day low calorie diet, laxatives and fasting have reported favorable results[6]. Oral simethicone is used as a premedication reduce the amount of gas in gastrointestinal tract. The result of comparing two groups protocols of using of simethicone as pre-medication for ultrasound examination where the patient will be given single dose for three days duration or one single dose of simethicon administered 1 hr before the ultrasound examination. It was found that the single dose result is the best in term of cost and benefit ration [5]. It was reported the significant improvement in the vitalization of the pancreas and other retroperitoneal structures after the use of Simethicone Coated Cellulose as an oral contrast agent. This combined agent used to decrease gas artifacts from the bowel. Also it can be as an effective oral contrast for non fasting patient and emergency cases [7]. In Italy active charcoal is widely used to reduce intestinal gas and to prepare patients for abdominal US exams. The result of using active charcoal and Alpha-galactosidase shows a significant improvement in abdominal ultrasound in the study, but need more justification regarding the time and cost of the preparation [8].

Our research was conducted to approve or disapprove the efficiency of using activate charcoal to improve the visualization of upper abdominal organs and better image quality in Ultrasound of the abdomen.

III. Methodology

A prospective research with population sample size of 52 adult patients and volunteers including both gender, different age groups, body mass index (BMI) (appendix 1) and with no history of previous major abdominal surgery or acute illness. While pediatric, pregnant ladies, abdominal surgery, bedridden, and patients with bowel obstruction where excluded according to the criteria. The research committee in King Abdul Aziz University approved the study protocol. Informed consent was obtained from all patients & volunteers. The routine upper abdominal ultrasound with usual preparation fasting instruction 8 hrs prior to exam, only water was allowed. Each patient was scanned twice, the first scan was conducted after routine preparation, while the second scan was conducted after modified preparation where the same patient instructed to keep fasting with administration of one charcoal capsule orally 8 hrs prior to exam. Then we compared the image quality by

taking the pancreas as a reference in this study. Ultrasound images for both exams for each patient were evaluated by qualified radiologist and senior sonographer by using especially designed evaluation form.

Appendix 1: Body mass Index

Body Mass Index	
Under Weight	< 18.5
Normal Weight	18.5- 24.9
Over Weight	25-29.9
OBESITY	30- 34.9
EXTREMELY OBESE	>35

IV. Result

A sample size of 52 patients and volunteers were included both gender, 12 of them were excluded and only 40 candidate included in the study 23 men and 17 women ranging in age from 18 to 61 years old with different BMI table 1 a & b.

Table 1: a) Gender & age group classification

SEX	Age Group					Total
	16-25	26-35	36-45	46-55	55-65	
Male	3	7	7	3	3	23
Female	6	3	2	4	2	17
Total	9	10	9	7	5	40

Table 1: b) body mass index classification

Sex	Body Mass Index				
	Under Weight	Normal Weight	Over Weight	Obese	Extremely Obese
Male	0	8	4	8	3
Female	2	5	4	3	3
Total	2	13	8	11	6

The images from the pre and post administration of the charcoal capsule were evaluated by two experienced staff in radiology at King Abdulaziz University Hospital – KAUH, body imaging radiologist and a senior sonographer with PHD in ultrasound, they evaluated and graded the images into three categories (very good, good and poor). The mean value result of visualization pre charcoal administration in the head of pancreas was 10% in very good, 47.5% in good and 42.5% in poor. The result in the neck of the pancreas is 33.75% in very good, 42.5% in good and 28.75% in poor. The pancreas body result 15% in very good, 33.75% in good & 51.20% in poor. The pancreas tail result 0 in very good, 21.2% in good & 78.75% in poor which is the highest result recorded Fig 1. The mean value result of visualization post charcoal administration in the head of pancreas was 35% in very good, 45% in good and 20% in poor. The result in of the pancreas neck was 45% in very good, 45% in good & 10% in poor. The pancreas body result 17.5% in very good, 60% in good & 22.50% in poor. The pancreas tail result 7.50%, in very good 30% in good & 62.5% in poor Fig 2.

