RESULTS OF PREPARED DILUTE BARIUM SULPHATE FORMULA SUSPENSION USED IN CONVENTIONAL CT OF ABDOMEN

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ABSTRACT

PURPOSE:

To produce well or acceptable barium sulphate formula suspension for CT of abdomen and pelvis using barium sulphate for conventional GI radiology.

MATERIALS and METHODS:

the patients undergone CT of the abdomen and the pelvis in Pranangklao Hospital during September 1, 2005 to April 12, 2006 were randomized to receive three types of contrast media: two dilute barium sulphate suspensions (one was hospital made, P.K contrast) and one water soluble iodine contrast media, and were studied by conventional CT to observe the data of the quality of bowel opacification, contrast related artifact, contrast palatability, early side effect and cost, by 3 radiologists independently and 1 CT technician. The data were tabulated and analysed using chi-square test, exact test, and percentage.

RESULT:

134 patients, for the acceptability of the patients, there were no statistic significant differences between the three contrast media in the drinking and vomiting but showed significant differences in the tastes, swallowing difficulty and nauseatic effects, whereas water soluble iodine contrast media was a little better. There were no statistic significances in the bowel opacification except at the stomach. Also there were no differences in the disturb artifacts. The P.K contrast was the cheapest, 4-10 times lower, than the other two contrasts used in this study.

CONCLUSION:

Barium sulphate for conventional GI radiology with proper suspension agent and formula can be used well in bowel opacification for CT of abdomen and pelvis and is the accepted agent for patients because of its safety and low cost.

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INTRODUCTION

In routine abdominal or pelvic computed tomography (CT) usually requires adequate opacification of the gastrointestinal tract (GI) with positive or negative contrast agents, because unopacified or improper bowel preparation, especially small bowel may simulate pathologic abnormalities as bowel masses or nodes.[1-8] The two commonly used opaque media are diluted barium sulphate and diluted water soluble iodinated contrast media. Barium sulphate suspension is the agent of choice for conventional gastrointestinal radiology because of its inert property, no peristaltic stimulation, no osmotic effect and no bowel absorption.[2] It seems logical to use barium sulphate in CT of the abdomen in general patients, asthmatic patients, iodinated allergic patients and patients with history of drug or seafood allergy. Barium sulphate suspension is easy to be improved in flavors or tastes but it has some disadvantages in sedimentation or flocculation within the stomach causing disturbing artifacts and loss of distal bowel opacification.[3] The price of commercial diluted barium sulphate suspension is rather expensive.[6] Diluted water soluble iodinated contrast media is easy to be prepared without sedimentation property in bowel but some patients find it is difficult to be swallowed because of its taste and can be absorbed causing allergy in some patients.[3]

The study is conducted to produce well or acceptable barium sulphate formula suspension for CT of abdomen and pelvis using barium sulphate for conventional GI radiology.

OBJECTIVE

To prepare an acceptable diluted barium sulphate formula suspension used in CT of abdomen and pelvis comparing with other two positive contrast media; 1. commercial dilute barium sulphate and 2. water soluble iodinated contrast, in quality of bowel opacification, contrast in relation to artifacts, palatability, early side effect and costs.

MATERIAL AND MATHODS

Ethics committees of our hospital, The Pranangklao Hospital, have granted an approval for this study.

PATIENTS

The patients undergone CT of the abdomen and the pelvis in Pranangklao Hospital, Thailand during September 1, 2005 to Apri l2, 2006, excluding children and the suspected bowel perforation cases.

TECHNIQUE

Conventional CT were used, Elscint, exel 2400 ELECT. (slice thickness 10 mm, scanning time 2.1 sec and using routine scan technique in the most cases)

CONTRAST MEDIA

Three types of contrast media were used, there are two dilute barium sulphate suspensions and one water soluble iodine contrast media.

1. In house (hospital made) prepared dilute barium sulphate formula suspension, 1.8% w/v barium sulphate contrast media (P.K. contrast), contains barium sulphate, suspending agent and the other ingredients such as vegetable gum, sorbitol, artificial sweetener and artificial sala Hale's blue boy-flavoured syrup by researcher and the pharmacist of Productive Pharmaceutical Department, Pranangklao Hospital.

2. Commercial barium sulphate formula suspension, 2.2% MedeSCAN

3. Dilute water soluble iodinated contrast media, telebrix 35, ultravist 370, xenetric 350 or omnipaque

METHOD OF INTERVENTION (preparation of contrasts to patients)

All patients were NPO for at least 8 hours prior to CT studies.

