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Perforation of the pulmonary artery by a bronchial wall stent

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Abstract Implantation of stents into the bronchial walls is a newly developed method to treat lung emphysema, which is now being tested clinically. During this procedure, a bronchoscope carrying a Doppler ultrasonography head is placed into a segmental bronchus and the blood vessels running in parallel to the bronchus are localized. Once a safe location without blood vessels is found, the bronchial wall is perforated and a stent is placed within the wall to improve the expiratory volume of these “bypasses” to the adjacent lung parenchyma. We observed a fatal complication with this method in a 60-year-old man. The bronchial wall and the pulmonary artery were perforated by one of the stents inducing massive bleeding, which could not be stopped. The patient died due to aspiration of blood in combination with massive loss of blood. The general risk to perforate the pulmonary artery during this procedure cannot be estimated from this single observation but should be considered regarding the legal and clinical aspects.

Keywords Pulmonary emphysema · Bronchoscopy · Bronchial stent · Complications

Introduction

Emphysema of the lungs is usually associated with the obstruction of the airways and may cause severe dyspnea. Conventional therapy consists mainly of reduction of pollution, prevention of respiratory infections, and treatment with corticosteroids and drugs that cause bronchodilatation. In the more severe cases, oxygen therapy can be necessary. Lung volume reduction surgery is limited to

patients with severe disease when other treatment options were exhausted [1, 2].

A new surgical therapy using bronchial stents was described by Lausberg et al. [3] who investigated the effect on the expiratory volume in removed emphysematous lungs (after explantation). They concluded that the creation of extra-anatomic bronchopulmonary passages could be a therapeutic option for emphysematous patients [3]. In the following case report, we present a fatal complication with this new method, which was applied in a 60-year-old man in Germany.

Technique of stent implantation

Under general anesthesia, a flexible bronchoscope is inserted into the bronchus. The segmental bronchus has to be located. With a Doppler sonograph, the direct surroundings of the bronchus should be evaluated from inside to locate the position of the corresponding blood vessels. On the opposite side of the vessels the bronchial wall is perforated using a needle and a stent with a valve is placed inside this segment to reduce the lung volume by an increased expiration. The stent that was used was an exhale emphysema treatment system (Broncus Technology, Mountain View, CA, USA).

Case report

In a 60-year-old man, two stents were already successfully placed into the right B9 and B10 lung segments. After sonographic control, a third stent was placed into segment B8 right and a massive bleeding started immediately. The leak was not found and the bleeding could not be stopped before the circulation collapsed. CPR was unsuccessful. As a result of this fatal complication during the intervention, an autopsy was performed.

Autopsy The dome of the diaphragm was found at the level of the fifth right rib and on the sixth left rib. After opening

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the thorax the left lung collapsed and the right lung had some adhesions with the thoracic wall. The right lung showed a 12:6:4 cm emphysematic bulla at the top and the left inferior lobe also showed such a bulla (8:3:2 cm).

The right bronchus was examined to find the stents in situ. The stents in the segmental bronchi 9 and 10 were correctly inserted (Fig. 1). The stent in the eighth segmental bronchus perforated the bronchial wall and a branch of the pulmonary artery. The bronchi were filled with blood and severe retrograde aspiration of blood was found macroscopically and histologically (Fig. 2). Furthermore, anemia of the parenchymatous organs was present, indicating hypovolemic shock. The amount of blood in the lungs was estimated to be 1,200 ml. From the autopsy results it could be concluded that the death was due to a perforation of the pulmonary artery in segment B8 caused by the implanted stent.

Discussion

The investigation of deaths that happen during medical treatment is a unique task in legal medicine. In most cases, mistakes leading to death cannot be proven. Sometimes, if new invasive methods were applied, in particular, information on the specific risk of the methods is not available.

While the development in legal medicine includes more and more imaging techniques [4-6] in clinical medicine, these techniques are used routinely and there is a trend toward microinvasive treatment, leading to new possibilities and new risks. One of these new methods is the implantation of exhale stents in the bronchial walls to treat emphysema. In the method described, the Doppler sonography is necessary to scan the local area of the segmental bronchus to localize the blood vessels and to find a safe place to implant the stents. Although the area was thought to be vessel-free from sonograph scan, a branch of the pulmonary artery was unexpectedly punctured and a fatal arterial bleeding was initiated. The pneumologist was not able to stop the bleeding before the circulation collapsed.

