REGURGITATION AND ASPIRATION OF GASTRIC CONTENTS DURING INHALATION ANESTHESIA *

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THE aspiration of gastric contents into the lungs creates a serious problem during anesthesia. Work has been carried on experimentally by several investigators to determine the underlying cause. Hölscher (1) in 1898, used dogs and guinea pigs with gentian violet as an indicator. Lemon (2) in 1926, observed some of the factors which caused aspiration. Ether was the anesthetic agent and dogs alone were used. Gentian violet and India ink were employed for the naked eye, and opaque substances for illustration. Some of his conclusions were that pneumonia could be expected after operation if the patient vomited during anesthesia. Risk of extensive aspiration was increased when the patient was in the inclined position and became less as the plane passed from horizontal to full Trendelenburg. The dangers were increased when light anesthesia was maintained so that the animal struggled, swallowed or vomited. Mendelson (3) in 1946, carried on experiments to evaluate the role of hydrochloric acid. Rabbits were used. Liquid containing hydrochloric acid was instilled into the trachea.

In the clinical investigation to be reported 3873 Evans blue (T-1824), nontoxic blue azo dye (4) was employed as an indicator which was readily visible to the naked eye even in excessive dilution. The indicator was administered one-half hour prior to the start of the inhalation anesthesia. A gelatin capsule containing 10 mg. of Evans blue was administered orally with an ounce of water to facilitate its being swallowed. If a Levin gastric tube had been passed preoperatively, 4 cc. of 0.25 per cent solution of Evans blue (10 mg.) was instilled into the stomach through the tube. The gastric tube was then cleared of the indicator with 10 cc. of water.

The inhalation anesthesia was nitrous oxide 80 per cent and oxygen 20 per cent in a semiclosed system, with the gradual introduction of ether. After a period of approximately five minutes, the flow of nitrous oxide was discontinued, and a closed system with carbon di-

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oxide absorption was instituted. An endotracheal tube was inserted in 98 of the 112 cases. At the completion of the operation, while the patient was still under anesthesia, a laryngoscope was inserted to view the pharynx for the presence of gastric contents. A number 7 or 8, 40 cm. Jackson bronchoscope was then inserted into the trachea. The tracheobronchial tree was carefully and thoroughly inspected for the presence of gastric contents which appeared in various shades of blue, depending upon the dilution factor of the Evans blue in the stomach. Since this indicator is a nonabsorbable dye, the only way that it could have entered the tracheobronchial tree was by regurgitation and aspiration.

A total of 112 major operations was followed. In 29 cases the indictator was found in the pharynx, an incidence of 25.9 per cent for the regurgitation of gastric contents. In 22 of these 29 cases of regurgitation, the indicator was found below the larynx, an over-all incidence of 19.6 per cent. In 76 per cent or approximately 3 out of 4, of the cases with regurgitation, gastric contents were aspirated into the lung.

TABLE 1

	No. of Cases	Dye Regurgitation	Complicated Induction	Technic During Operation	Surgical Manipulation and Position
Upper Abdominal	43	11	4	3	4
Lower Abdominal	33	7	2	1	4
Miscellaneous	30	9	2	3	4
Thoracic	6	2	0	1	1

There were 43 upper abdominal cases with 11 incidences of regurgitation, or 25.5 per cent (table 1); of 33 lower abdominal cases there were 7 occurrences, or 21.2 per cent; 30 miscellaneous operations included 9 cases of regurgitation, or 30 per cent, and in 6 thoracic operations there were 2 incidences of regurgitation, or 33.2 per cent. The occurrence of regurgitation could be grouped under three headings, namely: (1) complicated induction of anesthesia including swallowing and vomiting during this phase, (2) light anesthesia during operation, with coughing, swallowing, or vomiting, and (3) surgical manipulation and position of the patient on the operating table. For example, there were 18 cases in which cholecystectomy or a surgical procedure on the bile duct was performed, with 5 incidences of regurgitation. Of these, 2 were attributed to complicated induction associated with vomiting, 2 were due to light anesthesia with swallowing occurring during the operation, and one occurrence was thought to be the result of the placement of the retractors during the operative procedure.

