BALLOON TAMPONAGE FOR THE CONTROL OF HEMORRHAGE FROM ESOPHAGEAL VARICES*

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THE ADVENT OF THE BLOOD BANK, making large quantities of blood quickly available, has saved lives from ruptured esophageal varices. But, as has turned out to be the case with bleeding peptic ulcers, many patients will die if dependence is placed upon transfusions alone. In cases of peptic ulcer with persistent bleeding, operation has already proved its worth by reducing mortality in our hospital experience from 60 per cent to 5 per cent. So, in cases of bleeding from esophageal varices, if more lives are to be saved, a sure method of stopping hemorrhage at the bleeding site must be devised.

The concept of stopping hemorrhage at the site of a ruptured esophageal varix by tamponage is not a new one.[1-3] Our interest in the subject of balloon tamponage of the esophagus arose some ten years ago when we first began taking portal pressure readings in cases of portal hypertension. These pressure readings gave us the clue to the magnitude of pressure that would be necessary to collapse veins in the coronary-esophageal collateral circuit. By experiment it was determined that pressures of this magnitude (20 to 30 mm. of mercury) could be tolerated by the esophagus for considerable periods of time.

It is a fact, that the majority of cases, (75 per cent in our series), with bleeding esophageal varices have livers damaged by cirrhosis. It is equally well known that badly damaged livers tolerate anoxia from hemorrhage and shock poorly. Time after time patients may be brought out of shock by transfusions, only to be lost, days later, because of liver failure. It was our hope that if an efficient method of balloon tamponage could be made available for quick use in such cases, it would mean that the total quantity of blood lost might be greatly reduced. This would lessen the likelihood of immediate death from shock or delayed death from liver failure.

Knowing the relatively low magnitude of pressure necessary to collapse esophageal varices, it was hoped that traction upon a nasogastric tube bearing an inflated balloon in the stomach would be the simplest solution to the problem of hemorrhage. It is a fact that if sufficient traction is applied to a nasogastric tube, bearing an inflated balloon in the stomach, hemorrhage will cease. The balloon makes contact with and compresses the coronary veins at their junction with the esophageal veins and thus prevents the flow of portal blood through this collateral circuit.

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The above described mechanism prevails irrespective of the contour of the balloons employed. When, for example, the balloons upon inflation are spherical or globular in shape, traction upon the nasogastric tube causes the upper portion of the balloon to ascend within the esophagus to some extent. This affords compression of the veins at the coronary-esophageal junction. If a sausage shaped balloon be employed, though a greater part of it be placed in the esophagus to start with, upon inflation its lower portion expands rapidly, globular fashion, into the stomach. Providing that the nasogastric tube is taped securely to the nose to afford counter traction to the downward thrust of the balloon again, satisfactory compression of the veins at the coronary-esophageal junction will be attained and hemorrhage will cease.

This method of employing traction upon a nasogastric tube bearing a balloon or balloons for the arrest of hemorrhage from esophageal varices has been used by many and described by some.[1-3]

Constant tension, however, upon a nasogastric tube with an inflated balloon jammed into the lower end of the esophagus exerts pressure upon the entire naso-esophageal tract and an upward pull upon the stomach. This serves to initiate reflexes which result in contractions of the stomach and esophagus. As these contractions become exaggerated, retching with convulsive attempts at regurgitation supervene. Thus is promoted a condition which gets beyond the human power of wilful control. Granted that the balloon may be inflated to a size that would resist regurgitation of the tube, nevertheless, continuous retching creates an impossible situation and, besides, causes a sharp rise in portal blood pressure.

To abolish regurgitation reflexes and effect tolerance to traction upon a nasogastric tube requires deep sedation in the average case and even anesthesia in some. Whereas these are undesirable features, and particularly so when dealing with cases of cirrhosis of the liver, nevertheless they do not cancel out the usefulness of a device which has proved to be life saving.

The above observations pointed out to us the need of an esophageal balloon so designed that once placed correctly in the esophagus and inflated, it will not mushroom into the stomach and thus create a drag upon the nasogastric tube.