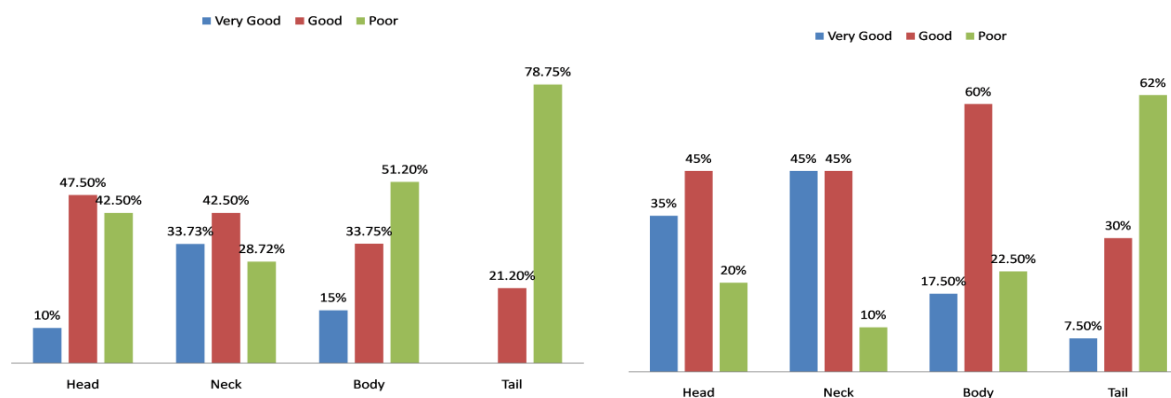


Fig 1: Pre charcoal administration mean value both evaluation. Shows the result of all anatomical parts of Pancreas

Fig 2: Post charcoal administration mean value both evaluation. Shows the result of all anatomical parts of Pancreas

3.1 Pancreas Head

Pancreas head visualization result in 40 patients ranging from 10% pre to 35% post administering charcoal in very good and from 47.5% to 45% in good while 42.5% to 20% in poor , therefore the overall improvement (25+2.5+22.5=50%).

3.2 Pancreas Neck

Pancreas neck visualization result from 33.75% pre to 45% in very good and from 42.5% to 45% in good while 28.75% to 10% in poor post administering of charcoal. The overall improvement result (11.25+2.5+18.75= 32.5%).

3.3 Pancreas Body

Pancreas body visualization result from 15% pre to 17.5% in very good and from 33.75% to 60% in good while 51.2% to 22.5% in poor post administering of charcoal. Therefore the overall improvement result (2.5+26.25+28.7= 57.45%).

3.4 Pancreas Tail

Pancreas tail visualization result from 0 to 7.5% in very good and from 21.2% to 30% in good and from 78.75% to 62.5% in poor. Therefore the overall improvement result (7.5+8.8+16.25= 32.55%).

3.5 Overall evaluation of image quality after administering Charcoal

The mean value result of both evaluators in term of the overall criteria (much better, better, no difference & worse) was 21% in much better, 42% in better, 33% in no difference & 4% only in worse. Therefore the overall improvement in the Pancreas visualization was 63% in total of 40 cases see Fig 3.

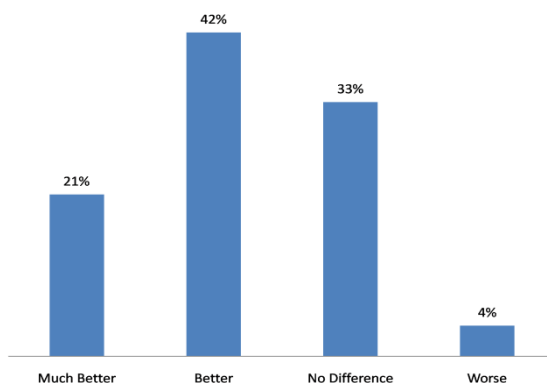


Fig 3: Mean value of criteria result

3.6 Criteria analysis in relation to body mass index

The overall result of 57.2% was the total improvement (much better & better) in relation to BMI (overweight, obese and & extremely obese) patients & 39.05% only is the improvement in under and normal weight patients. The overall improvement (much better & better) in relation to the gender and BMI (overweight, obese and & extremely obese) was 66.9% improvement in male and 49.9% is the improvement in female table 3.

