

## Three years experience with a new balloon catheter for the management of haemoptysis

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*Three years experience with a new balloon catheter for the management of haemoptysis. L. Freitag, E. Tekolf, G. Stamatis, M. Montag, D. Greschuchna. ©ERS Journals Ltd 1994.*

**ABSTRACT:** For the management of severe haemoptysis we have developed a double-lumen, bronchus-blocking catheter that can be introduced through the working channel of a standard fibrebronchoscope. We wondered whether this catheter would be suitable to control pulmonary haemorrhage in clinical practice.

Over a period of 36 months, 30 of these catheters were used in 27 patients with moderate and massive pulmonary bleeding from various lesions. Underlying diseases were: malignancies (11), vascular deformities (5), tuberculosis (4), silicosis (2), carcinoids (2), silicosis (2), endometriosis (1), bronchiectasis (1).

In 26 cases, the transbronchoscopic balloon tamponade was successful. In one patient, tumour growth close to the carina prevented securing of the balloon and double-lumen tube intubation was required. There were only minor complications attributable to the balloon. With the catheter in place for up to seven days, patients underwent surgery, received radiation, chemotherapy, drug treatment or bronchial arterial embolization.

In conclusion, we found this double-lumen, bronchus-blocking device safe and the technique practicable to control pulmonary haemorrhage.

*Eur Respir J., 1994, 7, 2033–2037.*

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Keywords: Bronchus blocker  
fibrebronchoscopy  
haemoptysis  
interventional bronchoscopy  
transbronchoscopic balloon tamponade

Received: December 7 1993  
Accepted after revision July 31 1994

Bronchial bleeding is a common complication in patients with bronchial carcinoma, tuberculosis, or chronic airway inflammation. Following transbronchial biopsies, severe bleeding may occur and can be life-threatening [1–5]. The mortality of massive haemoptysis results from asphyxiation rather than from exsanguination. The standard emergency treatment includes posture, Zavala's suction technique, instillation of vasoactive drugs, flushing with cold saline, laser or electrocoagulation [5–7]. However, some cases require further measures.

In former years, when tuberculosis was the most frequent cause of lethal haemoptysis, tamponade with impregnated swabs or sponges through a rigid bronchoscope was a common practice [8]. Even today, the most reliable measure to prevent suffocation from aspirated blood is intubation with a double lumen tracheal tube (such as Carlens tube or Robertshaw tube), so that at least one lung is saved for ventilation, regardless of the origin of the bleeding. If the side of bleeding is known, the contralateral stem bronchus can be intubated with a long tube. An alternative is the introduction of a Foley catheter into a stem bronchus. For localized and more peripheral lesions, a smaller balloon catheter is the instrument of choice [9–12].

Whilst Carlen's tubes and Foley catheters can only block stem bronchi, Fogarty catheters are suitable for occlusion of segmental bronchi; thus, providing more

lung tissue for gas exchange. Originally developed for vascular procedures, these instruments have some limitations. Commercially available catheters are either too thick to be guided through a small bronchoscope or they contain only one channel. As the valve is part of the catheter, it cannot be removed without destroying the instrument. Techniques have been described to cut off the hub and insert a pin plug to maintain the balloon pressure [10]. After cutting, deflation and reinflation of the catheter is no longer possible. A recently developed bronchus-blocking catheter overcomes these problems [13]. Our experience with this bronchus blocker is presented here.

### Methods

#### *Bronchus-blocking device and procedure*

The bronchus-blocking catheter has a length of 170 cm and an outer diameter of 2 mm. A flexible barrel-shaped latex balloon at the end of the device can be inflated with 3 ml of air, or with diluted contrast medium, to block a bronchus. Vasoactive drugs can be instilled through a second inner channel. A double valve at the proximal end of the catheter can be detached and easily reconnected (fig. 1).

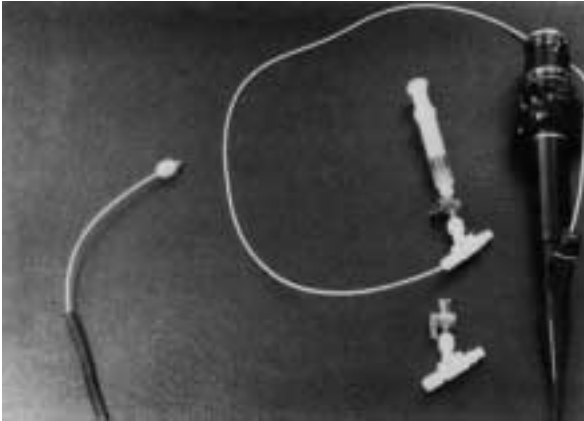


Fig. 1. – Blocking catheter inserted through the working channel of a fiberoptic bronchoscope. The double valve can be removed and reconnected after the bronchoscope has been withdrawn.