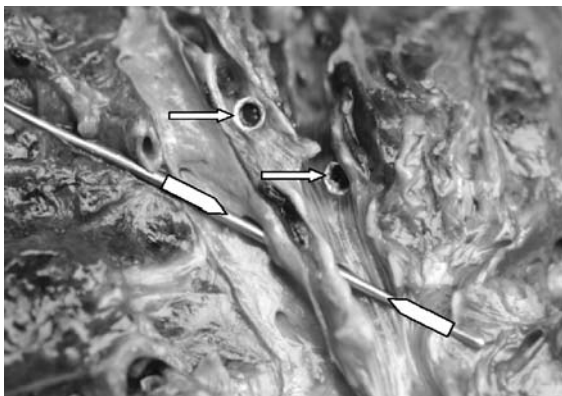


Fig. 1 Lower lobe of the right lung with opened segmental bronchi. The stents in the segmental bronchi 9 and 10 are marked by the small *horizontal arrows*. The probe marked by the two *large arrows* shows the position of the bronchiolar-arterial shunt caused by the third stent

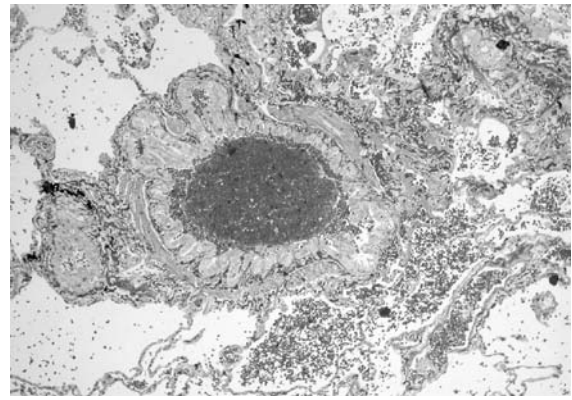


Fig. 2 Micrograph of the periphery of the lower lobe of the right lung showing aspiration of blood in a peripheral bronchiolus and the surrounding alveoli. (Azan, magnification 100×)

Three questions arise from this case in general and regarding legal aspects:

1. Is the sonographic detection of blood vessels in the lung a safe method to localize vessel-free areas of the bronchiolar wall?
2. Which requirements have to be fulfilled to manage such a massive bleeding and to save the life of patients?
3. Was there a clear indication to apply this method to the patient?

As far as the stent implantation could be reconstructed, the pneumologist got the typical sonographic signal indicating the position of the accompanying blood vessels. He changed the position of the bronchoscope and thought he had placed the stent opposite the bronchiolar wall, in a place where no arteries were present, as indicated by the absence of sonographic signals. Because a mistake by the pneumologist cannot be proven during this procedure, the fatal complication could either be due to a defect of the sonography unit (which was not found) or due to wrong positioning of the sonography head during the final measurement. We assume that the sonography head might have been in a more parallel position to the bronchial wall and not perpendicular to it, influencing the signal of the measurement.

When an arterial wall is perforated by a stent, massive bleeding occurs rapidly. It seems the only possible way to stop this bleeding, is to use a balloon catheter to close the perforated arterial wall from inside the bronchus or, if this is not possible, to block the bronchus nearby to prevent aspiration of blood into other lung segments. Therefore, for such an operation, a balloon catheter should always be inserted into the bronchus before the operation as a precautionary measure in case bleeding occurs. By blocking the arterial leak and/or the bronchus, massive bleeding and massive aspiration of blood can be prevented and there would be enough time for surgical treatment.

Last but not least, the indication for the method was limited in this patient because of the bullous emphysema with large bulla in the upper lobes of both sides, which should have been diagnosed before the stent implantation. In such cases, a conventional surgical treatment is recommended and should be more effective [7].

Conclusion

The implantation of stents in the bronchiolar wall of patients suffering from severe lung emphysema seems to be suitable to improve the expiratory volume [3].

The sonography head, which is necessary to locate the blood vessels running in parallel to the bronchi, has to be placed perpendicular to the inner bronchial surface. The sonography should be well documented to facilitate a reconstruction of the procedure if necessary.

Independent of an extended training of the physician (maybe in animal experiments), a sufficient emergency protocol has to be established to manage severe bleeding complications. The use of a balloon catheter to close the leak of the arterial wall immediately seems to be well suited. Patients must be carefully informed on this special risk of this new method.

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