František Novomeský
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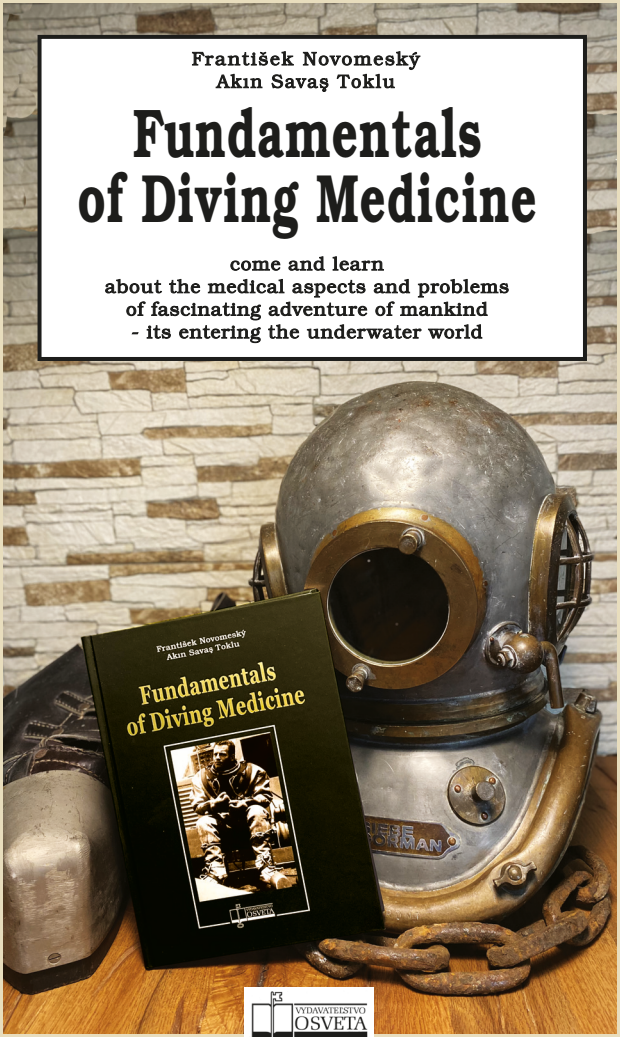
Fundamentals of Diving Medicine

come and learn
about the medical aspects and problems
of fascinating adventure of mankind
- its entering the underwater world



VYDAVATEĽSTVO OSVETA

Case report 7.5. Pulmonary barotrauma of ascent (local)

Diver: 25 years, female, otherwise healthy
Qualification: trainee in Open Water Diver course **Locality:** freshwater lake
Maximal depth/Bottom time: 4.0 m/12 min
Outcome: fatal
Description of accident: Training dive during OWD course.
The afflicted diver dove with a competent buddy, however after 12 minutes of stay underwater (the depth of 3.0–4.0 meters) in a low visibility the divers split apart. It was then noticed by bystanders on the shore, that the trainee suddenly surfaced, threw away her dive mask and submerged again. She was found after 20 minutes, laying at the bottom in the depth 4.0 meters, without any vital signs. The CPR was unsuccessful.
The autopsy revealed a well-defined zone of massively overinflated subpleural tissue of the right lung middle lobe (Fig. 7.12.). In the airways, the chronic mucous bronchitis was diagnosed (confirmed by microscopy), together with many viscous plugs of bronchial mucus, adhering to bronchial walls. Numerous gas bubbles were discovered in the cerebral arteries. A small amount of aspired water was found in the airways, without any evident signs of drowning.

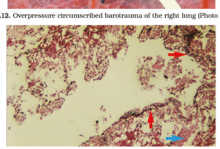


Figure 7.12. Overpressure circumscribed barotrauma of the right lung (Photo F. Novomeský).

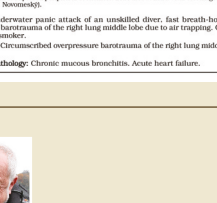


Figure 7.13. Suspicious centre of pulmonary "burst" in histology. Red arrows: residua of epithelium of ruptured peripheral bronchiole. Blue arrow: intra-vital bleedings into the alveoli (Photo F. Novomeský).