Table 3: Improvement result both evaluation in relation to BMI & gender

Result	Body radiologist	Senior-sonographer	Mean value
Improvement (over weight, obese, extremely obese)	53.3%	61.1%	57.2%
Improvement (under& normal weight)	40%	38.09%	39.045%
Improvement in male	58.8%	75%	66.9%
Improvement in female	46%	53.8%	49.9%

1.7 No improvement result

Overall result of no improvement was 62.4% in (no difference) in relation to BMI (over weight, obese & extremely obese) patients & only 37.2% is not improved in under t & normal weigh patients. The total not improved (no difference) in relation to the gender and BMI (overweight, obese and & extremely obese) was 36.9% in male and 62.5% in female Fig 4.

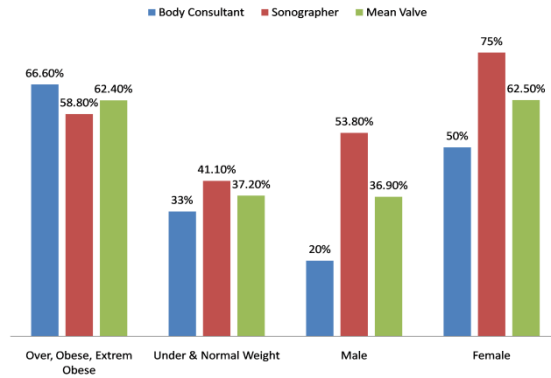


Fig 4: Shows not improved result in relation to BMI & gender

3.8 Relation of criteria to BMI

The mean value result of the criteria both analysis in relation to the BMI was in much better 12% in under weight, 29% in normal weight, 29% in overweight, 18% in obese & 12% in extremely obese. The criteria result in better 3% in under weight, 35% in normal weight, 29% in overweight, 21% in obese & 12% in extremely obese. The criteria result in no difference 4% in under weight, 35% in normal weight, 4% in overweight, 38% in obese & 19% in extremely obese. The criteria result in worse 67% in obese & 33% in extremely obese Fig 5.

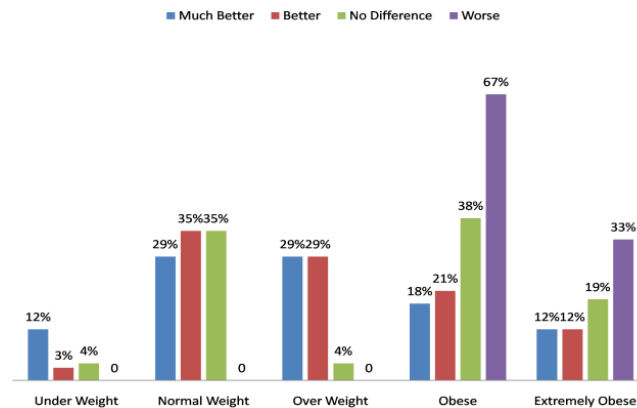


Fig 5: Mean value result of both evaluation criteria result to BMI

The mean value result of the criteria both analyses in relation to the gender was in much better 11% in male & 35% in female. The result in “better” was 43% in male & 41% in female. The result in “no difference” was 39% in male & 24% in female. The result in “worse” was 7% in male & 0 in female Fig 6.

