Pekka J. Karhunen,[1] *M.D., Ph.D. and Kaisa Lalu,*[2] *M.D., Ph.D.*

Radiographic Demonstration of Esophageal and Tracheal Fistulas at Autopsy Using a Contrasting Medium That Vulcanizes at Room Temperature

REFERENCE: Karhunen, P. J. and Lalu, K., **"Radiographic Demonstration of Esophageal and Tracheal Fistulas at Autopsy Using a Contrasting Medium That Vulcanizes at Room Temperature,"** *Journal of Forensic Sciences*, JFSCA, Vol. 36, No. 4, July 1991, pp. 1129–1133.

ABSTRACT: Esophageal and tracheal fistulas, which occur in 0.05% of medicolegal autopsies, were demonstrated in three cases by a postmortem radiographic technique using silicone rubber/lead oxide as a contrasting medium that vulcanizes at room temperature. In one 83-year-old male, a tracheoesophageal fistula was detected, which had developed after surgical repair of an esophageal rupture caused by a flexible fiberoptic endoscope. In a second case, carcinoma of the esophagus in a 78-year-old male had eroded the trachea and arcus of the aorta creating a fatal tracheoesophagoaortic fistula. In a third case, 55-year-old female developed a tracheobrachiocephalic artery fistula as a result of an infiltrating cystic adenocarcinoma of the trachea, resulting in a fatal hemorrhage into the trachea.

The results of this study indicate that diagnostic radiologic methods using a vulcanized contrasting medium are useful in supplementing normal dissection in autopsy cases with suspected fistulas of the esophagus or trachea.

KEYWORDS: pathology and biology, fistulas, X-ray analysis, postmortem examination, esophageal neoplasms, esophagoscopy, radiography, diagnostic procedures, postoperative complications, malpractice

Fistulas of the esophagus and trachea are rare and most commonly occur in association with trauma, malignant tumors, or infection of the thoracic organs [*1*]. The introduction of flexible endoscopes has, however, greatly increased the number of endoscopic diagnostic examinations of the esophagus and trachea [*2*], during which iatrogenic esophageal rupture may occur [*1,2*]. At autopsy, such fistulas may be difficult to locate by conventional dissection. Ludwig [*3*] reported the use of X-ray analysis and barium sulfate in detecting a fistula at autopsy. Barium sulfate, however, easily leaks and does not tolerate dissection. Vinyl acetate, also used as a contrasting medium in postmortem radiography, requires the use of a cold-water tank [*3*].

We have recently introduced an angiographic technique suitable for use in autopsy diagnosis of vascular events and complications [*4–8*]. This method involves the use, as a contrasting medium, of a silicone rubber/lead oxide solution that vulcanizes at room temperature [*4*]. This technique allows exact location of the lesion by X-ray. The rubbery cast tolerates dissection.

Received for publication 20 Sept. 1990; revised manuscript received 13 Nov. 1990; accepted for publication 17 Dec. 1990.

[1]Senior lecturer, Department of Forensic Medicine, University of Helsinki, Helsinki, Finland.
[2]Research associate, Department of Forensic Medicine, University of Helsinki, Helsinki, Finland.

In this paper, the authors describe the application of our radiographic method in demonstrating the location of fistulas of the esophagus and trachea at autopsy.

Cases and Methods

Autopsy Cases

Among 8337 consecutive medicolegal autopsies performed between 1987 and 1990 at the Department of Forensic Medicine, University of Helsinki, Helsinki, Finland, there were 5 cases (0.05%) with fistulas of the esophagus or trachea. Three of these cases were diagnosed by radiographic means. One of the cases was associated with iatrogenic endoscopic damage of the esophagus and two cases with malignant intrathoracic tumors.

Radiographic Method

In the case of the 83-year-old male (Case 1) with endoscope-induced rupture of the esophagus, the contrasting medium was perfused through a tracheostomy cannula, using a portable perfusion device and constant pressure of 80 mmHg. In the two other cases, the ascending aorta was transsected, and the contrasting medium was perfused in the aorta either manually (Case 2) or using the perfusion arrangement described above (Case 3). The technical construction of the portable perfusion device with its quick couplings to a compressed air line is described elsewhere [*4*].

