Int J Legal Med (2005) 119: 146–152
DOI 10.1007/s00414-004-0509-5

CASE REPORT

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Black oesophagus: a rare disorder with potentially fatal outcome

A forensic pathological approach based on five autopsy cases

Received: 8 September 2004 / Accepted: 27 October 2004 / Published online: 3 February 2005

Abstract Black oesophagus is a rare pathological condition of unknown aetiology characterised by a full length, circumferential black discolouration of the entire oesophageal mucosa. The disease is sporadically encountered during upper gastrointestinal endoscopy. We used conventional histology, enzyme histochemistry and immunohistology to examine five autopsy cases (four males, one female; age range 43–86 years) of black oesophagus. On microscopical examination, the esophageal mucosa was entirely necrotic with demarcation by a leukocytic infiltrate in the upper submucosa. This infiltrate was dominated by neutrophilic granulocytes and scattered macrophages lacking haemosiderin deposits, placing the noxious mucosal injury in a time frame of approximately 24–72 h prior to death. Black oesophagus was established as the immediate cause of death in one case due to desanguination from the oesophagus and significantly contributed to the fatal outcome in a second case. Apart from a history of chronic alcohol consumption in four cases, no other pre-existing pathological or debilitating conditions could be established. The remarkably consistent pathomorphological picture of the disease seems to be the result of impaired microcirculation of the oesophageal mucosa due to prolonged hypotension of variable aetiology. The diagnosis of black oesophagus requires exclusion of other causes such as ingestion of caustic materials and should be based on histological examination.

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Keywords Black oesophagus · Oesophagitis · Differential diagnosis · Sudden death · Autopsy

Introduction

Black oesophagus is a rare pathological condition characterised by a full length, circumferential black discolouration of the entire mucosa of the oesophagus. Black oesophagus is sporadically encountered as an unexpected finding during upper gastrointestinal endoscopy, but since its first description in 1990 by Goldenberg and co-workers [12], only a few case reports have appeared in the Anglo-american literature [4, 6, 7, 13–16, 25–28, 31]. Most of these reports deal with the endoscopical appearance of the disease, focusing on its clinical picture and course. The knowledge of the histopathology of black oesophagus is based on a small number of microscopically examined biopsy specimens revealing mucosal necrosis and inflammation [11, 15, 16, 26] but a detailed pathoanatomical description of the morphological correlates of this rare disorder is not available. To the best of our knowledge, only one study [14] has described the autopsy features of black oesophagus.

We examined five autopsy cases of black oesophagus focussing on the implications of this rare disorder for the forensic pathologist.

Materials and methods

Five cases of black oesophagus that were autopsied at the Institute of Legal Medicine, University of Hamburg, Germany, between 2002–2004 were studied. In each case histological examination of all organs and a thorough toxicological analysis including determination of blood alcohol concentration (BAC) were performed. Individual cases were analysed as to the sex, age, race, medical history, circumstances of death, autopsy findings, outcome of microscopical examination of internal organs and results of toxicology using a full complement of analytical methods such as high pressure liquid chromatography and gas chro-

Table 1 Individual characteristics of fives cases of black oesophagus autopsied at the Institute of Legal Medicine, University of Hamburg, Germany, between 2002–2004

Case no.	Age (years)	Sex	Medical history	Circumstances of death	Autopsy findings	Toxicology	Cause of death
1	43	Male	Mental retardation, alcohol abuse	Sudden death at home	Black oesophagus, erosive gastritis with 850 ml of haematinised fluid in stomach and small intestine, pallor of internal organs, acute purulent bronchitis, oedema of the brain and lungs, sparse post-mortem lividity	Negative	Haemorrhagic shock due to internal blood loss from erosive gastritis and necrosis of oesophageal mucosa
2	86	Male	Bedridden and intensive nursing, stationary patient on a geriatric ward following an apoplectic insult 4 years before	Sudden, unexpected death in hospital where the subject was admitted with infected grade 4 decubitus ulcers one week before death	Black oesophagus, 40 ml of haematinised fluid in the stomach without proof of a bleeding source in the gastrointestinal tract other than the pathological alterations of the oesophageal mucosa, bilateral lobar pneumonia with accompanying pleuritis, old myocardial infarction, old apoplectic infarction, multiple grade 4 decubitus ulcers above the os sacrum with accompanying osteomyelitis	Negative	Respiratory insufficiency due to pneumonia
3	46	Male	Epilepsy, alcohol abuse	Sudden death at home; suspicious circumstances at the scene (broken glassware, undressed lower part of body)	Black oesophagus, 60 ml of bloody, partly haematinised fluid in the stomach without proof of a bleeding source in the gastrointestinal tract other than the pathological alterations of the oesophageal mucosa, oedema of the brain and lungs, chronic obstructive pulmonary disease, dilatation of the urinary bladder	BAC 96 g/dl, UAC 143 g/dl	Undetermined
4	59	Male	Alcohol abuse	Body found outdoors in bushes in a public park in December (ambient temperatures at the estimated time of death between −4 and 2°C)	Black oesophagus, erosive gastritis with 650 ml of bloody and haematinised fluid in stomach and small intestine, chronic obstructive pulmonary disease, severe atherosclerosis, brain oedema, carcinoma of the kidney, fatty liver, non-fixation of livor mortis with full blanching on pressure at a rectal temperature of 17.7°C	Negative	Most probably hypothermia