Under *complicated induction of anesthesia* 2 cases were included of long induction with excitement but no regurgitation. There were 6 incidences of laryngospasm, but none of these patients had regurgi-

tation. In the 2 cases of continued swallowing during the induction, both patients had regurgitation with aspiration into the lungs. In each of the 6 cases with vomiting during induction, there was regurgitation into the pharynx, and 4 of these involved aspiration into the lungs.

TABLE 2

(A) Complicated Induction of Anesthesia

		No. of Cases	Dye Regurgitation
1. Long Induction with Excitement		2	0
2. Laryngospasm		6	0
3. Swallowing		2	2
(Both cases—dye present in lungs)			
4. Vomiting		6	6
a. Dye present only in pharynx	2		
b. Dye present in lungs	4		

(B) Faulty Technic During Maintenance of Anesthesia

1. Light Anesthesia with Swallowing		3	3
a. Cholecystectomy (2). Supine			
b. Ureterolithotomy. Supine			
2. Light Anesthesia with Coughing and Swallowing		1	1
a. Ureterolithotomy. Lateral			
3. Light Anesthesia with Vomiting		2	2
a. Retroperitoneal node dissection. Supine			
b. Sigmoid resection. Mod. Trendelenburg			
4. Extraction of Drainage Tubes		2	2
a. Entero-enterostomy—Miller Abbott Tube extracted 2½ ft.			
b. Vagotomy—Levin tube removed during operation			

(C) Surgery or Position

1. Upper Abdominal Operations		36	4
a. Supine	4		
2. Lower Abdominal Operations		30	4
a. Trendelenburg	3		
b. Supine	1		
3. Miscellaneous Operations		25	4
a. Lateral	2		
b. Prone	2		
4. Thoracic Operations		5	1
a. Lateral	1		

Faulty technic during the maintenance of anesthesia accounted for 8 incidences. Light anesthesia with swallowing, coughing, or vomiting during the surgical procedure was the main cause. The extraction of drainage tubes, such as the Levin tube or the Miller-Abbott tube, accounted for 2 instances of regurgitation.

Manipulation of the stomach and intestine or compression from retractors was thought to be a likely cause for regurgitation.

Position of the patient on the operating table during the surgical procedure must not be forgotten. Marked Trendelenburg position favors regurgitation, especially if the depth of anesthesia were suffi-

cient to cause relaxation of the cricopharyngeal muscle. In 96 cases, induction was smooth and anesthesia was satisfactorily maintained. In this group, there were 13 incidences of regurgitation.

TABLE 3

PREMEDICATION

	No. of Cases	Dye Regurgitation	
Morphine and Atropine	62	15	26.1%
Nembutal, Morphine and Atropine	23	6	
Phenobarbital, Morphine and Atropine	3	2	
Demerol and Atropine	15	5	28.6%
Demerol and Scopolamine	1	0	
Nembutal, Demerol and Atropine	4	1	
Nembutal, Demerol and Scopolamine	1	0	
Chloral Hydrate, Demerol and Atropine	3	0	
	112	29	25.9%

Premedication was investigated as a possible cause. The incidence of regurgitation was practically the same with morphine or demerol (table 3). Combinations of morphine and atropine, as well as demerol and atropine were used.

TABLE 4

A. Type of Anesthesia

	No. of Cases	Dye Regurgitation	
		No.	Per Cent
1. Endotracheal, Nitrous Oxide, Oxygen and Ether	98	23	23.4
2. Nitrous Oxide, Oxygen and Ether	14	6	35.7
B. Experience of the Anesthetist			
1. Experienced	62	14	22.5
2. Inexperienced	50	15	30

The incidence of regurgitation was less when the endotracheal tube was used.

The experience of the anesthetist was considered. The incidence of regurgitation increased when a novice or a person with limited experience administered the anesthetic agent. Complicated induction and faulty maintenance of anesthesia were more frequent in this group.

TABLE 5

PRESENCE OF DYE ON BRONCHOSCOPY

Pharynx Alone	7
Pharynx and Trachea	6
Pharynx, Trachea and Right Bronchus	11
Pharynx, Trachea and Left Bronchus	0
Pharynx, Trachea and Both Bronchi	5
	29

This table shows the various locations where the dye was found. In 7 instances, the indicator-stained gastric contents were present only in the pharynx, while in the remaining 22 cases they were present below the larynx. Gastric contents, when present in the left bronchus, were always seen in the right bronchus. In 11 instances it was seen in the trachea and right bronchus.