Silicone rubber that vulcanizes at room temperature [SilikonKautschuk RTV-Vergussmasse K, Wacker Chemie Gmbh., Munich (available in the United States from Wacker Silicones Corp., Adrian, Michigan)] was used as a contrasting medium. Briefly, 1000 g of liquid silicone rubber was made radiopaque with 250 g of lead oxide, mixed, and stored for use. Before use, 7 mL of silicone oil was added to a batch of 120 g of stock solution and mixed. About 3 to 5 such batches were needed. No more than 10 min before perfusion, 2 mL of vulcanizer was mixed with one batch of the mass, while being shaken continuously, and this was repeated as necessary. The mixture solidified into a rubbery cast within 2 h.

A Siemens full-wave X-ray machine was used with Agfa-Gevaert Scopix CR3B film. Radiographs were taken at a distance of 100 cm, using 60 to 80 kV and 300 mA.

Results

In all the cases, the presence and location of the fistula were clearly imaged. In the first case (Case 1), the contrasting medium filled the respiratory tract and even the esophagus and the upper part of the ventricle (Fig. 1*a*). The fistula was located at the end of the trachea just before the bifurcation. The rubbery silicone cast could be pulled out during dissection (Fig. 1*b*). In the second case (Case 2), a carcinoma of the esophagus had eroded simultaneously into the trachea and the arch of the aorta, resulting in a massive hemorrhage into the trachea, esophagus, and left main bronchus (Fig. 2*a*). In the female with cystic adenoma of the trachea (Case 3), a communication was detected between the trachea and the brachiocephalic artery, resulting in fatal hemorrhage into the trachea (Fig. 2*b*).

Discussion

Diagnostic radiography has seldom been used in medicolegal autopsy practice. This may be caused partly by the lack of X-ray facilities and partly by the difficulty of applying perfusion equipment intended for laboratory use in autopsy practice. Moreover, barium

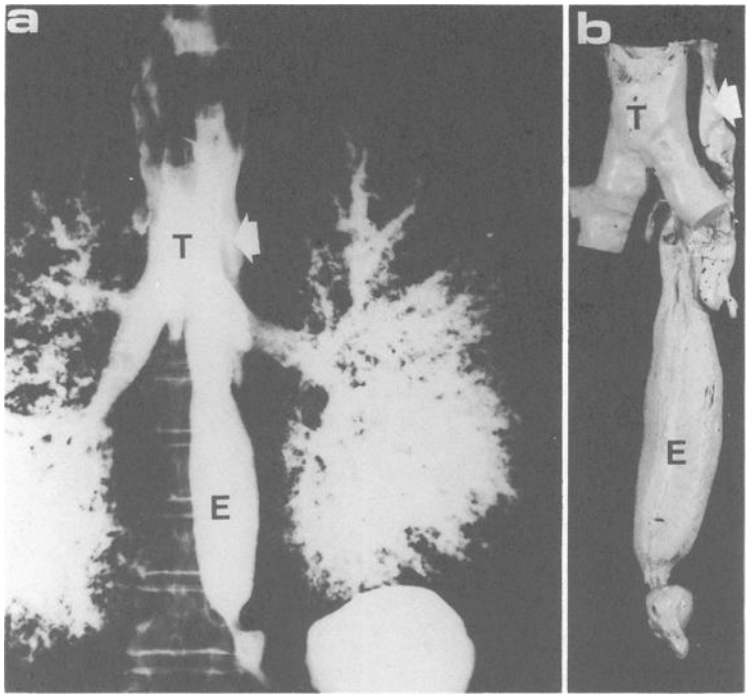

FIG. 1—*Case 1*: (a) *radiographic demonstration of a tracheoesophageal fistula following iatrogenic endoscopic damage of the esophagus. The silicone rubber/lead oxide suspension was perfused through the tracheostomy cannula into the trachea (T) and escaped through a fistula at the end of the trachea* (arrow) *into the esophagus (E), mediastinum, and ventricle. Note the alveolar sacs filled with the vulcanized compound.* (b) *The vulcanized rubbery cast, which tolerates dissection and can be pulled out at autopsy. The tracheal cast is amputated at both ends.*