Table 1 (continued)

Case no.	Age (years)	Sex	Medical history	Circumstances of death	Autopsy findings	Toxicology	Cause of death
5	59	Female	Alcohol abuse, recurring attacks of dizziness	Sudden death at home	Black oesophagus, approx. 1200 ml of haematinised blood in stomach, small and large intestine without proof of a bleeding source in the gastrointestinal tract other than the pathological alterations of the oesophageal mucosa, pallor of internal organs, subendocardial haemorrhages, chronic obstructive pulmonary disease, brain oedema, severe atherosclerosis, fatty liver, sparse postmortem lividity	Negative	Haemorrhagic shock due to internal blood loss from necrosis of oesophageal mucosa

BAC Blood alcohol concentration.
UAC Urine alcohol concentration.

matography with mass spectometry. In each case histological slides from the internal organs were re-evaluated. Paraffin-embedded tissue blocks from the oesophagus as well as stored tissue samples fixed in 5% buffered formalin were available in each case.

Routine histology and enzyme histochemistry

Paraffin-embedded tissue specimens of the oesophagus were cut in 4–5 μm sections and stained with haematoxylin and eosin (H&E), periodic acid-Schiff (PAS), phosphotungstic acid hematoxylin (PTAH), Prussian blue, Grocott and Gram stains for histological examination. Neutrophils were labeled by N-acetyl-AS-D chloroacetate esterase (NACE) enzyme histochemistry.

Immunohistology

Paraffin-embedded tissue blocks were sectioned at 4 μm and stained with monoclonal antibodies directed at CD3 (clone F7. 238, DakoCytomation, Hamburg, Germany), CD20 (clone L26, DakoCytomation) and CD68 (clone PG-M1, DakoCytomation) using the alkaline phosphatase anti-alkaline phosphatase (APAAP) technique.

Results

Case characteristics

The individual case characteristics are summarised in Table 1. All individuals were Caucasian, there were four males and one female with an age range between 43 and 86 years. With the exception of one case, all fatalities occurred outside hospital. Apart from a history of chronic alcohol consumption in four cases, the evaluation of the previous medical history was unremarkable in so far as no other analogous pre-existing pathological conditions or underlying debilitating illnesses could be established.

Mediastinitis and oesophageal perforation were not present in any of the cases. Bloody and haematinised fluid with total amounts between 40–1200 ml was present in the gastrointestinal tract in each case. Signs of a considerable blood loss prior to death such as sparse postmortem lividity and pallor of internal organs were observed in two cases. An erosive gastritis, histologically corresponding to haemorrhagic patchy mucosal necrosis, could be established as an additional bleeding source other than the pathological alterations of the oesophageal mucosa in two cases.

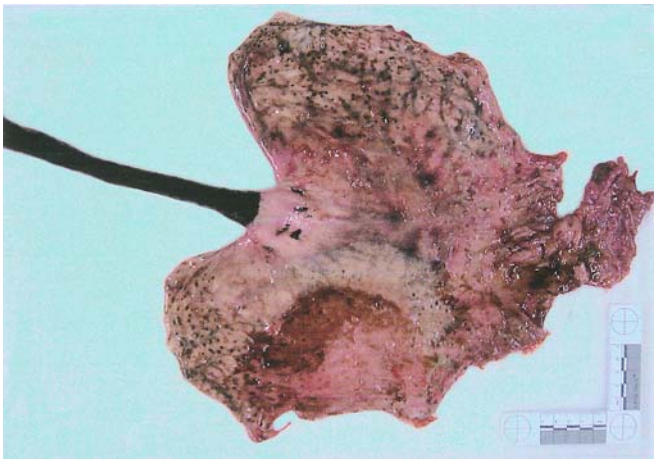

Fig. 1 Black oesophagus, native autopsy specimen. The entire oesophageal mucosa shows a black discolouration ending abruptly at the oesophagogastric junction. An erosive gastritis with confluent haemorrhagic spots at the cardia is also seen (case 4)