Postoperative atelectasis occurred in 5 patients of this group of 112 major operations. This complication supervened even when bronchoscopic aspiration was carried out immediately after operation. It was present in 3 of the 22 cases in which indicator-stained gastric contents were found below the larynx during the postoperative bronchoscopy. The remaining 2 cases of atelectasis occurred in the group in which there was no evidence of regurgitation and aspiration.

TABLE 6

POSTOPERATIVE ATELECTASIS

		No. of Cases
Dye Found at Bronchoscopy		3
1. Bilateral patchy atelectasis	36 hrs.	
2. Atelectasis—right lower lobe	24 hrs.	
3. Atelectasis—right lower lobe	28 hrs.	
No Dye Found at Bronchoscopy		2
1. Bilateral patchy atelectasis	36 hrs.	
2. Bilateral patchy atelectasis	48 hrs.	

There was one occurrence of regurgitation not included in the series of 112 major surgical operations which deserves consideration. A 10 mg. capsule of Evans blue was administered orally before inhalation anesthesia was induced. When the laryngoscope was passed for endotracheal intubation, no dye was seen in the pharynx. During the course of surgical procedure, the tracheobronchial tree was aspirated because of the presence of mucus. At the time of aspiration, a deeply blue stained, thick mucus was obtained. At the completion of operation, bronchoscopy revealed no dye in the pharynx, but a deeply stained, thick mucus material in the trachea and right bronchus. This observation seemed odd, since it was not understood how dye could be present in the trachea without being present in the pharynx. A Levin gastric tube was passed and gastric contents aspirated which were normal in appearance and not stained with Evans blue. The conclusions drawn were that the capsule given preoperatively was aspirated into the lungs rather than swallowed into the stomach. This patient was under heavy sedation with nembutal, morphine and atropine.

COMMENT

Swallowing and vomiting during the induction of anesthesia favors the aspiration of gastric contents into the lungs. Of 8 patients with this complication, aspiration was found in 6. Therefore, 75 per cent of

the cases in which swallowing or vomiting occurred during induction showed aspiration. Careful induction of the inhalation anesthesia is an important consideration for the anesthetist. Experience teaches the art of gradually increasing the concentration of the anesthetic agent without its becoming an irritant too early before the sensory receptors which excite the vomiting reflex are depressed. Too slow or too rapid administration of ether predisposes to vomiting during induction. If vomiting should occur, the Trendelenburg position is advised, the head should be turned to the side to facilitate emptying of the mouth, and the suction apparatus should be used immediately to aspirate the vomitus from the pharynx.

The insertion of an oropharyngeal airway before the abolishment of the pharyngeal reflex excites the vomiting and gag reflex. Light anesthesia, with pharyngeal reflexes present, should be avoided during maintenance. If the pharyngeal or endotracheal tube is in place and anesthesia should lighten to mid-first plane, gagging and vomiting may occur. The cough reflex should be maintained whenever possible, since it will aid in the prevention of aspiration.

Position on the operating table is an important consideration. The prone position is an outstanding offender when a pillow is used under the abdomen. The lateral position tends to predispose to regurgitation either when the patient is turned into position before or after the operation, or when retraction is employed during the operative procedure. Moderate to marked Trendelenburg position favors regurgitation, but careful aspiration of the pharynx prior to straightening the table may lower the incidence of aspiration into the lungs.

With intra-abdominal operations, gastric or intestinal manipulation during exploration or the surgical procedure invites regurgitation. Packing off of the intestine and careful placement of the retractors may decrease the incidence. Emptying of the stomach and decompression of a distended bowel are preoperative precautions which tend to aid in the prophylaxis. From my experience, the incidence of vomiting during induction of anesthesia and regurgitation during the surgical procedure seems to be greater during emergency operations.

The withdrawal of gastric or Miller-Abbott intestinal tubes should be avoided during operation, but if their withdrawal is necessary, suction apparatus should be available to aspirate the pharynx as the tube is being extracted. The movement of the tube through the esophagus favors regurgitation of gastric contents. If the pharynx is not aspirated of its contents and the cough reflex has been abolished, aspiration into the lungs will occur.

