

Katedra i Klinika Chirurgii Klatki Piersiowej Akademii Medycznej w Lublinie
Zakład Weterynarii Akademii Rolniczej w Lublinie
Katedra i Zakład Patomorfologii Akademii Medycznej w Lublinie
Department and Clinic of Thoracal Surgery, Medical University of Lublin
Department of Veterinary Medicine, Agricultural University of Lublin
Chair and Department of Pathomorphology, Medical University of Lublin

KAZIMIERZ GOŹDZIUK, DANUTA SKOMRA, IRENEUSZ
BALICKI, MAREK CZAJKOWSKI, ANDRZEJ MIROSŁAW,
PIOTR SYLIMANOWICZ

Experimental model of broncho-pleural fistula

Model doświadczalny przetoki oskrzelowo-opłucnowej

Available literature does not contain reports presenting an experimental model of an active broncho-pleural fistula and pleuritis occurring after lung tissue resection. Such a model can be useful in studies on complications after surgical treatment of various lung diseases. Complications like broncho-pleural fistula and pyothorax occur in 2.5 % - 16 % of patients operated for both non-inflammatory lesions e.g. lung cancer and purulent infections of the chest e.g. lung abscess, bronchiectases, pyothorax. These conditions inevitably require surgical treatment and modern techniques enable great improvement in achieved results (3).

This study presents an animal model of broncho-pleural fistula and pleuritis in sheep, after anatomical resection one lobe of the lung (lobectomy).

OBJECTIVE

The aim of this study was to elaborate a method of surgical creation of a broncho-pleural fistula on an animal model and to assess the influence of the fistula on the surrounding anatomical structures e.g. lung and pleura.

For the experiments we chose sheep because the anatomy of the respiratory system and weight of this animal is comparable to the human one (two pleural cavities, lobar division of the lungs, blood supply). Animal model may be useful in studies on broncho-pleural fistula and pyothorax pathology as well as for improving methods of treatment in these cases.

MATERIAL AND METHODS

For the experiments we used 15 individuals of cross-breed sheep of both sexes, 2 to 3 years old, weighing 35 to 68 kg (mean 51.5 kg). The animals were kept in the same conditions and were equally fed. After disinfestation with Savermin (Polfa) in a dose of 1 g/kg of body weight, two-week quarantine and veterinary examination the animals were qualified for surgery.

All animals underwent the same surgical procedure in identical operating room conditions, under the same anaesthesia. The operation and anaesthesia was performed by the same staff. The experiment consisted in performing the right thoracotomy and resecting the middle lobe of the right lung under general endotracheal anaesthesia. The animals were prepared for the surgery by shaving the right part of the chest and disinfecting of the skin with hibitan alcoholic solution.

Premedication was carried out 30 minutes before the beginning of the operation by intramuscular injection of Relanium Polfa in a dose of 1 mg/kg of body weight. After the animal was placed on the left flank, the region of the right forearm was locally anaesthetised with 2 % Lignocaine hydrochloride solution and after dissecting the median artery a catheter (Venflon) was introduced into it for drugs administration and infusions. It was also used to obtain arterial blood samples for laboratory examinations.

The animals were anaesthetised by intramuscular injection of Rometar (0.15 ml/kg b.w.) and intravenous injection of Thiopental (Biochemie GmbH, 10 – 20 mg/kg b.w.) until cilio-spinal reflex disappeared. Next an intubational tube was introduced into the trachea inhalation anaesthesia with nitrous oxide and oxygen mixture was commenced. To prevent gastric contents aspiration to the airways, gastric tube was introduced to the rumen in all animals.

RESULTS AND DISCUSSION

Broncho-pleural fistula is a severe condition in which air from the airways escapes to the pleural cavity. In the majority of cases it is a complication after surgical resection of lung tissue, or a consequence of respiratory system infections or trauma (5). Broncho-pleural fistula results in pneumothorax and infection of pleural cavity occurring as an

acute pyothorax. Respiratory insufficiency, and septic complications with mortality rate of 60–80% may be the next consequences of natural development of pyothorax with broncho-pleural fistula (5).

To obtain clinically active broncho-pleural fistula in an experimental animal is a relatively difficult task. An open bronchial stump left after lobe resection results in pneumothorax. Drainage of the pleural cavity leads to excessive leakage of respiratory air, respiratory insufficiency and death. Surgical narrowing of the bronchial stump causes spontaneous closure of the fistula and quick recovery.

