

A case report and literature review of barium sulphate aspiration during upper gastrointestinal examination

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Abstract

Rationale: Even though barium sulphate aspiration during upper gastrointestinal examination is a well-known phenomenon, complication such as long-term lung injury and death may still occur. This may depend upon the concentration, amount, anatomy, or certain predisposing factors.

Patient concerns: A 47-year-old woman who had a barium swallow to screen for foreign body in esophagus.

Diagnoses: Chest radiographs demonstrated massive barium sulphate depositions in her trachea and inferior lobe of right lung.

Interventions: A chest x-ray was done that revealed massive barium sulphate depositions in her trachea and lower lobe of right lung. As the patient did not have further complaints, she requested a transfer to West China Hospital of Sichuan University, the hospital being near her residence, for further treatment. She eventually recovered and was discharged after 1 week.

Outcomes: There were 23 articles (22 English and 1 Chinese with 17 men and 11 women) included in the study. The risk factors of barium sulphate aspiration are dysphagia (10/28, 35.71%) followed by esophageal obstruction caused by tumor (5/28, 17.86%) and foreign body in esophagus (3/28, 10.71%). Infants (5/28, 17.86%) are also one of the high-risk population. Both the lungs were affected in most of the patients (21/28, 75%). Majority of the presentation in patients (21/28, 75%) were dyspnea, hypoxemia, acute respiratory distress syndrome (ARDS), or respiratory failure. Few patients (7/28, 25%) showed no symptoms or mild symptoms such as cough and fever. Barium sulphate aspiration can be life-threatening with a high risk of death (nearly 40%).

Lessons: When performing an upper gastrointestinal examination with barium sulphate, careful consideration of concentration and amount of barium sulphate and that of risk factors should be undertaken so as to avoid life-threatening aspiration.

Abbreviations: ARDS = acute respiratory distress syndrome, CT = computed tomography, MRI = magnetic resonance imaging, PBL = pulmonary bronchoalveolar lavage, PET-CT = positron emission tomography-computed tomography, USG = ultrasonography.

Keywords: barium sulphate aspiration, lung, upper gastrointestinal examination, x-ray

1. Introduction

Upper gastrointestinal examination with barium sulphate swallow is a widely used investigative technique all over the world. It does

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The authors declare that there is no conflict of interest related to this study.

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not need any justification for the importance of its role in the diagnosis of diseases of the upper gastrointestinal tract such as foreign body in esophagus, esophageal cancer, achalasia, diverticulum, and many more. Generally regarded as a safe examination technique in our clinical practice, rare cases of aspiration of barium sulphate during upper gastrointestinal examination have been observed that has led to complication and even death.^[1,2]

In this article, we present a case of barium sulphate aspiration during upper gastrointestinal examination. Beside this, a further endeavor has been undertaken to review all available publications on barium sulphate aspiration during upper gastrointestinal examination while focusing upon clinical presentation, predisposing factor for aspiration and cause of death, death rate, and prognosis following aspiration with the prospect to aid the patients and clinicians of better understanding of this examination, which to the best of the authors' knowledge, has not been reported before.

2. Materials and methods

This study was approved by the institutional review board of Suining Central Hospital with waiver of patient informed consent, as the data were available in electronic medical records of our hospital.

2.1. Case presentation

A 47-year-old woman was advised by her doctor in our hospital to undergo a barium swallow examination to investigate for

possible esophageal foreign body. During the examination, she felt a slight discomfort that was accompanied by repeated coughing. It was suspected that she might have had aspirated barium sulphate into her lungs (120% weight/volume), which led to termination of the procedure. Immediately, a chest x-ray was done that revealed massive barium sulphate depositions in her trachea and lower lobe of right lung (Fig. 1A, B). She was then shifted to Emergency Room for her vitals to be monitored. On examination, she had a respiratory rate (RR) of 23/minute, heart rate (HR) 105/minute, blood pressure (BP) 152/86 mm Hg, and oxygen saturation (O₂%) 96%. Chest auscultation did not reveal any abnormality. After 2 hours of observation, it was noted that the patient's vitals were stabilized with RR 17/minute, HR 82/minute, BP 124/78 mm Hg, and O₂% at 99%. As she did not have further complaints, she requested a transfer to West China Hospital of Sichuan University, the hospital being near her residence, for further treatment. She eventually recovered and was discharged after 1 week. One year later, a telephonic follow-up of the patient revealed that she was alive and did not have any complaints.