It must be remembered that an esophageal balloon, to be effective in the arrest of hemorrhage from esophageal varices, must exert pressure upon veins from the coronary-esophageal junction upward. Thus the lower end of the balloon must project slightly into the stomach. To prevent over-expansion during inflation of that lowest portion of the sausage-shaped esophageal balloon which projects, unsupported, into the stomach, the idea occurred to one of us (R. W. S.) of reinforcing the lower one-third of the balloon with a double thickness of rubber. This reinforced, self-retaining, esophageal balloon was first employed by us in September, 1946. The case was that of a 15-

year-old girl suffering from a severe attack of hematemesis due to portal hypertension, secondary to extrahepatic portal block. At first the bleeding was stopped in the usual manner, employing the traction principle of balloon tamponage as follows: A triple lumened nasogastric tube bearing two balloons was passed. The lowermost spherical-shaped balloon was inflated in the stomach, following which the nasogastric tube was withdrawn just snug and taped securely to the nose. Finally, the upper esophageal balloon was inflated. During inflation of this balloon, the nasogastric tube became taut and began to pull upon the nose. The pressure in the balloon rose during inflation to 30 mm. of mercury but only after 200 cc. of air had been introduced, at which point bleeding ceased. Shortly afterward, in spite of sedation, the child began to retch and finally regurgitated the tube with the inflated balloons intact.

Because of the recurrence of bleeding in this case, a second attempt was made. In this instance, a nasogastric tube bearing a special sausage-shaped esophageal balloon was passed. The balloon was identical in size and shape to the balloon previously used except for the important difference that the lower one-third was reinforced with a double thickness of rubber. Inflation of this balloon resulted in a startling difference: the mercury in the manometer began to rise immediately and, following the injection of only 50 cc. of air, bleeding from the esophageal varices ceased entirely. This small amount of air compared to the 200 cc. required in the unreinforced balloon to accomplish the same result.

The obvious reason for the difference in behavior between the unreinforced and the reinforced balloons during inflation is that the lower end of the unreinforced esophageal balloon expands, globular fashion, into the stomach and thus consumes great quantities of air; whereas, the double thickness of rubber at the lower end of the reinforced balloon resists overexpansion and forces the air to exert equal pressure upon the esophageal veins throughout the length of the balloon. Because of this special design, promoting equalization of pressure, there is no tendency for the reinforced esophageal balloon to mushroom into the stomach and cause the dreaded drag upon the nasogastric tube. The facts are that the balloon remained inflated with complete control of hemorrhage in this 15-year-old child for a period of 48 hours. Though only light sedation was employed, the patient made no serious effort to regurgitate the tube.

In Figure 1 is shown a satisfactorily designed tube for balloon tamponage of the esophagus.* Note the generous size of the main, central lumen of the tube. This is essential to permit aspiration of old blood from the stomach and for feeding in certain cases. The tubes to the balloons are relatively small and are incorporated in the outer wall of the large tube. The distal balloon, when inflated in the stomach has a primary purpose as a marker for quick and proper positioning of the upper balloon in the esophagus. Although

* Made according to our design by the Davol Rubber Company, Providence, R. I.

there is a radiopaque marker incorporated in the wall of the tube between the balloons, roentgenograms are not necessary in the average case. The most important feature of the whole assembly which shows up least in the photograph is the reinforced area of the esophageal balloon: note the shading of double thickness rubber in the distal third of the balloon.

The specially designed esophageal balloon has been employed by us for the control of bleeding from esophageal varices in 30 patients with outstanding success. There were no deaths from shock due to hemorrhage and, in our opinion, many pints of blood were saved. In addition to its efficiency in stopping hemorrhage, an asset of primary importance is the fact that the tube and balloon are well tolerated by the average patient and may be employed for long periods of time.