Histologic examinations were carried out on the 14th postoperative day, after the animals were sacrificed by exsanguination. Active broncho-pleural fistula and inflammation in the surrounding of the foreign body were found in all animals with gas pad sutured onto the open bronchial stump. Inflamed pleural space was smaller than volume of the resected lobe, because the remaining lobes distended after the operation. Inflammation focus was filled with sero-purulent contents and covered with pleural adhesions. Never was a pneumothorax found, which confirms effectiveness of gas pad sutured onto the bronchial stump in reducing air leakage from the airways.

Significant histologic changes in the surrounding tissues confirm strong influence of purulent focus on the lung tissue where large areas of atelectasis and inflammatory infiltration were found (Fig. 1) – 1, 2, 4, 6. Surfaces of visceral and parietal pleura were thickened and covered with fibrin. Inflammatory infiltration with neutrophils, lymphocytes and macrophages were found under the pleura (Fig. 2). The lumen of the bronchi was filled with purulent exudate. Under the mucous membrane massive inflammatory infiltrations were found. This picture of pathologic changes resembles very much the one found in human pyothorax with active broncho-pleural fistula.

Human bronchial fistula after lung tissue resection rarely heals spontaneously and requires surgical intervention. It also causes chronic purulent pleuritis. Poor life quality and short survival period of these patients stimulates to seek more effective treatment methods. Experiments on animals may contribute to further improvement in surgical treatment of these diseases, bringing hope for quicker and permanent recovery.

CONCLUSIONS

1. Sheep is an adequate experimental animal for respiratory system pathology studies.
2. Creation of reproducible experimental model of broncho-pleural fistula requires infection of pleura and introduction of a foreign body onto the open bronchial stump to prevent pneumothorax.
3. Animal model of broncho-pleural fistula may be useful in studies on human respiratory system purulent complications.

REFERENCES

1. Anthony V. B., Mohammed K. A.: Pathophysiology of pleural space infections. *Semin. Respir. Infect.*, 14, 17, 1999.
2. Brockmeyer C. et al.: Spontaneous lesions in the respiratory epithelium of the Syrian golden hamster as seen by scanning electron microscopy. *Exp. Pathol.*, 36, 247, 1989.
3. Goździuk K., Sawa A.: Leczenie przetoki oskrzelowo-opłucnowej po wycięciu płuca. *Pol. Przegl. Chir.*, 4, 332, 1999.
4. Sasse S. A. et al.: Serial pleural fluid analysis in a new experimental model of empyema. *Chest*, 109, 1043, 1996.
5. Wain J. C.: Management of late postpneumonectomy empyema and bronchopleural fistula. *Chest Surg. N. Am.*, 6, 529, 1996
6. Wiener-Kronish J. et al.: Alveolar epithelial injury and pleural empyema in acute *P. aeruginosa* pneumonia in anesthetized rabbits. *J. Appl. Physiol.*, 75, 1661, 1993.

Otrz.: 2000.06.14

STRESZCZENIE

Autorzy opracowali zwierzęcy model pooperacyjnej przetoki oskrzelowo-opłucnowej powstałej po resekcji płuca. Doświadczenie wykonano na 15 owcach, którym wykonano torakotomię w znieczuleniu ogólnym dotchawiczym. W czasie operacji otwierano prawą jamę opłucnową, wycinano anatomicznie płat środkowy płuca, następnie naszywano tampon gazowy na otwarty kikut oskrzela. Po rozprężeniu pozostałego mięszu płucnego zamknięto klatkę piersiową, zszywając warstwowo powłoki bez pozostawienia drenu. Okres leczenia pooperacyjnego prowadzono przez 2 tygodnie. Po tym czasie wykonywano powtórzną torakotomię celem wykonania badań śródoperacyjnych i badań autopsyjnych. Po otwarciu klatki piersiowej stwierdzano obecność ograniczonego procesu zapalnego w jamie opłucnej, niekiedy z obecnością treści surowiczowo-ropnej w łączności z czynną przetoką kikuta oskrzela. Przyległe części płuca objęte były czynnym procesem zapalnym i niedodmą. Zakażenie spowodowane było własną florą z dróg oddechowych zwierzęcia. Przebieg choroby w okresie pooperacyjnym podobny był do schorzenia występującego u ludzi, u których wystąpiło powikłanie w postaci zakażenia opłucnej.