2.2. Literature search

Two authors independently conducted literature retrieval of all available publications on barium sulphate aspiration during upper gastrointestinal examination. The literature were searched in the databases of PUBMED, OVID, EBSCO, EMBASE, and China National Knowledge Infrastructure (CNKI) from their inception to June 2017. Language or publication date was not restricted and limited to focus on human beings only. The remaining publications were then taken into account according to their abstract and/or title. For example, the literature retrieval in the PubMed database was performed with the strategies below:

#1: (“barium” OR “barium sulphate” OR “barium sulfate” OR “barium sulphate aspiration” OR “barium sulfate aspiration” OR “barium aspiration”)

#2: (“upper gastrointestinal examination” OR “upper gastrointestinal tract examination” OR “upper digestive tract” OR “barium swallow”)

#3: (“esophagus” OR “esophageal” OR “stomach” OR “gastric” “duodenum” OR “duodenal”)

#4: #1 AND #2 AND #3

Other databases of Springer link, Google scholar, and Baidu scholar were also searched to identify relevant articles. Another 2 authors independently checked the reference list of all publications initially identified in the PUBMED, EMBASE, and other databases for additional articles.

2.3. Statistical analysis

In order to evaluate the prognosis of barium sulphate aspiration during upper gastrointestinal examination, the adult patients were divided into 2 groups. Patients who died because of barium sulphate aspiration were placed into group A, while those patients who recovered after the aspiration were placed into group B. Age of patients from the 2 groups was expressed as mean \pm standard deviation. The independent-sample *t* test was conducted by using statistical software (SPSS, version 22.0; SPSS Inc, Chicago, IL). *P* < .05 indicated a significant difference.

3. Results

3.1. Literature retrieval and the results

After a thorough computer literature search, careful verification of references, and screening based upon the titles and abstracts, 28 articles^[1–28] were identified for selection. Among these, 2 articles^[1,21] reported the same cases in their literature, thus, only 1 article^[21] was selected. Three more articles^[3–5] were excluded because the authors failed to obtain the full text. As a result, a total of 23 articles^[6–28] was selected for the study.