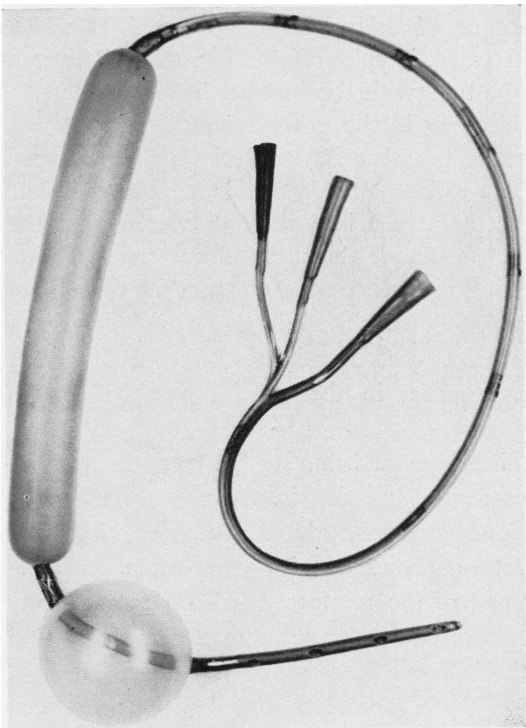

FIG. 1.—A photograph of a naso-gastric tube-balloon assembly for the emergency control of hemorrhage from esophageal varices. Note the generous size of the tube for gastric suction. Observe that the distal one-third of the sausage-shaped esophageal balloon is more shaded, indicating a greater thickness of rubber. A metal roentgen ray marker is incorporated in the wall of the tube between the balloons.

It is now well known that in cases of cirrhosis with severe liver damage bleeding from esophageal varices may be unduly prolonged because of an alteration in the clotting mechanism, due to hypoprothrombinemia. This was well illustrated in one of our recent cases in which the nasogastric tube was left in place for a period of seven weeks, during which period the patient was tube fed. This 56-year-old man with serious liver failure started to bleed from his esophageal varices the moment the pressure in the esophageal balloon was released. This performance continued for many weeks, during the most part of which he was semistuperous from cholemia. On admission he was deeply jaundiced, and had ascites and peripheral edema. He rapidly developed enlargement of both breasts, testicular atrophy and a falsetto voice; his cholesterol esters were but 12 per cent of the total. The bromsulfalein retention was 55 per cent one-half hour after injection and the serum albumin 2.3 Gm. per 100 cc. Amazingly enough, four and one-half months after admission, the patient rather suddenly began to improve. At eight months following onset, he is back at his job as an editor.

It is a frequent experience that patients with severe cirrhosis bordering on cholemia, when suddenly complicated with hemorrhage from esophageal varices, will die promptly of total liver failure, transfusions notwithstanding. Never, in our experience, has a patient as ill as the one above cited survived. It is true that we also used transfusions and hykinone in abundance on this patient during the critical several weeks.

Notwithstanding, one could best judge the prevailing incapacity of his blood to clot simply by releasing pressure in the esophageal balloon and aspirating a sample of stomach contents. The patient proved to have small esophageal varices, scarcely demonstrable by roentgen ray. This is suggestive evidence that the blood clotting dyscrasia and not the degree of portal hypertension was largely responsible for the tendency to prolonged bleeding from the varices. It is our considered conviction that the control of blood loss with balloon tamponage was the most important factor in saving this man's life. Another feature of interest is the large amount of protein and carbohydrate feeding mixture this patient consumed daily via gavage feedings.

The Sengstaken, reinforced, esophageal balloon is assuming a role of increasing importance in preparing those cases of portal hypertension complicated by hemorrhage for the portacaval shunt operation. There are many patients with cirrhosis of the liver who, because primarily of a severe grade of portal hypertension, have one attack of hematemesis after another with grave regularity. Such patients are doomed to die and very soon, unless they obtain operative relief. In our series of 71 cases of cirrhosis in which a portacaval shunt has been established, there are 15 cases belonging to this desperate group. Surprising though it may seem, 13 of the 15 patients survived.

The nasogastric tube bearing the reinforced esophageal balloon did yeoman service in this group in affording control of hemorrhage during that treacherous period of transfusions to bring up the blood volume and red blood cell mass to normal before operation. The tube covered a longer period of forced nutrition in one case in whom transfusions could not be used preoperatively because of violent febrile reactions to as little as 50 cc. of blood. This patient, though she was jaundiced and had a badly functioning liver in some other respects, survived a side-to-side portal vein to venacava anastomosis, in spite of receiving several transfusions while under anesthesia. Her postoperative course was stormy, but she is alive and symptom-free. All roentgen ray evidence of esophageal varices are gone and she has been free of hemorrhages now for nearly two and one-half years since operation.