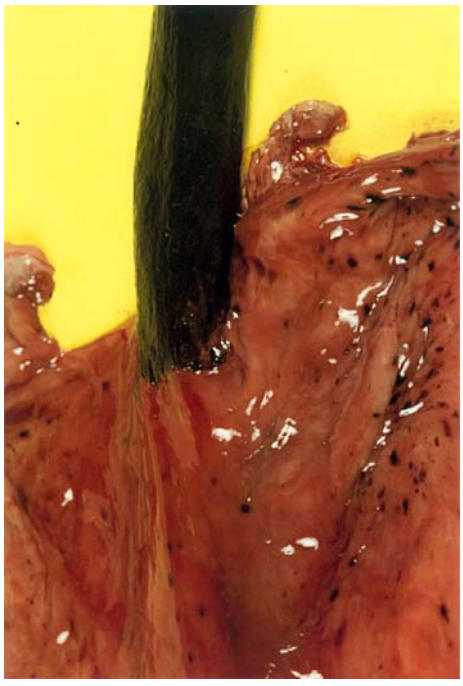

Fig. 2 Black oesophagus, native autopsy specimen. Closer view of the sharp demarcation of the circumferential black discolouration of the oesophageal mucosa at the oesophagogastric junction. In addition, an erosive gastritis with widespread patchy haemorrhagic lesions is seen (case 1)

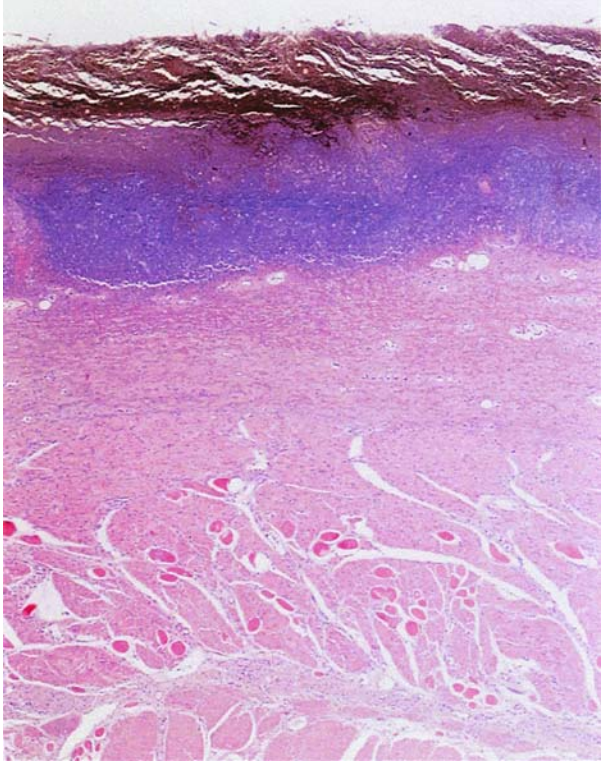

Fig. 3 Histological appearance of black oesophagus. Full-thickness necrosis of the oesophageal mucosa sharply demarcated by a broad zone of inflammatory cells located in the upper layer of the submucosa (case 1). Hematoxylin-eosin, original magnification ×10

The toxicological analysis for drugs other than ethanol was negative in all cases; BAC was positive in one case (96 g/dl). Death was attributed to hemorrhagic shock due to internal blood loss from necrosis of the oesophageal mucosa in one case (case 5) and in one case death was due to a combination of exsanguination from erosive gastritis and necrosis of the oesophageal mucosa (case 1). The exact cause of death could not be established in two of the cases (cases 3 and 4; Table 1).