Conclusion: Underwater panic attack of an unskilled diver, fast breath-hold ascent, local (circumscribed) barotrauma of the right lung middle lobe due to air trapping. Chronic mucous bronchitis in a smoker.
Cause of death: Circumscribed overpressure barotrauma of the right lung middle lobe. Massive CAGE.
Concomitant pathology: Chronic mucous bronchitis. Acute heart failure.

7.3.6.3. Morphologic predisposing factors for pulmonary barotrauma of ascent in divers

- Pulmonary cysts and neoplasms
- pulmonary fibrotic diseases
- inflammatory diseases of peripheral airways
- pathologic conditions of the bronchi (*bronchiectases, bronchiolitis*)
- severe forms of bronchial asthma
- pulmonary sarcoidosis
- pneumothorax
- pulmonary emphysema
- obstructive forms of inflammatory diseases of the airways
- heavy smoking habit
- idiopathic decrease of pulmonary compliance with lower extensibility of the lungs, without the presence of any other pulmonary pathologic finding.

Severe pulmonary barotrauma of ascent, together with ascent barotrauma of the intestinal tract, can also arise as a consequence of underwater explosions (military underwater operations, commercial diving). If a diver, at the moment of an explosion underwater, is situated in sufficient proximity to the epicenter of the explosion, a massive blast wave rapidly spreads through the water, which strikes diver's body. If the underwater blast wave strikes the chest of the diver, its momentary compression develops, accompanied by a sharp increase in the intrapulmonary pressure.
The sudden increase in pressure of intrapulmonary gas, provoked by an underwater blast wave, can cause extensive destruction of the alveolar walls with massive intra-alveolar and perifocal bleeding. At the same moment, the alveolar gas is forced to the damaged pulmonary capillary network and the bloodstream, with subsequent AGE. The blast wave spreading through the water and the divers body, can also lead to ruptures of the visceral pleura and escape of the intrapulmonary gas into the pleural cavity (pneumothorax).
The clinical picture of pulmonary barotrauma of ascent depends mainly on quantity of lung parenchyma that is injured. Minor lung injuries can remain clinically asymptomatic, the afflicted diver may not have any distinct clinical difficulties, apart from a subjective feeling of pressure or tension in the chest, to which they rarely ascribe any higher attention. In cases of more extensive pulmonary barotrauma of ascent, the condition can further manifest in three characteristic clinical features (Fig. 7.14.):
- arterial gas embolism
- pneumothorax
- mediastinal and subcutaneous emphysema.

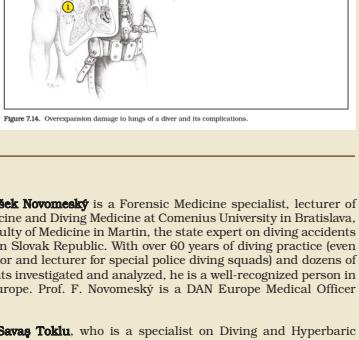


Figure 7.14. Overexpansion damage to lungs of a diver and its complications.

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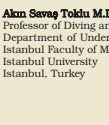
Prof. František Novomeský is a Forensic Medicine specialist, lecturer of Forensic Medicine and Diving Medicine at Comenius University in Bratislava, Jessenius Faculty of Medicine in Martin, the state expert on diving accidents investigation in Slovak Republic. With over 60 years of diving practice (even as an instructor and lecturer for special police diving squads) and dozens of diving accidents investigated and analyzed, he is a well-recognized person in its field in Europe. Prof. F. Novomeský is a DAN Europe Medical Officer (Slovakia).



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Prof. Akın Savaş Toklu, who is a specialist on Diving and Hyperbaric Medicine, was a medical advisor on the construction site during compressed air work in the Eurasia Tunnel Project that connected Europe and Asia underneath the Bosphorus. He also worked as a diving physician on-site in some underwater archaeological works, excavations, constructions, and salvage operations. He is a lecturer at Istanbul University, Istanbul Faculty of Medicine, where the residency program on Diving and Hyperbaric Medicine is provided. He also shares some clinical case reports from his department or diving operations. Prof. A. S. Toklu is a DAN Europe Medical Officer (Turkey).

This textbook, elaborated by two experienced and recognized specialists from both wings of today's medicine - morphology and clinics - may serve as a comprehensive basis for students of medicine with an interest in underwater medicine and even a skilled diving physician, but would also be a rich source of knowledge for diving instructors to better understand the way for safe diving procedures.

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