It is of interest that in the group of chronic, recurring bleeders, there are two cases of partial portal vein thrombosis. One patient with an old thrombus which had become covered with intima got an excellent result following an end-to-side anastomosis of the portal vein to the venacava. The patient is active and has been free of hemorrhages now for more than one year since operation.

The second patient had a thrombus of about the same size, (40 per cent of the diameter), but of more recent origin. The intima had not covered the thrombus. A small hematemesis occurred immediately after an esophagram made on the sixteenth day following an end-to-side anastomosis of the portal vein to the venacava. Though the roentgenograms showed the varices to be smaller than before operation, we concluded that the anastomosis was either occluded or inadequate in size and that a splenorenal shunt was indicated. Accordingly, a nasogastric tube was passed and balloon tamponage established. Over a ten-day period, the patient was given a high protein-carbohydrate mixture by gavage. The blood volume and red blood cell mass were brought up to normal. At this point, the patient went through a splenorenal shunting operation which was followed by an uneventful recovery. Following this procedure, repeated roentgenograms of the esophagus failed to reveal any varices. The patient had had no further episodes of hemorrhage when last heard from.

Some idea of the drain incurred upon blood banks in trying to keep these chronic, recurring bleeders alive on transfusions alone may be illustrated by the following case of a 36-year-old white male with Laennec's cirrhosis who, during a year of treatment under the Patek regimen, had shown marked improvement of liver function. His jaundice, ascites, and leg edema had cleared but the hepatosplenomegaly had persisted. Likewise, roentgenograms of the esophagus following a barium swallow revealed large, extensive varices.

Six weeks prior to the patient's admission to the Presbyterian Hospital, two severe hematemeses occurred, four days apart. The estimated blood loss of 4500 cc. was replaced by transfusion. From the day of the patient's admission to the medical ward of the Presbyterian Hospital until the day of his transfer to Surgery, over an interval of 21 days, this patient had nine hematemeses. The estimated blood loss over this period totaled 14,700 cc. of blood. A total of 16,000 cc. (22 pints) of blood was given in replacement therapy. In spite of this, the patient was in severe shock at least once. On several occasions it was feared that the patient was going into coma because of a state of stupor.

On the night of transfer to the Surgical Service, the patient had a hematemesis of 2700 cc. Bleeding was promptly checked by a reinforced esophageal balloon. The patient was given 2500 cc. of blood during the night and a portacaval shunt, anastomosing the portal vein to the venacava, end-to-side, was performed the next day. The patient recovered from the operation and has had no further hemorrhages, now nearly a year since operation.

It may be that this patient's need of 22 pints of blood over a 21-day period could be supplied by an average community hospital. The facts are, however, that on the occasion of severe shock, this man consumed 12 pints (6000 cc.) of blood, over a 24-hour period. It is our opinion that such patients would have a far better chance of coming through alive if the average hospital were equipped for balloon tamponage. Furthermore, estimating the over-all cost of blood at $30.00 a pint, this patient alone could have equipped 55 community hospitals for balloon tamponage.

For some time, in our papers on portacaval shunt,[4, 5] we have stressed the usefulness of this simple device.

Figure 2 is a photograph showing equipment with the naso-gastric tube in place.