1. P.K. contrast:

1.1 Upper abdomen study: 375 ml of the solution was given orally in 20-30 min before the scan and 125 ml was given immediately before the scanning (total = 500 ml).

1.2 Whole or lower abdomen study: three 250 ml were given orally in 20 min intervals (750 ml) and 250 ml was given per rectal enema, immediately before the scan (total = 1000 ml).

2. MedeSCAN:

2.1 Upper abdomen study: 375 ml was given orally in 20-30 min before the scan and 125 ml was given immediately before the scanning (total = 500 ml).

2.2 Whole or lower abdomen study; three 250 ml were given orally in 20 min intervals (750 ml) and 250 ml was given per rectal enema, immediately before scannig. (total = 1000 ml).

3. Water-soluble contrast:

3.1 Upper abdomen study: 375 ml was given orally in 20-30 min before the scan and 125 ml was given immediately before the scanning (total = 500ml, using 15 ml contrast media mixed with water to 500 ml).

NPO = Nothing per Oral

3.2 Whole or lower abdomen study; three 250 ml were given orally in 20 min intervals (750 ml) and 250 ml was given per rectal enema, immediately before scannig (total = 1000 ml, using contrast 30 ml mixed with water to 1000 ml)

Bowel opacification (good, poor) in eight regions were observed by three radiologists independently without knowing what type of the contrast media was used and judging from at least 2 similar opinions. Disturbed artifact were classified into 3 grades (none, artifacts not effecting diagnostic information (weak), and artifacts impairing diagnostic information (marked)). The records along with patients' compliance such as flavor, difficulty in swallowing and nauseating effects were recorded by CT technician who was the only person aware of the type of the contrast agent used. Compliance was rated by the acceptability of patients to the contrast media as regarding to ability to drink (all, volume left over or residual contrast media), taste or flavor (good, acceptable, disagreeable), difficulty in swallowing (yes, no), Nauseating effect (yes, no) and vomiting (yes, no). The data were tabulated and analysed using chi-square test, exact test, and percentage.

RESULTS

Conventional CT examination of the abdomen and the pelvis were performed on 134 patients (70 men, 64 women; aged 16-85 years; mean = 54 years using three contrast media: P.K contrast, MedeSCAN, water soluble iodinated contrast) which were divided into 3 groups.

Table 1 Contrast media used.

Contrast media	Frequency (cases)	Percent
MedeSCAN	33	24.63
P.K contrast	46	34.33
Water-soluble contrast	55	41.04
Total	134	100.00

Form table 1, the water soluble contrast media was the most contrast media used, 55 cases (41.04%) and the least was MedeScan, 33 cases (24.63%).

Table 2 Acceptability to patients of the contrast media in drinking.

Contrast drinking	Contrast media						Total	
	MedeSCAN		P.K contrast		Water-soluble			
	cases	%	cases	%	cases	%	cases	%
Total	29	87.9	38	82.6	45	81.8	112	83.6
Left over	4	12.1	8	17.4	10	18.2	22	16.4
Total	33	100.0	46	100.0	55	100.0	134	100.0

Chi-squared value = .600, P = .741, α<0.05. .

From table 2, the patients drank the total contrast media about 83.6% and had the residual contrast media about 16.4 %, so the residual contrasts media were approximately 100-250 ml. There is no statistic significance differences in the drinking between the three contrast media.

Table 3 Acceptability of the patients of the contrast media in tastes.

Taste	Contrast media						Total	
	MedeSCAN		P.K contrast		Water-soluble			
	cases	%	cases	%	cases	%	cases	%
Good	11	33.3	5	10.9	31	58.5	47	35.6
Acceptable	21	63.6	35	76.1	21	39.6	77	58.3
Disagreeable	1	3.0	6	13.0	1	1.9	8	6.1
Total	33	100.0	46	100.0	53	100.3	132	100.0

Chi-squared value = 27.298, P = .000 (Exact sig., 2-sides), α<0.05. .

From table 3, there is statistic significance in taste between the contrast media, which P.K contrast was prominently in disagreeable, 6 case (13%) whereas MedeSCAN 1 case (3%) and Water- soluble contrast 1 case (1.9%).

Table 4 Acceptability to patients of the contrast media in the difficulties in swallowing.

Difficulties in swallowing	Contrast media						Total	
	MedeSCAN		P.K contrast		Water-soluble			
	cases	%	cases	%	cases	%	cases	%
Yes	5	15.2	8	17.4	8	1.9	14	10.6
No	28	84.8	38	82.6	52	98.1	118	89.4
Total	33	100.0	46	100.0	53	100.0	132	100.0

Chi-squared value = 7.203, P = .024 (Exact sig., 2-sides), α<0.05. .