In the case of pulmonary haemorrhage, the source of bleeding is localized with a fibrebronchoscope. With the bronchoscope in wedge position, the catheter is guided through the working channel and the balloon is inflated until the bleeding stops. The bronchoscope can be withdrawn, whilst the catheter with the inflated balloon remains in place. The valve is detached and the bronchoscope is pulled out over the catheter. Due to its special design, the valve can be reconnected and approximately 0.5 ml of contrast medium, which usually leaks, is re-injected. The blocking procedure takes only a few seconds. Central airways can be blocked as well as segmental bronchi and even cavities, if the procedure is performed under fluoroscopy (fig. 2a and b). If the bleeding does not cease, the blocker provides enough time for further measures to control haemoptysis.

#### Study population

Over a period of 36 months, 30 catheters were used in 27 patients with moderate or severe pulmonary haemorrhage. During this period, a total of more than 15,000 bronchoscopies were performed in our hospital. The word "haemoptyses" appeared in 5.9% of all endoscopy reports. The catheters were used only in patients who had lost at least 100 ml of blood. There were 19 male and 8 female patients, with a mean age of 58 yrs (range 21–85 yrs). The underlying diseases, origin of bleeding, placement of the balloon, further treatment and outcome are shown in table 1. Localization of the balloon, and time of placement are shown in figures 3 and 4.

#### Results

All but one of the attempted balloon tamponades were successful. One patient with bleeding from a tumour in the left main bronchus had to be intubated with a Carlens tube, as the distance between tumour and carina was so short that the balloon could not be anchored. In the remaining 26 patients, a total of 29 catheters were inserted and left in position between 15 min and one week.

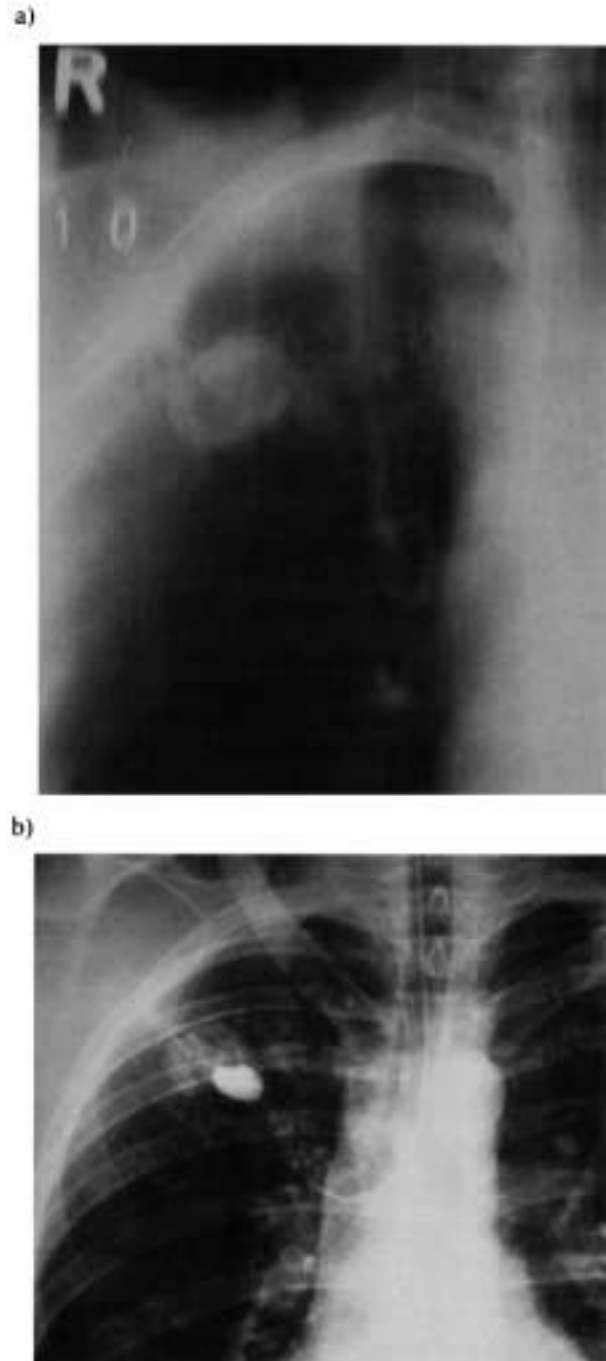


Fig. 2. – a) Bleeding from a tuberculous cavity. b) Balloon, filled with diluted contrast medium blocking the segmental bronchus and the cavity.