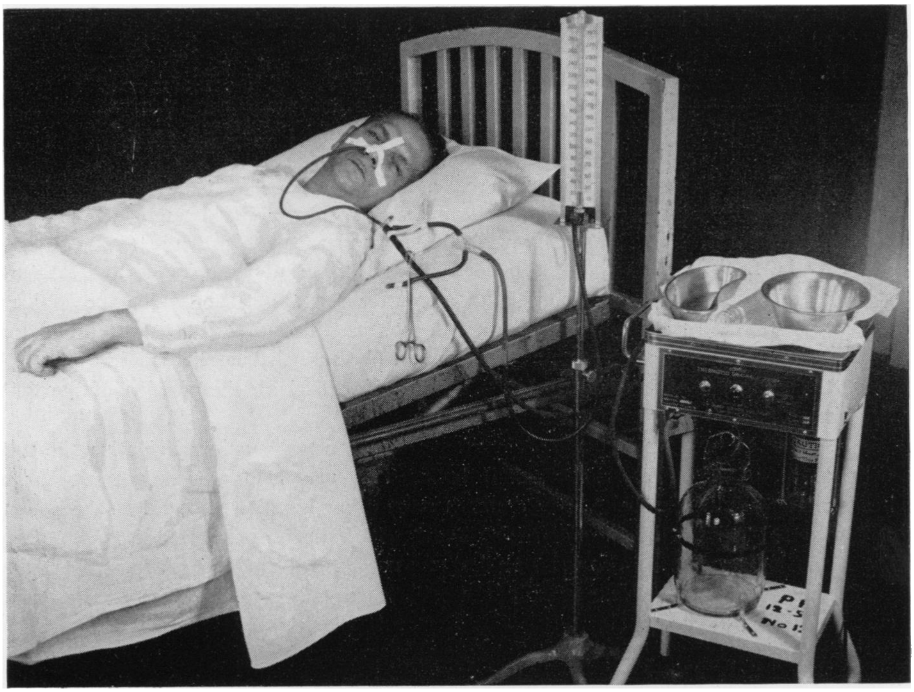

FIG. 2.—A photograph showing a patient having esophageal balloon tamponage.

INSTRUCTIONS FOR PASSING THE ESOPHAGEAL BALLOON FOR THE CONTROL OF BLEEDING FROM ESOPHAGEAL VARICES

Equipment Needed:

1. Esophageal varices tube with balloons attached.
2. Mercury manometer or Aneroid gauge of the Tycos sphygmomanometer to be connected with a "y" glass tube to upper sausage balloon.
3. Fifty cc. syringe.
4. Constant intestinal suction machine.
5. Lubricating jelly (not petroleum jelly).
6. Glass of water with straw.
7. One clamp for rubber tubing such as a Crile, Kelly, or Kocher hemostat.

Instructions for Passing the Tube:

A. Coat the lower part of the tube and the balloon with a thin coat of lubricating jelly.

B. After spraying the nostrils and the posterior pharynx with cocaine or butyn, pass the tube through the nostril until the tip is in the posterior pharynx or throat. Then, with swallows of water sipped through the straw in the glass of water, pass the tube to at least the 50 cm. mark. Next, inflate lower balloon with 150 to 200 cc. of air and withdraw tube slightly until resistance is encountered. Then inflate the upper sausage balloon to 20 mm. of mercury pressure and finally tape tube to nose securely.

C. Next, aspirate the stomach so that all of the blood is out of the stomach as well as air and swallowed water. During the aspiration, it is advisable to irrigate the tube frequently with at least 40 cc. of water to prevent the tube from clogging due to blood clotting.

D. Adjust pressure in upper balloon until bleeding ceases as determined by aspiration, usually 20 to 25 mm. of mercury as read on the manometer connected to one branch of the glass Y tube. When the balloon is in the proper position, the pressure will vary with cardiac and respiration pulsations and with contractions of the esophagus which may raise the pressure to 70 mm. of mercury. The pressure should not fall much below the above mentioned pressure. This pressure will require approximately 40–60 cc. of air. If more air than this amount is needed to give an adequate pressure (viz. 200 cc.), one may be fairly certain that the balloon is well out of the esophagus and into the stomach and hence down too far. After sufficient air is placed within the balloon, securely clamp the branch of the Y tube that was used to inflate the balloon so that it will not leak air. Check the pressure frequently to be sure that no leakage has occurred. A portable roentgenogram may be taken at this point to check the position of the tube. See the paragraph on construction of the tube.