Gross pathology of black oesophagus

A circumferential black discolouration of the oesophageal mucosa that extended along the entire oesophagus and ended abruptly at the oesophagogastric junction (Figs. 1 and 2) was observed in all cases. The black discolouration

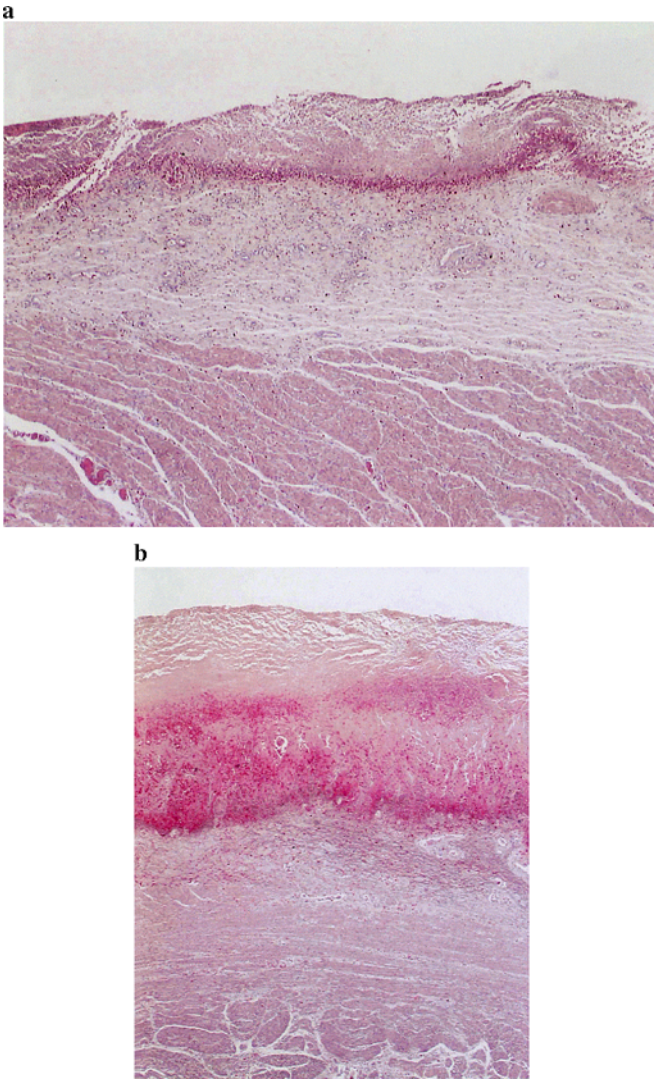

Fig. 4a-b NACE enzyme histochemistry of black oesophagus. The demarcation zone of inflammatory cells located in the upper layer of the submucosa corresponds to a dense infiltrate of neutrophil granulocytes. **a** Case 1. Original magnification ×15. **b** Case 3. Original magnification ×10

could not be washed away by rinsing the mucosal surface with water. Ulcerations, lacerations or other sources of bleeding were not detectable macroscopically within the oesopageal mucosa in any of the cases. On transversal cut sections, the oesophageal mucosa appeared sharply demarcated by its blackish appearance against the submucosa, muscularis propria and adventitia that were unremarkable at gross examination. The mucosa of the mouth, epipharynx and hypopharynx as well as the larynx showed neither discolouration nor any other remarkable findings in any of the cases.

Histopathology of black oesophagus

In all cases a complete necrosis of the oesophageal mucosa including the basement membrane was present. The mucosa was fully replaced by a thick layer of necrotic debris showing partly spot-like and occasionally more confluent haemorrhagic areas and necrotic epithelial cells. A sharp zone of demarcation by inflammatory cells, consisting predominantly of neutrophilic granulocytes and scattered macrophages, was seen in the upper layer of the submucosa (Fig. 3). Occasionally, the glandulae oesophageales located within in the upper layer of the submucosa showed intact epithelial cells lining the gland ducts. Apart from vascular congestion and intravascular granulocyte accumulation in vessels of all sizes, the lower layer of the submucosa and the muscularis propria were unremarkable. No inflammatory cells or any other pathological changes were detectable in the adventitia. In none of the cases were signs of an accompanying vasculitis or microthromboses detectable in any of the layers of the oesophageal wall. The necrosis of the mucosa as well as the underlying pathological alterations located in the upper layer of the submucosa ended abruptly at the transitional line of the oesophagogastric junction and the gastric mucosa located in the immediate vicinity of the oesophageal lesions was unaffected.

There was no light microscopical evidence for viral infection such as the presence of virocytes, cytoplasmic or nuclear inclusions, in particular not in the epithelial cells of oesophageal glands.