From table 4, there is statistic significance in the difficulties of swallowing between the contrast media, MedeSCAN and P.K contrast were prominently in 5 cases (15.2%) and 8 cases (17.4%), respectively. The water soluble contrast media was acceptable in the swallowing.

Table 5 Acceptability to patients of the contrasts in nauseating effect.

Nauseating effect	Contrast media						Total	
	MedeSCAN		P.K contrast		Water-soluble			
	cases	%	cases	%	cases	%	cases	%
Yes	10	30.3	16	34.8	3	5.7	29	22.0
No	23	69.7	30	65.2	50	94.3	103	78.0
Total	33	100.0	46	100.0	53	100.0	132	100.0

Chi-squared value = 13.966, P = .001, α<0.05.

From table 5, there is statistic significance in nauseating effect between the contrast media, MedeSCAN and P.K contrast were prominently in 10 cases (30.3%) and 16 cases (34.8%), respectively.

Table 6 Acceptability to patients of the contrasts in vomiting

Vomiting	Contrast media						Total	
	MedeSCAN		P.K contrast		Water-soluble			
	cases	%	cases	%	cases	%	cases	%
Yes	3	9.1	1	2.2	2	3.8	6	4.5
No	30	90.9	45	97.8	51	96.2	123	95.5
Total	33	100.0	46	100.0	53	100.0	132	100.0

Chi-squared value = 2.240, P = .383 (Exact sig., 2-sides), α<0.05.

From table 6, there is no statistic significance in vomiting between the contrast media.

Table 7 Study

Study	Frequency (cases)	Percent
Upper abdomen	72	53.7
Lower abdomen	5	3.7
Whole abdomen	57	42.5
Total	134	100.0

The main studies were upper abdominal CT, 72 cases (53.7%) and a few cases were lower abdominal CT, 5 cases (3.7%)

Table 8 Degree of filling opacity of different gastrointestinal regions

Gastrointestinal regions (Cases,%)	Contrasts								
	MedeSCAN		P.K		Water-soluble		chi-squared		
	good	poor	good	poor	good	poor	values	p	Sig.
Stomach	22 68.8	10 31.3	41 93.2	3 6.8	48 88.9	6 11.1	9.771	.008	S
Duodenum	19 59.4	13 40.6	34 77.3	10 22.7	44 81.5	10 18.5	5.432	.066	NS
Jejunum	29 90.6	3 9.4	33 75.0	11 25.0	47 87.0	7 13.0	4.034	.133	NS
Ileum	14 100.0	0 0	17 89.5	2 10.5	25 89.3	3 10.7	1.623	.592 (E)	NS
Ascending colon	7 50.0	7 50.0	13 68.4	6 31.6	20 71.4	8 28.6	1.998	.368	NS
Transverse colon	8 57.1	6 42.9	14 73.7	5 26.3	15 53.6	13 46.4	2.013	.366	NS
Descending colon	9 64.3	5 35.7	16 84.2	3 15.8	21 75.0	7 25.0	1.730	.444 (E)	NS
Sigmoid colon	12 85.7	2 14.3	17 89.5	2 10.5	21 75.0	7 25.0	1.777	.481 (E)	NS
Rectum	13 92.9	1 7.1	18 94.7	1 5.3	26 92.9	2 7.1	0.075	1.000 (E)	NS

(E)= exact test.

From table 8, only the stomach region shows statistical significance in filling opacity of the three contrast media, MedeSCANs were rather poor opacification, 10 cases (31.3%) followed by water-soluble contrast media, 6 cases (11.1%) and the best were P.K. contrasts whereas the rest of different GI regions were no statistical significant.

Table 9 Occurrence of contrast-related artifacts

Contrast media	Imaging artifact					
	None	%	Weak	%	Marked	%
MedeSCAN	32	97.0	1	3.0	0	0
P.K contrast	37	80.4	8	17.4	1	2.2
Water-soluble	50	90.9	5	9.1	0	0
total	119	88.8	14	10.4	1	0.7

Chi-squared value = 6.509, P = .114 (Exact sig., 2-sides), $\alpha < 0.05$.

From table 9, the imaging artifacts were infrequent occurrence, seen only 1 case (2.2%) of P.K contrast in marked or disturb diagnostic information. No statistic significance in artifact occurrence between the contrast media.