Two patients with large cavities needed two catheters. In one inoperable patient with silicosis, a second blocker had to be placed 5 days after removal of the first one.

With the inflated balloon in place, bronchial arterial embolization could be performed in 12 cases without the coughing of blood and danger of suffocation (fig. 5). The catheters could be left in place until the patients underwent surgery (n=11), received radiation (n=5), or drug therapy (n=4).

Table 1. – Patient data, underlying diseases, origin of bleeding, position and time of tamponade, further treatment and outcome

Pat No.	Age yrs	Sex	Diagnosis	Origin	Cause	Placement	Time	Treatment	Outcome and observation period
1	85	F	Squamous cell carcinoma	RUL	Biopsy	Ostium B3	15 min	Terlipressin, radiation	No bleeding, 15 months
2	62	M	Multiple aneurysms	ML, LLL	Spont.	B4r and B8l	3 days	Two times embolization, surgical ligature	Cardioresp. failure exitus
3	48	M	Tuberculosis	RUL	Spont.	Cavity B2, 3	7(5) days	Embolization, lobectomy	No bleeding, 20 months
4	64	M	Squamous cell carcinoma	RUL	Biopsy	Ostium B3	1 h	Laser coagulation, lobectomy	No bleeding, 19 months
5	68	F	Carcinoid	L stem br	Laser	Main br	1 h	Emergency pneumonectomy	No bleeding, 15 months
6	69	M	Tuberculosis	LUL	Spont.	Ostium LUL	2 h	Embolization, chemotherapy	No bleeding, 14 months
7	70	F	Squamous cell carcinoma	LLL	Laser	LL br	36 h	Radiation therapy	No bleeding, 1 month
8	60	M	Giant cell carcinoma	LUL	Spont.	Main br	3 days	Embolization failed, radiation	No bleeding, 1 yr
9	42	M	Squamous cell carcinoma	L stem br	Spont.	Main br	36 h	Pneumonectomy	No bleeding, 10 months
10	52	M	Oat cell carcinoma, cumarine	LLL br	Spont.	LL br	4 days	Chemotherapy, radiation	Fatal haemoptysis after 1 month
11	62	M	Aneurysm	LLL	Spont.	Ostium B6	2 h	Lobectomy	No bleeding, 9 months
12	68	M	Lymphangiosis	RUL	TBB	Ostium RUL	20 min	None	Alive, 7 months
13	68	M	Giant cell carcinoma	RUL br	Biopsy	Ostium RUL	10 min	Pneumonectomy	No bleeding, 7 months
14	56	M	Silicotuberculosis	RUL	Spont.	B3	2 days	Embolization, drugs	No bleeding, 6 months
15	52	F	Pulm. vascular deformity	RUL	Spont.	Ostium B2	3 days	Embolization	No bleeding, 6 months
16	32	M	Tuberculosis	RUL	Spont.	Cavity RUL	2 days	Anti-TB drugs	No bleeding, 5 months
17	62	M	Aneurysm	ML	Spont.	Ostium ML	2(2) days	Embolization failed, lobectomy	No bleeding, 5 months
18	75	F	Bronchiectases, cumarine	Lingula	Spont.	Lingula br	5 days	Embolization	Lost for follow-up
19	61	M	Squamous cell carcinoma	RUL	Spont.	Ostium B1	28 h	Fibrine sealant, radiation	No bleeding, 4 months
20	63	M	Silicosis	RUL	Spont.	Ostium B1	3 days	Embolization	No bleeding, 3 months
21	51	F	Endometriosis	Lingula	Catamenial	Lingula	4 h	Embolization, hormones	No bleeding, 3 months
22	21	F	Carcinoid	RLL	Biopsy	Ostium B9	3 h	Lobectomy	No bleeding, 1 month
23	34	M	AV-aneurysms	LUL	Spont.	B3	6 h	Lobectomy	No bleeding, 2 weeks
24	56	F	Metastases	LUL	Spont.	Ostium B5	2 days	Lobectomy	No bleeding, 2 weeks
25	65	M	Silicosis, aspergillosis	ML	Spont.	Ostium B5	3 days	Embolization	Minor bleeding, pneumonia
26	66	M	Silicosis	LLL	Spont.	B8, B6	3(2) days	None	No bleeding, 2 weeks

Pat: patients; F: female; M: male; Pulm: pulmonary; AV: arteriovenous; RUL: right upper lobe; ML: middle lobe; LLL: left lower lobe; L: left; LUL: left upper lobe; br: bronchus; RLL: right lower lobe; Spont: spontaneous; TBB: transbronchial biopsy.