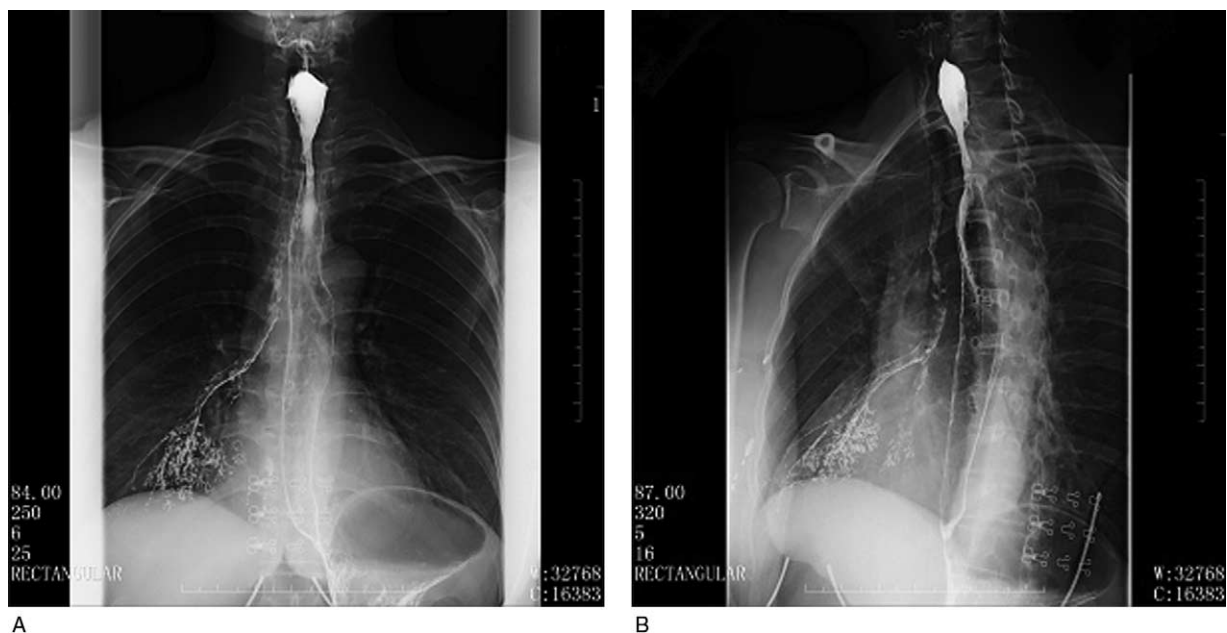


Figure 1. (A, B) A 47-year-old woman who had a barium swallow to screen for foreign body in esophagus. Chest radiographs demonstrated massive barium sulphate depositions in her trachea and inferior lobe of right lung.

Table 1**Barium sulphate aspiration during upper gastrointestinal examination.**

Study	Year	Reference	Sex	Age, y	Indication	Distribution	Clinical presentation	Prognosis
Gray et al ^[6]	1989	6	F	74	Dysphagia	BL, R>L	Pneumonia	Death
			F	85	Dysphagia	R	Pneumonia	Death
Penington ^[7]	1993	7	F	81	Dysphagia	R	Severe complication	Recovery
Pracy et al ^[8]	1993	8	M	60	Dysphagia	R	Acute pneumonia	Stability
Gombar et al ^[9]	1995	9	F	48	ND	L	Hypotension	Death
Lopez- López-Castilla et al ^[10]	1997	10	M	0.17	Vomiting	BL	Mild ARDS	Clinical stability
Tamm and Kortsik ^[11]	1999	11	F	68	Tumor recurrence	BL	ARDS	Clinical stability
			M	60	Esophageal tumor	BL	Hypoxemia	Death a year later
Voloudaki et al ^[12]	2003	12	F	73	Eructation	BL, L>R	Asymptomatic	Recovery
Fruchter and Dragu ^[13]	2003	13	M	80	Dysphagia	BL	ARDS and hypotension	Death
Kaira et al ^[14]	2004	14	M	70	Gastric tumor	BL, R>L	Severe hypoxemia	Recovery
Venkatraman et al ^[15]	2005	15	M	3	Gastroesophageal reflux	L	Mild to moderate ARDS	Recovery
Chiu et al ^[16]	2005	16	F	1.33	Foreign body in esophagus	BL, R>L	ARDS	Recovery
Gernez et al ^[17]	2005	17	M	66	Mesothelioma	BL, L>R	ARDS	Death
Katsanoula et al ^[18]	2007	18	M	43	Dysphagia	BL, L>R	Dyspnea and hypoxemia	Death
			M	37	Gastroesophageal reflux	BL, L>R	Asymptomatic	Recovery
Wani and Yeola ^[19]	2008	19	M	53	Dysphagia	BL	Dyspnea	Recovery
Basu et al ^[20]	2009	20	M	0.58	Volvulus	BL, R>L	Dyspnea	Recovery
Buschmann et al ^[21]	2011	21	F	64	Gastric cancer	BL, R>L	ARDS	Death
Varatharaj et al ^[22]	2012	22	F	70	Dysphagia	BL	ND	Recovery
Albeldawi and Makkar ^[23]	2012	23	M	79	Weight loss and dysphagia	BL, L>R	Respiratory failure	Death
Gerada and Gerada ^[24]	2013	24	M	77	Dysphagia	BL	Respiratory failure	Death 6 months later
Shulan and Ali ^[25]	2013	25	F	ND	Postoperative review	BL, R>L	Dyspnea	Mechanical ventilation
Jackson et al ^[26]	2014	26	M	0.02	Gastroesophageal reflux	BL, R>L	Asymptomatic	Recovery
Fuentes Santos and Steen ^[27]	2014	27	M	76	Postoperative review	R	Asymptomatic	Recovery
Liu et al ^[28]	2016	28	M	51	Foreign body in esophagus	BL	Cough and fever	Recovery
			M	45	Esophagopleural fistula	BL, R>L	Cough and fever	Recovery
This study	2017		F	47	Foreign body in esophagus	R	Asymptomatic	Recovery

ARDS=acute respiratory distress syndrome; BL=Bilateral; F=Female; L=Left; M=Male; ND=not documented; R=Right.