Table 10 Cost of the contrast media.

contrasts	Cost of contrast (Bahts)	
	Upper abdomen study	Whole abdomen study
MedeSCAN	160	320
P.K. contrast	19	38
Water-soluble, ionic	84	168
Water-soluble, non-ionic	195	390

From table 10, the water- soluble iodinated contrast media had two agents as ionic and non-ionic, which non-ionic agent cost was two times more expensive than ionic agent and was slightly higher than MedeScan. The P.K contrast was lowerest, 4-10 times lower.

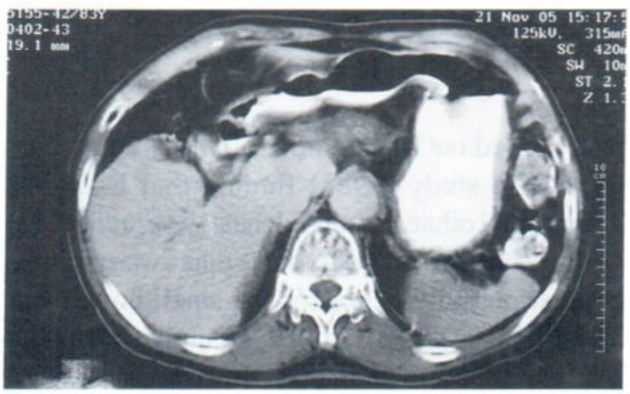

Fig. 1

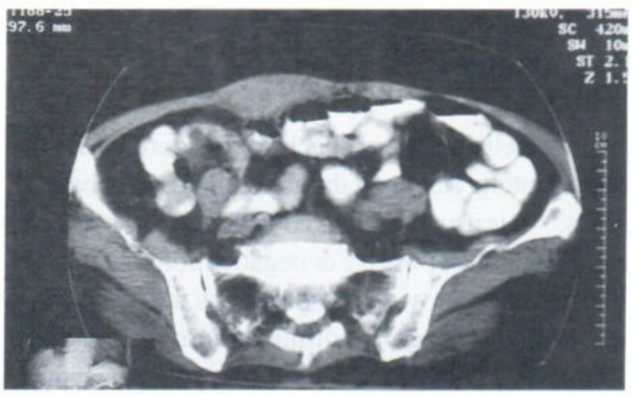

Fig. 2

Fig. 1,2 Water-soluble contrast

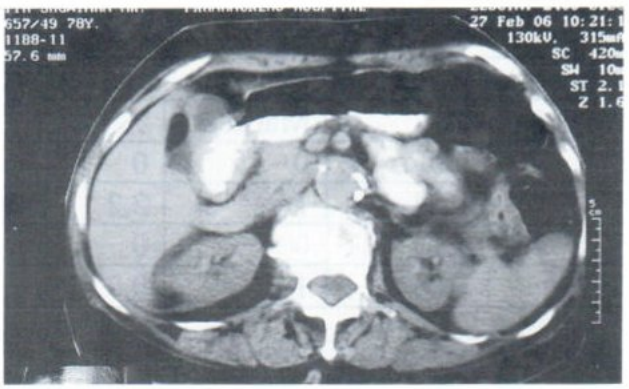

Fig. 3

Fig. 4

Fig. 3,4 Mediscan contrast

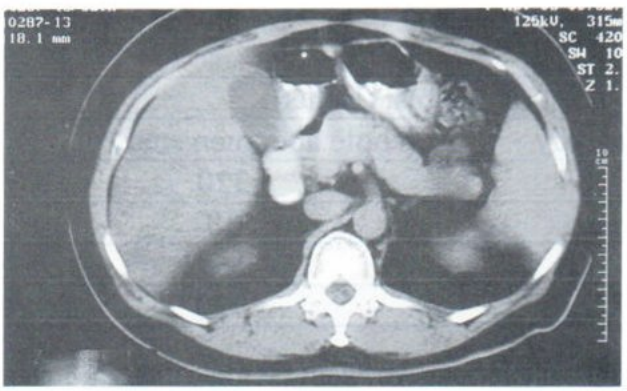

Fig. 5

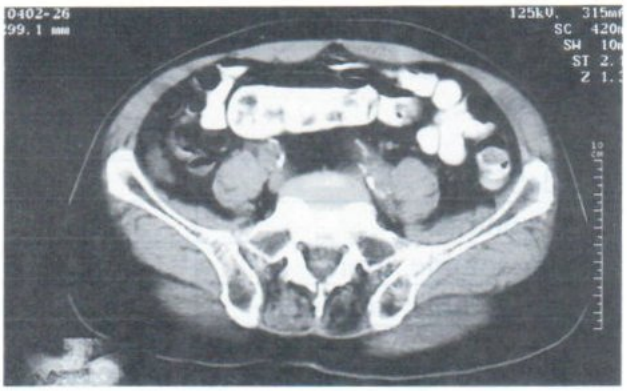

Fig. 6

Fig. 5,6 P.K. contrast

DISCUSSION

Reliable bowel opacification is critical for the correct interpretation of the abdominal and pelvic CT scans.[1-8] It is usually achieved with oral and per rectal administation of positive or negative contrast agents.[4] The common or widely used agents for GI contrast are the positive agents: dilute barium sulphate and dilute water soluble iodinated contrast media, which have both ionic and non-ionic contrast agents. The negative contrast agents: water,[9] oil emulsion, milk[10] or simethicone-coated cellulose[11] are less in favor. The comparison of dilute barium sulphate with dilute water soluble iodinated contrast media in bowel opacification, artifact, patient side effect and cost had been carried out in a number of research by Carr and Banks study (1985) finding that E-Z-CAT (commercial dilute barium sulphate) was preferred in the duodenal label[5] and diatrizoate dilute water soluble contrast possibly better for the small bowel, but CHAMBERS and BEST (1984) study showed no differences.[1] Dilute barium contrast media prefered to water soluble contrast media in Megibow and Bosniak study (1980),[2] Nyman and Andersson study (1984),[3] Hatfield et al study (1980),[4] or Kivisaari and Kormano study (1982).[12] A study by Matsuoka et al (2000)[8] used both positive (dilute iodinated solution) for pelvic CT and followed by negative (water) oral

contrast agent for upper abdominal CT.

The barium sulphate contrast media is good in inert property, no bowel absorption and hypersensitivity,[2] but has disadvantage in sedimentation or flocculation causing artifact in the stomach and decrease contrast in the distal bowel.[3] We can reduce this disadvantage by using suspending agent to prevent over-rapid sedimentation.[2] The water soluble contrast media is good in opacification and preparation, but has some disadvantage in taste and is absorbed into the circulation (Johensen 1978),[13] which may increase the risk of allergic reactions especially in the patient with a history of hypersensitivity. We can improve these disadvantages with non-ionic contrast media, but the cost is also increasing.[3]