E. Then connect the stomach aspiration tube to constant suction, irrigating the tube with 40 cc. of warm saline every half hour. This will help prevent the tube from being clogged with blood clot. The stomach must never be allowed to fill as the patient will then regurgitate the tube. Keeping the head of the bed elevated also helps keep the stomach empty. This also helps to decrease nausea and gagging. Adequate sedation is absolutely essential. We generally use sodium amytal intravenously and intramuscularly. This may be supplemented with Demarol if necessary. It is not necessary to keep the patient unconscious, but a slightly stuporous state is desirable at first. Regurgitation is due to two causes usually, the most important is lack of sedation, and the other is allowing the stomach to become filled. Bleeding should be stopped and the stomach can be kept free of blood once adequate pressure is maintained upon the esophageal wall. If the tube should be regurgitated, it should be re-passed immediately and without hesitation.

F. The tube with the balloon inflated should be kept at the minimal pressure required to control bleeding, approximately 25 mm. of mercury for at least 48 hours and then deflated for 12–24 hours to see if new bleeding occurs. If none occurs then the balloon may be slowly withdrawn with very little danger of starting new bleeding. During the time that the balloon is in place, the patient must be kept hydrated and can be given some nutrition by intravenous or clysis fluids. Feedings can be given through the stomach part of the tube, 100 to 150 cc. per hour, with the head of the bed elevated and the patient on his right side. If all goes well, the stomach may be aspirated just before feedings. Too thick feedings must be avoided as they will clog the tube and remain in the stomach an undue length of time. It must be remembered that placing too much feeding within the stomach will increase the dangers of vomiting the tube, and therefore extreme caution must be used for there is great variability in the tolerance of patients.

In cases requiring prolonged tamponage, tube feedings are more important. The following is a good formula for cirrhosis cases:

		Proteins Gm.	Carbohydrates Gm.	Fats Gm.
Skimmed milk....................	= 1500 cc.	75	60	0
Eggs............................	= 3	19	..	17
Glucose "Dyno"..................	= 120 Gm.	..	120	..
Protein hydrolysate "Protinol"	= 100 Gm.	61.5	30	..
Ground liver.....................	= 200 Gm.	47	..	33
		202	210	50

Add water up to 2400 cc.
Total calories = 2098 for 24 hour intake.

Glucose and protein hydrolysate proportions may be varied to alter Protein and Carbohydrate ratio.

G. It is important to emphasize that the patient is to swallow nothing, not even saliva, once the tube is in place. In cases having excessive mucus accumulation the balloon may be deflated for a few minutes several times a day.

H. After the tube has been withdrawn, the patient may be started on clear fluids and slowly advanced to a soft diet.

I. If, after the esophageal balloon is inflated to as much as 30 to 35 mm. of mercury, repeated aspirations from the stomach reveal bright red blood, it usually means the source of bleeding is from a coronary vein on the stomach wall: a rare occurrence in our experience. In this event, the patient is given additional sedative at once, the nasogastric tube is snubbed up firmly and taped securely to the nose. Finally, the stomach balloon is inflated with more air gradually, to avoid retching. It may require a total of 300 to 400 cc. of air to arrest bleeding.

SUMMARY

A nasogastric tube with a specially designed esophageal balloon is presented for the emergency control of hemorrhage from bleeding esophageal varices. The device is well tolerated by the average patient under mild sedation. Cases are cited to illustrate its usefulness.

BIBLIOGRAPHY

[1] Westphal, K.: Uber Eine Kompressions Behandlung Der Blutungen Aus Esophagus Varizen. Deutsche Med. Wchnschr, **56**: 1135, 1930.
[2] Kaplan, B.: Medical Record, **154**: 175, 1941.
[3] Rowntree, L. G., E. F. Zimmerman, M. H. Todd and John Ajac: Intraesophageal Venous Tamponage. J. A. M. A., **135**: 630, 1947.
[4] Blakemore, Arthur H.: The Portacaval Shunt for the Relief of Portal Hypertension. The Mississippi Doctor, pp. 1–10, June, 1949.
[5] Blakemore, Arthur H.: The Portacaval Shunt in the Surgical Treatment of Portal Hypertension. Presented at the Southwestern Surg. Congress, Houston, Texas, Sept. 27, 1949. In press.