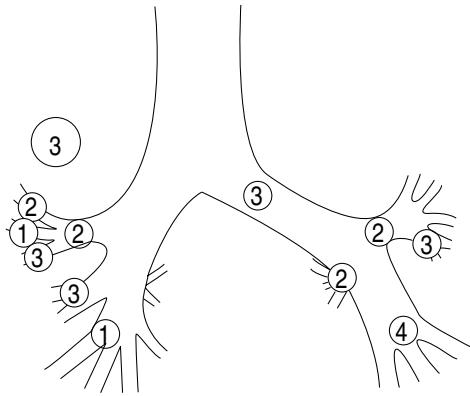


Fig. 3. — Positions of balloons. Three balloons were placed in the left main stem bronchus, 23 at the level of segmental bronchi, and three in peripheral cavities.

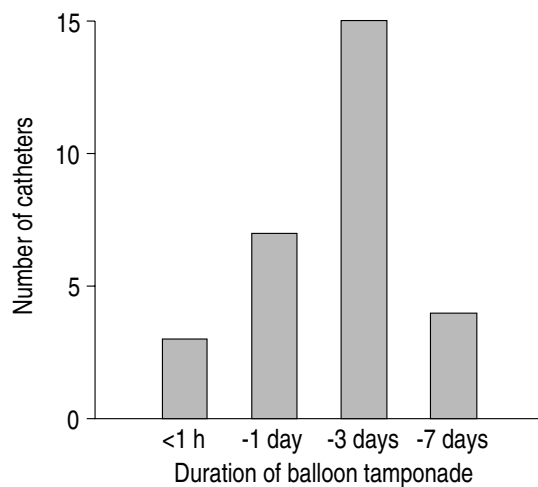


Fig. 4. — Duration of placement of the catheter with inflated balloon, <1 h, up to 1, 3 and 7 days.

The bronchus blocker was deflated for a few minutes at least three times a day to check whether the bleeding had stopped, and to prevent local mucosal damage from the balloon. We did not observe ulcers or scars, even if the catheters remained for several days.

All patients who needed the balloon for more than a few hours received intravenous antibiotics, in order to prevent poststenotic infection. One lobar pneumonia was observed in a patient who had needed the balloon for 5 days. The pneumonia developed one day after the catheter had been withdrawn after bronchial artery embolization. Blood cultures revealed *Staphylococcus aureus*. Treatment with cephalosporin and an aminoglycoside was successful. No other infectious complications were diagnosed clinically or pathohistologically in the dissected lungs or lobes after surgery, and no ulcers were found.

The catheters were well-tolerated by the patients. There were hardly any complaints. Coughing usually stopped after a few minutes. Hoarseness was observed only when the catheter was left in place for more than 3 days and when the patient talked too much. A single patient developed granulation tissue at the vocal cords after 5 days. Four weeks after catheter removal the voice was perfectly normal.

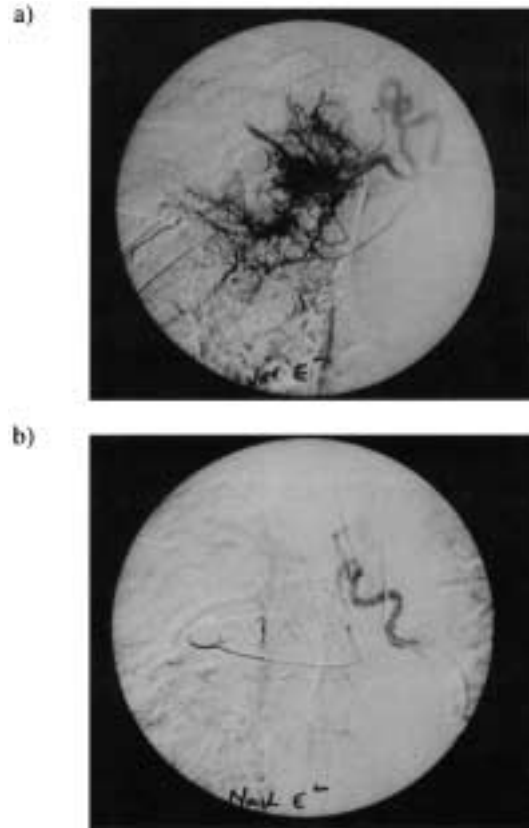


Fig. 5. — Whilst the segmental bronchus is blocked with the blocking catheter, a selective bronchial arterial embolization is performed in a patient bleeding from a tumour with hypervascularization. Arteriogram: a) before; and b) after embolization.