Grocott staining was negative for mycotic infection. Bacteria were not detectable neither in interstitial spaces nor incorporated in leukocytes by using Gram staining. Prussian blue staining failed to show any haemosiderin deposits within the occasional macrophages accompanying the dense neutrophil infiltration in the upper layer of the submucosa. PTAH staining revealed no fibrin deposits.

Immunohistology and enzyme histochemistry

The majority of inflammatory cells underlying the mucosal necrosis consisted of neutrophil granulocytes as evidenced by histology and NACE labeling (Fig. 4a, b). Staining for CD68 antigen visualised small numbers of macrophages within the inflammatory infiltrate (Fig. 5), whereas CD3-positive T-lymphocytes and CD20-positive B lymphocytes occurred in only small numbers and in scattered distribution.

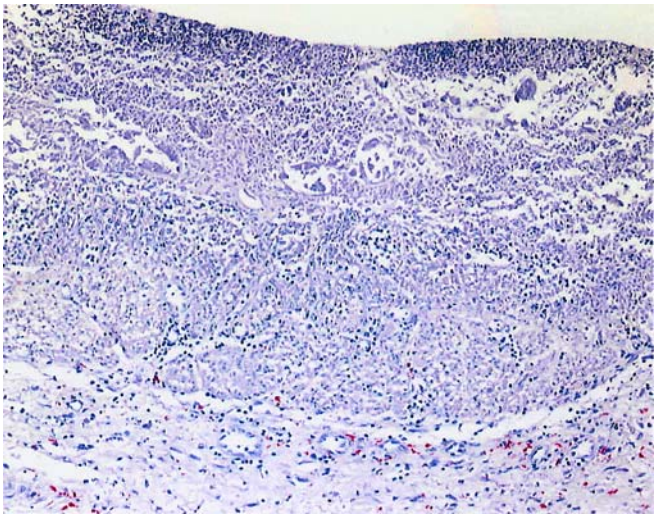

Fig. 5 CD68 immunostaining with monoclonal antibody PG-M1. Few macrophages are present in the lower portion of the inflammatory cell infiltrate seen in the upper layer of the submucosa (case 4). Original magnification ×60

Discussion

In the present autopsy-based study we examined five cases of black oesophagus using histology, enzyme histochemistry and immunohistology to better describe the pathoanatomical correlates of this rare disorder. A circumferential black discolouration of the oesophageal mucosa that extended along the entire oesophagus and ended abruptly at the oesophagogastric junction was observed at autopsy in each case. Histologically, this black discolouration showed a homogenous picture corresponding to acute oesophagitis with a full-thickness necrosis of the mucosa that was sharply demarcated by a broad zone of neutrophilic granulocytes located in the upper submucosa.

According to the results of the study by Jacobsen and coworkers investigating 310 consecutive autopsy cases for the presence of pathological alterations of the oesophageal mucosa at the time of death, the most important differential diagnosis of black oesophagus is haematin colouration [14]. However, in most cases where a blackish appearance of the oesophageal mucosa can be attributed to mere haematin colouration, this black pigmentation does not usually affect the entire oesophagus in such a circumferential pattern as observed here [14], but will rather display a longitudinal striated appearance limited to the lower parts of the organ.

In forensic pathological autopsy practice a similar picture of a blackish discolouration of the oesophageal mucosa may occasionally be seen in cases of chemical injury to the oesophagus, e.g., after ingestion of strong alkaline agents or acids. Chemical oesophagitis as the cause of the black discolouration of the oesophageal mucosa observed here

was excluded by the absence of any damage to or pathological alteration of the mucosa of the mouth and pharynx; in addition, a toxic origin of the observed changes of the oesophagus was excluded by the outcome of toxicological analysis. Further differential diagnosis of black oesophagus include malignant melanoma [30], acanthosis nigricans [21], anthracosis [26] as well as melanosis and pseudomelanosis of the oesophagus [8, 19, 28, 32]: the latter two conditions representing pathological entities in which accumulation and tissue deposition of melanocytes or of pseudomelanin (corresponding to lipofuscin) may lead to the aspect of black oesophagus. In addition, black discolouration phenomena of the oesophageal mucosa, although apparently in a more circumscribed pattern, have been described in association with ingestion of quinidine and tetracycline [18, 23] and following chronic exposure to charcoal or coal dust [17, 22].