sulfate is not an ideal contrasting medium, and also, other media tried previously have not been satisfactory in use [*3*]. We have recently introduced a novel angiographic method with a simple portable perfusion device and silicone rubber that vulcanizes at room temperature as the contrasting medium [*4*]. The method has proved suitable in detecting vascular complications in postoperative autopsies following a fatal outcome in neurosurgery [*6,7*], coronary bypass surgery [*4*], and abdominal catastrophes from rupture of the splenic artery [*5*], as well as in demonstrating traumatic rupture of a vertebral artery [*8*].

Acquired tracheoesophageal fistulas are rare and are, for the most part, due to malignant tumors. Nonmalignant tracheoesophageal fistulas are even rarer and are most commonly the result of trauma or infection [*1*]. In our case, the trauma was caused by a flexible endoscope during esophagoscopy. Although flexible endoscopes offer advantages over semirigid endoscopes, the incidence of complications has not diminished. In one report, the mortality from gastric perforation by fiberoptic endoscopes almost quadrupled in comparison with that from standard gastroscopy [*2*], probably because of the increased number of examinations. Use of a flexible endoscope in sclerotherapy of esophageal varices has been reported to cause perforation in 1 to 6% of the patients [*9*]. The treatment of the perforation includes early surgical repair, as was also performed in our case. The condition carries, however, a high mortality, especially when the perforation is in the thoracic esophagus [*10,11*].

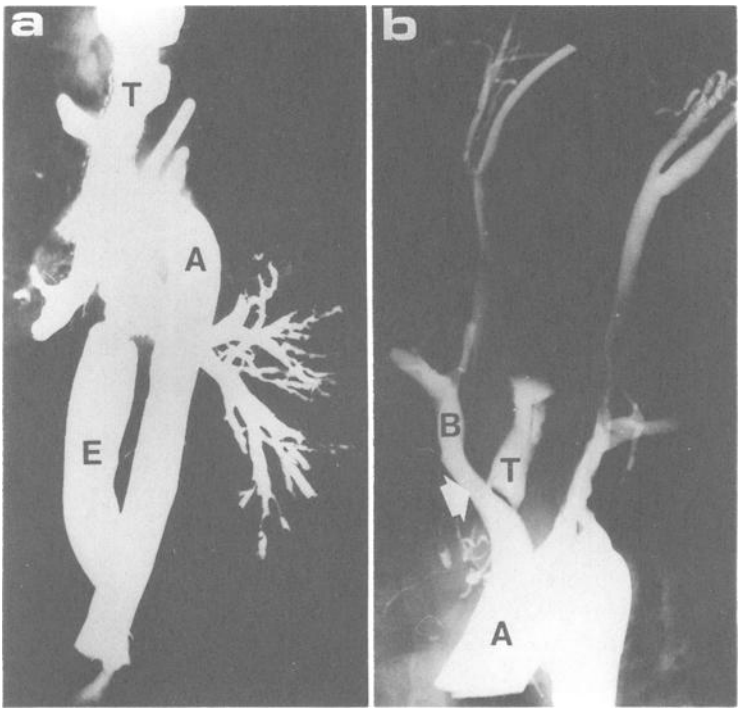

FIG. 2—*Case 2*: (a) *anteroposterior radiograph showing the tracheoesophagoaortic fistula. The contrasting medium was perfused retrograde from the aorta (A); it also filled the esophagus (E) and trachea (T) through a fistula at the arch of the aorta.* (b) *The X-ray, after manual infusion of the contrasting medium into the base of the aorta, discloses a tracheobrachiocephalic artery fistula (B)* (arrow).

More rarely, a fistula may develop as an unusual, but usually lethal, complication between the esophagus and the aorta [*12*] or between the esophagus and the pericardial sac [*13*]. In two cases presented here, carcinoma of the trachea had eroded the brachiocephalic artery, and carcinoma of the esophagus had eroded the trachea and the arch of the aorta. Both hemorrhages were fatal.