The GI tract has a capacity in excess of 4 litres which lead to the dilution of high-density contrast agents. Therefore, at least 800 ml to 1 litre of these agents is needed for abdominal CT. A bolus of oral contrast agent exits the stomach in 30 minutes. It reaches and exits the duodenum in 15-40 minutes, the jejunum in 30- 90 minutes, the ileum in 45 -150 minutes and the colon in 90 minutes to 16 hours, respectively, so well opacification need proper large amount of contrast.[7]

Now, there is low density barium sulphate suspension (VoLumen) for oral contrast in Multidetector CT (MDCT)[14] and PET/CT15 studies provided improved or excellent distention and visualization of bowel wall, good for bowel wall pathology diagnosis.

In this study, 134 cases in CT abdomen and pelvis with three contrasts 24.63% of medeSCAN, 34.33% of P.K contrast and 41.04% of water- soluble contrast (table 1).

The main studies were upper abdominal studies, 53.7% and a few cases in lower or pelvic abdomen (table 7). The acceptability of the patients in drinking and vomiting were no significant difference (tables 2 and 6) but the differences in taste or flavor, difficulties in swallowing and nauseating effect were significant differences (tables 3, 4 and 5), prominently in dilute barium sulphate contrast media as P.K. contrast and medSCAN, may be from rather high concentration, stickiness and large amount of the contrasts. Degree of filling opacity of different GI sections (table 8), only stomach is statistically significant differences, the other are not , the same as in the previous studies.[2-5,12] The differences of stomach opacity may be caused by the delay studies, so some costrast medias has passed downward into the distal bowel already. There were a few artifacts occurred in the three contrast medias but no significant differences, the same as in the other studies. The costs of each contrast media were difference, the P.K. contrast media of our hospital preparation as the dilute barium sulphate formula was the cheapest, 4-10 times lower, than the others.

There are many factors in the selection of the contrasts for bowel opacification such as age (children or elderly), for medical or surgical interventions (suspected bowel perforation or post bowel anastomosis), patients status (history of hypersensitivity or had problems of difficulties in swallowing), CT machinery (conventional CT, MDCT or PET/CT) or costs. Final choice will be on the relative importance of these factors.

CONCLUSION

Barium sulphate for conventional GI radiology with proper suspension agent and formula can be used well in bowel opacification for CT of abdomen and pelvis but the preferred agent for the patients will be for their safety, diagnostics and low costs.

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