EXPLANATION TO FIGURES

Fig. 1. Light micrograph of lung tissue in the surrounding of the broncho-pleural fistula. Inflammatory infiltrations, foci of atelectasis and emphysema are visible (H + E, Mag. 100x).

Fig. 2. Light micrograph of the histologic section of the lung surface. Thickened visceral pleura is covered with fibrin. Subpleural inflammatory infiltrations with neutrophiles, macrophages and lymphocytes are visible (H + E, Mag. 100x).

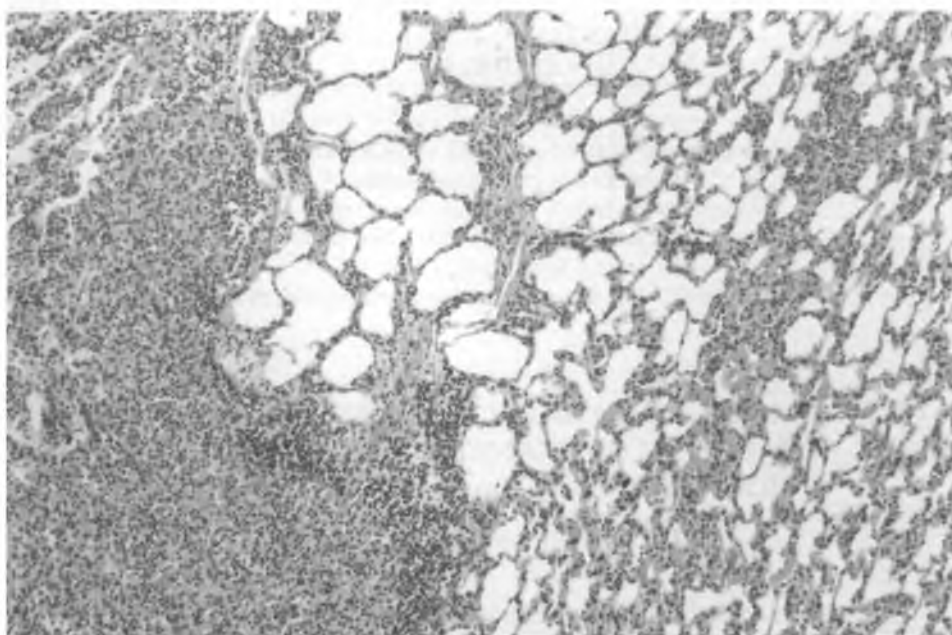


Fig. 1

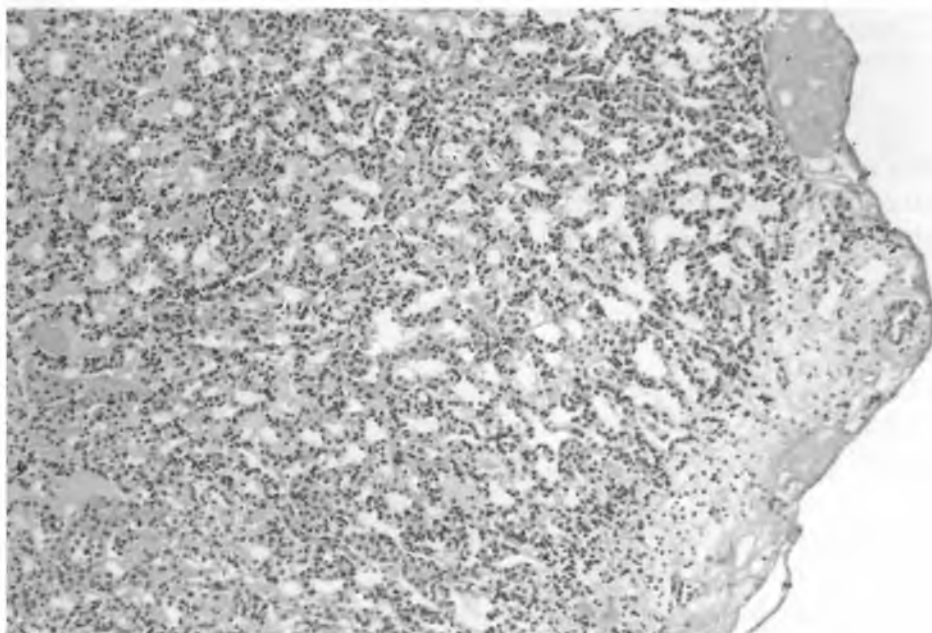


Fig. 2