Preoperative medication does not seem to play a major role in regurgitation during inhalation anesthesia. Morphine, however, does cause depression of the cough reflex, and may excite nausea and vomiting in some individuals. If such a history is obtained from the patient, the opiate should be omitted. The hypodermic injection of

morphine is best given sixty to ninety minutes before the start of inhalation anesthesia so that sufficient time is allowed for the absorption and maximum effect of the drug. Thus, whatever the effect, it will be seen before anesthesia is started.

The use of the endotracheal tube aids in maintaining a patent airway if regurgitation does occur. If aspiration of gastric contents has taken place during the induction of anesthesia, the endotracheal tube affords a means of repeated clearing of the trachea with a suction catheter during the surgical procedure. Vomitus may extravasate along the course of the tube if it fits loosely in the larynx and trachea. This can be prevented by using an inflatable cuff on the endotracheal tube, especially in cases of intestinal obstruction with distention in which regurgitation is expected. Thorough suctioning of the mouth and pharynx is advisable before removal of the endotracheal tube. Aspiration of the pharyngeal contents may occur when the first inspiration is taken after removal of the endotracheal tube.

Postoperative nursing care in the recovery room is of paramount importance in the prophylaxis of aspiration pneumonitis. During the postanesthetic emergence, vomiting may occur, and if good nursing care is not available, aspiration can be anticipated. It is my custom to place the patient on the side with the upper leg flexed on the abdomen so he or she will not roll forward. The head is turned to the side. The tongue falls forward to maintain a good airway and prevents any degree of obstruction. If vomiting does occur, it flows out the mouth. When vomiting takes place, suction apparatus should be at the bedside for immediate removal of the vomitus. During the first twenty-four hours after operation, the avoidance of large doses of opiates is important to maintain a satisfactory cough reflex. Under marked narcotic depression, vomiting can occur with aspiration into the lungs.

SUMMARY

This investigation revealed an incidence of 25.9 per cent of regurgitation of gastric contents into the pharynx in a series of 112 major surgical operations. In the 29 cases of regurgitation there was an incidence of 76 per cent of aspiration of the gastric contents into the lungs. Complicated induction of inhalation anesthesia with swallowing and vomiting favors aspiration. Light anesthesia with the pharyngeal reflexes not abolished might be avoided. When the anesthetist is experienced the incidence of regurgitation tends to be lower and when regurgitation occurs, proper steps are instituted to avoid aspiration.

Preoperative preparation of the patient must include an empty stomach and decompressed bowel. Gentle intra-abdominal exploration may decrease the incidence of regurgitation. The careless packing of intestine and placement of the retractors may tend to increase the in-

cidence. The position of the patient during the surgical procedure may play a part in the increased incidence in operations requiring other than the supine position. The withdrawal of drainage tubes during anesthesia predisposes to regurgitation and if the cough reflex has been abolished, aspiration into the lungs may occur. Pharyngeal suction of accumulating material should be performed if the removal of such a tube is necessary.

It is advisable to obtain the maximum effect of premedication before the start of inhalation anesthesia. Sufficient time is allowed to elapse for absorption. The effects then are seen prior to the start of anesthesia. The depressing effects of morphine on the cough reflex must be borne in mind.

The endotracheal tube affords a patent airway and facilitates tracheal suction during operation. The conscientious attention on the part of the anesthetist to keep the pharynx free of material will lower the incidence of aspiration. Thorough suctioning of the pharynx and trachea at the completion of the surgical procedure will act as a prophylaxis against atelectasis and aspiration pneumonitis.

Immediate postoperative nursing care is a continuation of the attention rendered the patient by the anesthetist. A well equipped and completely staffed recovery room tends to lower the incidence of postoperative complications. Scrupulous care is as important during the recovery as during the induction of anesthesia.

REFERENCES

1. Hölscher, R.: Experimentelle Untersuchungen über die Entstehung der Erkrankungen der Luftwege nach Aethernarkose, Arch. f. klin. Chir. 57: 175–232, 1898.
2. Lemon, W. S.: Aspiration, Arch. Surg. 12: 187–211 (Jan.) 1926.
3. Mendelson, C. L.: The Aspiration of Stomach Contents into the Lungs during Obstetric Anesthesia, Am. J. Obst. & Gynec. 52: 191–205 (Aug.) 1946.
4. Gibson, J. G., and Evans, W. A.: Clinical Studies of the Blood Volume. Clinical Application of Method Employing Azo Dye "Evans Blue" and Spectrophotometer, J. Clin. Investigation 16: 301–316 (May) 1937.