Conclusions

Our results suggest that diagnostic radiographic procedures should be increasingly and flexibly applied in autopsy practice in addition to ordinary dissection to improve the accuracy and quality of the diagnosis. Especially in suspected surgical malpractice cases, radiography provides indisputable and illustrative evidence of what has happened. The introduction of methods commonly used as diagnostic tools in clinical medicine into autopsy practice could be one way to increase the need for and interest in performing autopsies.

Acknowledgments

The authors are grateful to Seppo Tyynelä and Jouko Kuuseva for excellent assistance in the autopsy room as well as for the radiographs.

References

[1] Long, R. W. and Morin, J. E., "Acquired Nonmalignant Tracheoesophageal Fistula," *Canadian Journal of Surgery*, Vol. 24, No. 1, 1981, pp. 54–55.

[2] Meyers, M. A. and Ghahremani, G. G., "Complications of Fiberoptic Endoscopy: I. Esophagoscopy and Gastroscopy," *Radiology*, Vol. 115, No. 2, May 1975, pp. 293–300.

[3] Ludwig, J., *Current Methods in Autopsy Practice*, W. B. Saunders, Philadelphia, PA, 1972.

[4] Karhunen, P. J., Männikkö, A., Penttilä, A., and Liesto, K., "Diagnostic Angiography in Postoperative Autopsies," *American Journal of Forensic Medicine and Pathology*, Vol. 10, No. 4, Dec. 1989, pp. 303–309.

[5] Karhunen, P. J. and Penttilä, A., "Diagnostic Postmortem Angiography of Fatal Splenic Artery Haemorrhage," *Zeitschrift Für Rechtsmedizin/Journal of Legal Medicine*, Vol. 103, No. 2, 1989, pp. 129–136.

[6] Karhunen, P. J., Penttilä, A., and Erkinjuntti, T, "Arteriovenous Malformation of the Brain: Imaging by Postmortem Angiography," *Forensic Science International*, Vol. 48, Nov. 1990, pp. 9–19.

[7] Karhunen, P. J., "Neurosurgical Vascular Complications Associated with Aneurysm Clips Evaluated by Postmortem Angiography, *Forensic Science International*, in press.

[8] Karhunen, P. J., Kauppila, R., Penttilä, A., and Erkinjuntti, T., "Vertebral Artery Rupture in Traumatic Subarachnoid Haemorrhage Detected by Postmortem Angiography." *Forensic Science International*, Vol. 44, No. 2/3, Feb. 1990, pp. 107–115.

[9] Perino, L. E., Cholson, C. F., and Goff, J. S., "Esophageal Perforation After Fiberoptic Variceal Sclerotherapy," *Journal of Clinical Gastroenterology*, Vol. 9, No. 3, June 1987, pp. 286–289.

[10] Prinsley, P. R. and Murrant, N. J., "Cervical Esophageal Perforation Caused by Diagnostic Flexible Esophagoscopy," *Journal of Otolaryngology*, Vol. 18, No. 6, Oct. 1989, pp. 314–316.

[11] Moghissi, K. and Pender, D., "Instrumental Perforations of the Oesophagus and Their Management," *Thorax*, Vol. 43, No. 8, Aug. 1988, pp. 642–646.

[12] Gable, D. S. and Stoddard, L. D., "Acute Bacterial Aortitis Resulting in an Aortoesophageal Fistula: A Fatal Complication of Untreated Esophageal Carcinoma," *Pathology Research and Practice*, Vol. 184, No. 3, March 1989, pp. 318–324.

[13] Mellon, J. K., Galvin, I. F., Bowe, P. C., Gibbons, J. R., and Maghout, M. H., "Oesophagopericardial Fistula and Cardiac Tamponade After Oesophagoscopy," *European Journal of Cardiothoracic Surgery*, Vol. 2, No. 4, 1988, pp. 282–283.

Address requests for reprints or additional information to
Pekka J. Karhunen, M.D., Ph.D.
Department of Forensic Medicine
University of Helsinki
Kytosuontie 11
SF-00300 Helsinki
Finland