Dilemmas in aeromedical evacuation of a scuba diver with pneumomediastinum

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Pneumomediastinum occurs as the result of pulmonary air leak that is induced by a variety of conditions including pulmonary barotrauma (PBT) and oesophageal perforation. It is a recognized risk of self contained underwater breathing apparatus (SCUBA) diving. Pneumomediastinum has been reported as the most common form of PBT in divers [1, 2] and is also known to occur frequently following traumatic oesophageal perforation. This paper reports on a patient who presented with pneumomediastinum and surgical emphysema after SCUBA diving, the likely cause of which was narrowed down to either PBT or an oesophageal perforation. Since oesophageal perforation with its high morbidity and mortality could not be ruled out, the patient had to be air evacuated to a specialized center at the earliest. A number of issues posed dilemmas in deciding fitness of the patient for urgent aeromedical evacuation.

The report highlights the importance of obtaining aeromedical advice in evacuation of such patients from peripheral locations and the dilemmas faced in deciding fitness for the same. It also emphasizes the importance of teamwork among various clinical specialties in the absence of sophisticated investigation modalities.

Case Report

A 27 year old serving Naval Officer (Diver) of the Royal Navy performed two repetitive SCUBA dives of 30 metres and 24 metres using compressed air. Both the dives were uneventful. Decompression stops had been adhered to as per the dive tables and he had an accumulated dive time of about 2 hours for the day. About an hour after the last dive he complained of sudden onset, severe constricting pain in the neck soon after swallowing a piece of cooked chicken at lunch. Pain increased on deep breathing and was accompanied by dysphagia and odynophagia. He was kept under observation on board his ship by the Medical Officer and was brought to the Indian Naval Hospital only later that evening at around 2130 hrs, about 9 hours after the onset of symptoms. There was no history of breath-holding during ascent, pain chest, joint pains, headache, giddines, haemoptysis, respiratory distress, hoarseness, skin itch, tingling sensation in the limbs. The patient was a non-smoker and did not offer any relevant past medical history. On admission, examination revealed a well built and well nourished male with all vital parameters within normal limits. Surgical emphysema was detected in the left side of the neck. Hamman's sign was negative. A systemic examination including otorhinolaryngological examination revealed no

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abnormality. Routine haematology, biochemistry, urinalysis and ECG were normal. Lateral radiograph of the neck showed air in the retropharyngeal space extending up to the base of the skull and AP view showed air in the subcutaneous plane. No radio opaque foreign body was seen. Chest radiograph did not reveal any abnormality including evidence of pneumothorax, pneumomediastinum or pulmonary pathology. The patient was diagnosed as a case of surgical emphysema - neck, probably due to a traumatic oesophageal perforation by a chicken bone. He was placed on Dangerously Ill List (DIL), kept nil orally and managed conservatively with IV fluids, Inj Cefoperazone with salbactam sodium 2 g IV BD, Inj Amikacin 1 g IV OD, Inj Metronidazole 500 mg IV TDS and Inj Pantoprazole 40 mg IV OD.

In the absence of a Computed Tomography (CT) scan and contrast swallow, oesophageal perforation could neither be confirmed nor ruled out. Since mediastinitis was considered a definite risk, there was a need for management of the case at a specialized centre. It was therefore essential that a speedy evacuation be conducted. The only possible means of achieving this, from the remote islands of the Andaman and Nicobar to mainland India was by air.

When the patient was examined at 0630 hours the next day to determine fitness for air evacuation, it was observed that he had improved markedly, odynophagia had reduced and there were no clinical signs of cardiorespiratory distress. A repeat chest radiograph, prior to deciding fitness for evacuation, revealed a thin radiolucent shadow between the right border of the cardiac shadow and pleura, suggestive of a pneumomediastinum; no mediastinal shift was seen. At this stage, the index of suspicion of PBT was considered high and 100% oxygen was started by a close fitting oronasal mask. This would speed up the process of air being absorbed from the mediastinum and would also help in washing out the nitrogen, affording protection from in flight DCS.

The patient was successfully evacuated by a pressurized commercial aircraft to London via Kolkata and New Delhi. He was accompanied by an experienced medical officer and one paramedical staff along with necessary medical equipment. He was not available for follow up, thereafter.

Discussion

Pneumomediastinum may occur spontaneously due to rupture of alveoli in the lungs (PBT), perforation of the pharynx or oesophagus, rupture of the trachea, main bronchi or small intrapulmonary airway and a pneumoperitoneum [3]. It is quite often associated with a pneumothorax or subcutaneous emphysema [4]. In this case, oesophageal perforation or a PBT were the two possibilities as the probable causes of pneumomediastinum, which was associated with a subcutaneous emphysema in the neck.