Three dislocations occurred when the balloons were placed too close to an ostium. Twice the balloon moved out of the upper lobe bronchus into the bronchus intermedius. In both cases, the problem could easily be managed by repositioning the catheter deeper into the segmental bronchus.

In one early case, we had used undiluted contrast medium to block the balloon. After 2 days, the viscous liquid had dried up and the balloon could not be removed. It had to be perforated using an aspiration needle. Since we now use 1:5 diluted contrast medium (Angio-graphin, Schering, Berlin, Germany), we had no further problems with deflation of the balloons. Filled with this diluted contrast medium, the blocker is clearly visible on X-ray for easy control of the correct position.

We lost one functionally inoperable patient who had pulled out the catheter by himself and died due to aspiration and cardiorespiratory failure, despite immediate intubation and resuscitation.

On 12 occasions, embolization of the bronchial arteries was performed. The radiological intervention was remarkably facilitated as the balloon prevented coughing of blood. The radiologist could work with less pressure as the patient was no longer in a life-threatening situation. In eight cases, this procedure was immediately successful and yielded good long-term results. Three patients, in whom the embolization had failed, had to be operated on. In total, 11 of the 26 patients needed

surgical interventions (seven lobectomies, three pneumonectomies, one ligature). The high rate of operations indicates the severity of the bleedings.

### Discussion

Minor bleedings do not require a catheter blockage. Posture (bleeding side down) and cough suppressing drugs are usually sufficient.

The group of patients described here suffered from bronchial bleeding for a variety of reasons (neoplasms, tuberculosis, vascular abnormalities). The patients had either coughed up more than a cupful of blood or had lost more than 100 ml of blood during the bronchoscopy. The true amount of lost blood is difficult to estimate, as part of it is swallowed whilst another part is diluted with saline solution. The decision to use a bronchus blocker was made if the bleeding did not stop after all other bronchological measures had been exhausted.

The idea of using a balloon for tamponade is not new, though only reports about smaller series have been published [9–12]. In combination with the rigid bronchoscope, we had successfully used the original Fogarty catheter for years. However, positioning the balloon into a bleeding segmental bronchus parallel to a rigid scope or endotracheal (ET)-tube is time-consuming and requires a high degree of skill. It can be accomplished much more easily, using a fibrebronchoscope and this new catheter. The catheter can bridge the time required to transfer the patient to the operation room, embolize the bronchial arteries, or take other measures to stop the cause of the bleeding [2, 14–18]. Usually, these measures require some time for preparation and effect, depending on the cause of the bleeding. Good fixation of the catheter and patient co-operation are necessary, as demonstrated by one patient, who died after accidentally dragging out the blocker himself.

The fibreoptic approach is only practical if enough blood can be suctioned through the flexible bronchoscope to keep the lens clear. Massive haemoptysis, where large amounts of blood obliterate the view of the bronchus, is managed best with rigid bronchoscopy. The blocking catheter described can also be used in combination with open bronchoscopes. An alternative, if rigid bronchoscopy is not available, is the selective mainstem intubation of the nonbleeding lung with an extra long ET-tube. If all other measures fail, the use of a double-lumen tube can be life-saving [19]. In one case, when placement of the blocker failed for anatomical reasons, it was the only option left. During the same period of 36 months, six patients were primarily intubated with Carlens tubes, most of them during laser photo resection of large central tumours. A blocking catheter was not used because of the severity of the bleeding.

We shall briefly mention that we used the blocking catheters for other purposes. In two patients with bronchopleural fistulae, lobar bronchi were successfully blocked. The procedure failed in one such case, probably due to heavy parallel ventilation. We used the

device to inflate an atelectatic left lower lobe after lung transplantation, by blocking the upper lobe bronchus with the catheter and the right lung with a double-lumen tube. The easy handling of the bronchus blocker may, thus, widen its future indications.

In conclusion, the new bronchus-blocking catheter is a practical and simple instrument. The method described to manage haemoptysis is suitable, as long as the amount of blood that is coughed-up does not make fibrebronchoscopy impossible.

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