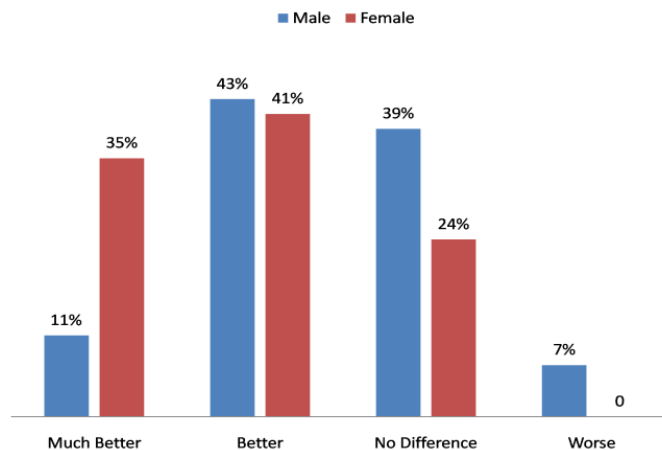


Fig 6: Shows mean value result of both evaluation criteria to gender

3.9 Relation to age group

The highest result in much better was 41% in group (16-25), 23% in group (36-45) and 18% in two groups (26-35) & (46-55). The result in better was 29% which is the highest in group (36-45), 26% in group (26-35), 21% in group(16-25) and 12% in two groups (26-35) & (46-55). The no difference recorded the highest result by 31% in group (26-35), 23% in group (56-65), 19% in group (46-55), 15% in group(16-25) and only 12% in group (36-45) The worse result only in two groups 33% in group (36-45) and 66% In group (46-55).

V. Discussion

Activated charcoal is a highly adsorbent powder made from superheated, high surface area, porous particles produced by organic material [3]. It is an excellent adsorbent of many chemical substances including gases [9]. The unsatisfactory ultrasound scans of the pancreas frequently seen due to excessive amount of abdominal gases. This study showed that the active charcoal can improve the visualization of the pancreas in ultrasound. From our research results mentioned above, we found that the pancreas head has a high improvement result next to the pancreas body which scored the highest improvement rate. The total improvement in pancreatic head was 50% which was expected since the pancreas head can be seen easily comparing to other parts of the pancreas. The administration of charcoal to patients undergoing abdominal ultrasound contributed in noticeable reduction of the gases which led to increase the visualization of pancreatic head . In the Pancreas neck the improvement in visualization was also found to be better by 32.5% in post charcoal administration scans compared to pre-administration of charcoal .

The study also showed that the greatest improvement was in Pancreas body visualization compare to the rest where the overall improvement was found to be 57.45% . In the Pancreas tail, usually it is very difficult to visualize it because of its location between stomach and spleen with routine preparation of abdominal ultrasound, while post charcoal administration exams showed improvement in image quality and the visualization of the tail was improved by 32.5% .

There was evidence of a significant overall improvement in relation to BMI in overweight, obese & extremely obese patients; this improvement was found to be 57.2% which is higher than the result found in under & normal weight which was improved by 39.05% only. The improvement of image quality post charcoal administration in males was 66.9% while for females was 49.9% as shown in table 3. On the other hand, the not improved cases in male was found to be 36.9% while 62.5% in female this has negatively influenced the overall improvement result in females which was 49.9% as shown in

Fig 4. Poor female Physical activity as results of our society life style may be a major factor that affects the efficiency of charcoal in female. From our study, we concluded that adding one capsule of charcoal to patient preparation for a total sample of 40 cases has directly improved the visualization of pancreas by 63% while in 37% of the sample the quality was not improved as shown in Fig 3.

VI. Conclusion

Active charcoal is useful, safe and cost effective and can be used to reduce gastrointestinal gases to improve the visualization of the pancreas and other structures in routine adult abdominal ultrasound. Patient preparation for routine abdominal Ultrasound examination can be updated by adding the administration of charcoal to eliminate gases that usually degrade image quality in abdominal ultrasonography.

5.1 Conflicts of Interest

Authors don't have conflict of interest to declare in this study.

5.2 Limitation

- Limited time to complete the research
- Sample size was not large due to refusal of patients to participate in this research as additional preparation and rescan were needed.

5.3 Recommendations

- We recommend a further investigation to be conducted with increasing the dose to be two capsules instead of one capsule.
- Increase sample size from both genders in future research
- Fine tune patient preparation by instructing the patients to stop fizzy drinks, avoid heavy meals two days before the exam in addition to charcoal administration.
- To update patient instructions by adding the statement "avoid drink milk , coffee, and smoking on the same day of exam".

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