Chest radiographic detection of an oesophageal perforation relies on the presence of indirect radiological signs, including pneumomediastinum, left-sided pneumothorax, and pleural effusion. The infectious and inflammatory response as a result of leakage of gastric contents can disseminate to nearby vital organs and can result in high morbidity and mortality [5].

Pulmonary air leaks result from PBT sustained during SCUBA or compressed air diving, with rupture of the terminal alveoli secondary to increased intrathoracic pressure. This may happen if air is not exhaled on ascent. It may also result due to acute changes in breathing patterns causing an increased lung volume or sudden pressure changes [6]. Rupture of sub-pleural blebs and bullae is also an accepted cause for PBT. Air may also

leak through intact membranes of marginal alveoli with increased intra-alveolar pressure [7].

Pneumomediastinum may present without any symptoms. However, some patients may present with dominant oesophageal symptoms like chest pain, fever, subcutaneous and mediastinal emphysema suggestive of an oesophageal perforation. Such a series has been reported in which a dilemma was faced in identifying the aetiology of the pneumomediastinum [8]. Similarly, in the case described here, the patient presented with dysphagia and odynophagia.

Although the chest radiograph on admission revealed no abnormality; the next morning, it revealed a thin radioluscent shadow between the right border of the cardiac shadow and pleura, suggestive of a small pneumomediastinum. This could be attributed to a slow leak of air into the mediastinum.

Safe aeromedical evacuations of diving accidents have been conducted in the past [9, 10]. However, the decision to evacuate this patient by air posed several dilemmas in this case.

(a)Did the patient's condition warrant evacuation by air? -Cases of PBT following diving have been reported. No active treatment was resorted to in these cases and recovery was uneventful [6, 11]. Hence, although the ideal treatment of pneumomediastinum accompanied by subcutaneous air consists of treating with oxygen and keeping under observation, in the light of a suspected oesophageal perforation with the risk of life threatening sequalae, it was felt that the risk of treating the patient locally with inadequate medical facilities, greatly outweighed the risk of an urgent aeromedical evacuation.

(b) Were there any signs and symptoms suggestive of arterial gas emb-- (AGE) Type I or Type II Decompression sickness (DCS), pneumothorax or pneumomediastinum? There was no history, no identifiable risk factors such as rapid ascent, breath hold, detectable lung disease and no signs or symptoms suggestive of AGE / DCS. The clinical condition of the patient and chest radiograph ruled out a pneumothorax. A very small pneumomediastinum was however seen. It is important to rule out these conditions since both are contraindications to flying, if untreated. [12].

(c) If the cause of the emphysema and pneumomediastinum was due to a ruptured superficial bulla, was there a risk of another such episode in flight? The chest radiograph did not reveal any signs of bullae, however their presence could not be ruled out on a plain chest radiograph since it is seen that bullae go undetected in antecedent conventional chest radiography [9, 13]. Hence the risk of recurrent rupture of a bulla during the flight could not be ruled out with certainty.

(d) Prior to evacuation, had the patient completed the mandatory preflight surface interval? In accordance with guidelines for flying after diving, the patient's dive profile required him to complete a minimum preflight surface interval of24-48 hours [14] which he would fulfill prior to emplaning.

(e) There were certain in-flight risks, which had to be considered and resolved: development of in-flight pneumothorax; development of a delayed PBT; recurrence of rupture of bullae and risk of post flight DCS. Divers who do not have symptoms of DCS can develop symptoms during or after a commercial flight [15] and cases of delayed onset PBT have also been reported [16]. The risk of in¬ flight development of these conditions was considered minimal in view of the following: (i) the amount of air visualized in the mediastinum was minimal and would reduce further with administration of 100% oxygen. Symptomatically

also, the patient had improved overnight and was stable; (ii) the patient was to be evacuated in a pressurized commercial aircraft with a cabin altitude between 5000-8000 feet; (iii) the requirement of having completed the post-dive safe surface interval prior to the flight had been fulfilled.

Conclusion

A number of lessons were learnt while deciding fitness for aeromedical evacuation of this case. There is no absolute contraindication to aeromedical evacuation and each case has to be treated on its merit, a decision being taken with caution after all the probable risks have been adequately considered. Prior to aeromedical evacuation, the latest investigations should be available for assessing the patient to ascertain fitness for flying. In this case it was only the chest radiograph, taken a few hours prior to the flight which showed the pneumomediastinum. This case also underlines the importance of a clinical examination being conducted just prior to embarkation and continuous in-flight monitoring of the patient. Practice of Operational Aviation Medicine present unique situations which require team work from all clinical specialties for a successful outcome especially in the absence of sophisticated investigation modalities. In this case the specialties of Surgery, Otorhinolaryngology, Internal Medicine, Radiodiagnosis and Aviation Medicine contributed to the successful initial management and safe aeromedical evacuation of the patient.

Conflicts of interest: None identified.

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