3.2. Patients description

Out of these 23 articles, 22 were published in English^[6-27] and 1 was published in Chinese.^[28] There were a total of 28 patients including 17 men and 11 women included in the study. Barium sulphate aspiration occurred in 5 infants and 22 adults (Shulan and Ali^[25] did not report the patient's age in their study). The adults had a mean age of 63.50 ± 14.52 years (range from 37 to 85 years). The patients' description of this study is listed in Table 1.

3.3. Risk factors of barium sulphate aspiration

The risk factors associated with barium sulphate aspiration are dysphagia (10/28, 35.71%) followed by esophageal obstruction caused by tumor (5/28, 17.86%), and foreign body in esophagus (3/28, 10.71%). Furthermore, gastroesophageal reflux, history of operation, eructation, and vomiting can also increase the risk of barium sulphate aspiration. Infants (5/28, 17.86%) certainly seem to be at a higher risk of barium sulphate aspiration, which could be attributed to poor cooperation, while crying and coughing during procedure most certainly will increase the possibility of aspiration during undergoing upper gastrointestinal examination.^[16,20]

3.4. Distribution of the aspirated barium sulphate in the lungs

Barium sulphate was aspirated mostly into bilateral lungs (21/28, 75%) followed by right lung [17.86% (5/28)] and left lung [7.14% (2/28)]. Among 21 patients with bilateral involvement, 8

patients (8/21, 38.10%) had equal involvement of both lungs, while 13 patients (13/21, 61.90%) either had right (8/21, 38.10%) or left lung (5/21, 23.81%) predominance. Most of the aspiration occurred into the lower lobe followed by the middle and lingual lobe. However, whole lung was involved in infants.^[10,16]

3.5. Clinical presentation of barium sulphate aspiration

Few patients (7/28, 25%) either had mild symptoms such as cough and fever or did not have any symptoms. In contrast, most of the patients' (21/28, 75%) had features such as dyspnea, hypoxemia, acute respiratory distress syndrome (ARDS), respiratory failure, or an elevated white blood count after the aspiration of barium sulphate.

3.6. Concentration of barium sulphate and clinical presentation

Six articles reported the exact concentration of the aspirated barium sulphate.^[6,7,10,14,16,26] Gray et al^[6] reported the highest concentration of barium sulphate (250% weight/volume) resulting in death of the patient. The other 5 articles^[7,10,14,16,26] reported a relatively lower concentration of barium sulfate ($\leq 200\%$ weight/volume) when compared with the value by Gray et al.^[6] After the aspiration, none of the patients died.

3.7. Prognosis of barium sulphate aspiration

Out of 22 adult patients, aspirated barium sulphate led to 8 mortality (8/22, 36.36%), while 12 recovered (12/22, 54.55%).

What is more, 2 patients died of complication within 1 year (2/22, 9.10%),^[11,24] and another one required brief mechanical ventilation (1/22, 4.54%).^[25] All 5 infant patients fully recovered^[10,15,16,20,26] from the disease. The patients' age of A and B groups were 67.38 ± 15.27 and 60.92 ± 14.05 years, respectively, and the independent-sample *t* test indicated that there was no significant difference between the 2 groups ($t=0.973$, $P=.343$, respectively).

4. Discussion

Barium sulphate swallow for upper gastrointestinal examination is an important diagnostic method in the primary diagnosis of upper gastrointestinal diseases. Although it is generally regarded as a safe examination, life-threatening barium sulphate aspiration do occur in clinical practice.^[1,2] This study reports a case of barium sulphate aspiration during upper gastrointestinal examination and review of relevant literature on this subject while focusing upon clinical presentation, cause of aspiration, death rate, cause of death, and prognosis after the aspiration of barium sulphate. From this study, it can be shown that majority of the patients had symptoms of dyspnea, hypoxemia, ARDS, and respiratory failure, while few patients were asymptomatic or had mild symptoms such as cough and fever postaspiration; the risk aspiration involve factors such as dysphagia, esophageal obstruction caused by tumor, foreign body in esophagus, gastroesophageal reflux, history of operation, eructation, vomiting, and uncooperative infants, etc.; for most of the patients, barium sulphate aspiration can be life-threatening with a high risk of death (nearly 40%), although more than 50% of the patients will recover in the end.