The investigation of sudden, unexpected death is an important and challenging issue in medico-legal autopsy practice, occasionally placing heavy demands on the forensic pathologist to provide satisfactory answers to the investigating authorities in specific cases [2, 3, 5, 9, 10, 20, 33]. Apart from Mallory-Weiss syndrome and ruptured oesophageal varices [33], acute necrotising oesophagitis has been described as the source of fatal upper gastrointestinal bleeding in association with carcinoma of the oesophagus [1, 29] and after medications had failed to transit the oesophagus and acted locally ultimately producing necrotising oesophagitis [18]. According to the literature, severe blood loss from mucosal necrosis in black oesophagus has been documented as the immediate cause of death (as verified by autopsy) in one case to date [14] and, according to clinical findings, in at least four more cases the disorder most probably influenced the fatal outcome [4, 6, 26], although no autopsies were performed in these cases to verify this assumption. In the present study, black oesophagus was the immediate cause of death in one case (case 5). In this case death was due to severe blood loss from necrosis of the oesophageal mucosa; signs of considerable blood loss prior to death were detected at autopsy (e.g., sparse postmortem lividity, pallor of internal organs) and no other potential bleeding source could be established by gross pathology and microscopical examination. In one case of the present series, necrosis of the oesophageal mucosa most probably contributed to the fatal outcome (in conjunction with internal blood loss from erosive gastritis, case 1). An erosive gastritis as additional bleeding source other than the necrosis of the oesophageal mucosa could be established by gross pathology and microscopical examination in two cases (cases 1 and 4). An association between black oesophagus and erosive gastritis has been observed endoscopically in some previously published cases, too [15, 16, 26]. However, we believe that the co-existence of both pathological conditions is most probably a coincidental, purely stress-related phenomenon rather than a specific pathological constellation. The exact cause of death could not be established after autopsy, microscopical examination and a thorough toxicological analysis in two cases (cases 3 and 4). In these two cases, apart from black oesophagus, no major pathological findings were present that were sufficient to explain death satisfactorily, although in one case circumstantial findings pointed clearly towards fatal hypothermia (case 4). Of course, black oesophagus may be a pure incidental finding at autopsy (case 2) that may have no pathological relevance to the cause of death, but according to the results of this study, the disorder, although very rare, may become a relevant differential diagnosis of sudden death in particular cases.

A variety of pathophysiological mechanisms with different underlying aetiologies has been proposed to account for the development of black oesophagus and the disorder has been related to several underlying debilitating illnesses, including, i.e. alcohol abuse [16], malignancies [26], herpetic infection [7], poor nutritional status [4], immunocompromise [6] and ischemia due to cardiac pathology [13, 15, 25, 27]. The latter five conditions can be excluded in our cases. However, none of the debilitating conditions previously described in association with black oesophagus or the pathogenetic mechanisms they may induce, can satisfactorily explain the pathological findings in all cases and, accordingly, the true aetiology and exact mechanisms accounting for the development of the disease remain as yet unknown [15, 16, 26, 27]. It remains unclear which factors may induce or influence the development of necrosis of the entire oesophageal mucosa in such a homogenous pattern as observed here in one individual suffering from a particular debilitating condition but not in the other cases. In most clinical reports, the endoscopical finding of black oesophagus was completely reversible and oesophageal necrosis resolved completely with improvement of the associated disease and after supportive treatment including adequate caloric contribution, intravenous fluid administration and haemodynamic stabilisation thus reestablishing the conditions for a sufficient oesophageal blood supply [6, 13, 15, 16, 26, 31]; oesophagectomy was required in only one case [12].

The remarkably consistent pathomorphological picture of the disease seems to correspond to the end stage of a prolonged and complex hypotension of the blood supply of the entire oesophageal mucosa rather than the morphological counterpart of a homogenous pathological entity. In none of the cases investigated here was the manifestation of black oesophagus known prior to death. According to the observed chronomorphological picture of acute oesophagitis with a sharp demarcation of mucosal necrosis by predominantly neutrophilic granulocytes and less macrophages in the absence of haemosiderin deposits, the noxious mucosal injury must have developed within a time frame of approx. 24–72 h prior to death.

In conclusion, the results of the present study suggest that for the forensic pathologist the autopsy finding of black oesophagus may represent more than just another morphological curiosity. The pathological relevance and medico-legal significance of black oesophagus lies in (1) the possibility of misinterpreting the black discolouration as a sequel of e.g., ingestion of corrosive, caustic or other toxic agents thus likely misleading the subsequent in-

vestigations (e.g. death scene analysis, toxicological analysis) and (2) the obvious potential of this rare disease to cause or at least to contribute to fatal outcome manifesting as sudden death in some probably predisposed individuals.

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