The cause of death after the aspiration of barium sulphate may be explained by the following ways: even though barium sulphate is a nonirritant substance^[18] and lung tissue is well tolerated against barium sulfate, its ability is limited^[28]; the death after barium sulphate aspiration is related to its amount. The lung tissue can tolerate a small amount of barium sulphate. When a large quantity is aspirated, lung tissue's endurance capacity is exceeded that can lead to death^[28]; barium sulphate can affect the pulmonary ventilation and perfusion function, causing dyspnea, hypoxemia, ARDS, and respiratory failure. On the contrary, deposition of barium sulphate into the lungs can also lead to pneumonia, bronchial granuloma, and pulmonary fibrosis^[12,20]; and concentration of barium sulphate aspirated was also associated with death^[6]. Six studies reported the exact concentration of the aspirated barium sulphate.^[6,7,10,14,16,26] Gray et al^[6] reported the highest concentration of barium sulphate (250% weight/volume), which soon resulted in death of the patient after aspiration. All of the other 4 studies^[7,10,14,16,26] reported a relatively lower concentration of barium sulphate ($\leq 200\%$ weight/volume) than that used by Gray et al.^[6] This amount did not result in death of any of the patients. In our case, patient was subjected to relatively lower concentration of barium sulphate (120% weight/volume). Although barium sulphate deposited into her trachea and lower lobe of right lung, the patient did not experience any symptoms and she recovered 7 days later; anaphylactic reaction from barium aspiration^[6,11]; and simultaneous aspiration of gastric contents^[2,18,21,28] may play an important role in causing death.

The authors of this article initially thought that the patients' age may play an important role in the prognosis of barium sulphate aspiration during upper gastrointestinal examination. Thus, only the adult patients were selected and divided into 2

groups. The adult patients, on the basis of death and recovery, were divided into group A and group B, respectively. However, there was no significant difference between the 2 groups ($t=0.973$, $P=.343$, respectively). This can be explained by the small size of the adult population ($n=20$). As a result, whether the patients' age has any role in the prognosis of barium sulphate aspiration during upper gastrointestinal examination or not is still not clear. A study with large number of population will be needed to clarify this.

For patients with a high risk of barium sulphate aspiration during upper gastrointestinal examination, some measures can be taken to avoid risk. First, endoscopy, ultrasonography (USG), computed tomography (CT), magnetic resonance imaging (MRI), and even positron emission tomography-computed tomography (PET-CT) examination may be applied for the upper gastrointestinal diseases.^[29-34] CT evaluation is not only fast but also has higher accuracy, thus it can be considered as the first choice. Second, some other contrast agents such as hytrast, iopydol, and iodixanol that had been proved to be safe for the lungs and digestive tract can replace barium sulphate.^[11,18,35,36] Lastly, Rasley et al^[37] stated that a change in posture (e.g., lying on the side, rotating the head, moving the head downward so the chin touches the neck) during the upper digestive tract examination can be helpful to prevent barium sulphate aspiration.

When it comes to the treatment of barium sulphate aspiration, there is no standardized procedure or guideline from the evidence-based medicine at present. Symptomatic and supportive therapy such as oxygen inhalation, stabilizing the vitals (respiration, HR, BP, and oxygen saturation), and antibiotic therapy for secondary infection are mainly used currently. Pulmonary bronchoalveolar lavage (PBL) therapy can also be used whenever possible^[10,11] but not routinely recommended because of the danger of dissemination of the contrast medium into the bronchoalveolar system.^[11,18,27] Chest physiotherapy to promote clearance may also have some role in the treatment.^[27] In addition, routine investigation such as arterial blood gas analysis, chest X-ray, blood and examination and biochemical examination, etc., are helpful to assess the condition and monitor the efficacy of treatment.

5. Conclusion

When performing an upper gastrointestinal examination with barium sulphate swallow, risk factors should be carefully taken into consideration to avoid life-threatening barium sulphate aspiration.

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