5. CASE REPORT - PULMONARY BAROTRAUMA by IP Unsworth

Introduction

Reduction of ambient pressure from depth in a pressure chamber or from underwater will cause intrapulmonary gas expansion according to Boyle's Law (Vf(001,p)). This expansion presents the possibility of overfilled lungs, either trapped locally or as a whole. The recognised consequences of pulmonary over-distension are: traumatic arterial air or gas embolism; interstitial and mediastinal emphysema, or pneumothorax usually under tension. Such as case of tension pneumothorax is described.

Case Report

A 55 year old female was referred to the Hyperbaric Unit, at Prince Henry Hospital, Sydney, for a course of hyperbaric oxygenation. This patient had a one year history of squamous cell carcinoma of the floor of the mouth treated by DXR, bilateral suprohyoid dissection with thoracic flap reconstruction, and permanent tracheostomy. Chest x-rays showed chronic obstructive airways disease with a circular opacity in the right middle lobe, thought to be inflammatory but neoplastic. During an aggressive episode the patient tore the pedicle from its oral attachment and came to require OHP to improve vascularisation of the floor of the mouth and pedicle.

The regime of oxygenation was 2 hours daily at 2.8 ATA (60 ft) on a semi-closed 100% O_2 absorber circuit connected to the tracheostomy whose cuff was inflated with water throughout the entire treatment. Decompression times were 5 minutes at 20 feet, 25 minutes at 10 feet, with a total decompression time of 41 minutes. Seven sessions were completed satisfactorily, though there was a tendency for tenacious bronchial mucous to develop.

On the 8th session at 10 feet, the patient indicated by gestures that she had right upper abdominal pain - no speech was possible because of the tracheostomy. This was thought to be due to gas-distended gut. She was recompressed to 15 feet, the pain disappeared, and a slow bleed to the surface commenced at 1 foot/minute. There was no change in colour of the patient who, as previously, was breathing 100% O_2 on the way to the surface. An increase in ventilation rate was noted, but associated with apprehension of the patient following her discomfort.

On arrival at the surface, she was taken off oxygen, the chamber vacated and 2 to 3 minutes later increasing respiratory distress and

cyanosis were noted, the BP 90/50, then the patient appeared to lose consciousness. IPPR by ambu bag with external cardiac massage were begun. The tracheostomy was aspirated as the patient had a history of two previous cardiac arrests at the referring hospital, following blockage of the tracheostomy by mucous. Examination of the chest then showed absent air entry on the right with an increased percussion note, trachea deviated to the left and a CXR showed complete right lung collapse with the mediastinum shifted hard over and the right diaphragm pushed well below the left. ECG showed only sinus tachycardia.

The diagnosis was of a right sided tension pneumothorax with virtually 100% oxygen as the intrapleural gas. This can be fairly certain as the patient was on oxygen to the surface and thus after the barotrauma had occurred. Treatment consisted of the insertion of a wide bore polythene intercostal underwater drain and in 12 hours there was complete re-expansion, aided by the rapid absorption of oxygen from the intrapleural reservoir.

Discussion

Lung damage resulting from over-inflation (pulmonary barotrauma) may present as one or more of three entities:

i. Gas embolism
ii. Mediastinal emphysema
iii. Tension pneumothorax

Of these, the most severe is embolization in which gaseous emboli enter the arterial circulation. Mediastinal emphysema can impede venous return and myocardial action by distension of the mediastinum while a tension pneumothorax can impede venous return through raised intrathoracic pressure.

Local trapping of air is unlikely to be prevented by such actions as continuous voluntary exhalation during pressure reduction. The aetiology of pulmonary barotrauma presupposes that the lung region involved was able to equalise (equate) with the inhaled gas (air or oxygen) while at pressure, but was unable to vent the gas sufficiently rapidly during ascent. Such regions considered are obstructed segments, lung cysts or bullae (Golding, 1960) and as a rarity, a tuberculous broncholith acting as ball valve (Liebow, 1959). Other authors (Dermksian and Lamb, 1959) suggest congenital cysts, scar-tissue vesicles and emphysematous valve vesicles may function as air

trapping sacs.

Prevention of these accidents due to local overinflation must depend largely on excluding from pressure those individuals in whom airway obstruction is likely to occur. This is not a simple task in Hyperbaric Medicine as often the patients most requiring OHP are those with susceptible pulmonary lesions and thus a calculated risk must be taken. However, the question of pulmonary barotrauma must also be of concern, not only to submarine and diving medical officers, but also to every doctor who examines prospective sports divers. Some candidates and patients may be eliminated on history or physical examination alone, plus chest x-rays. Apart from these, pulmonary function studies using spirometry and nitrogen or helium washout patterns may be of some value. In Hyperbaric Medicine, prospective patients fall into two groups, those in whom the risk is not justified, and those in whom the value and benefit of OHP is greater than the risk involved.

Treatment of pulmonary barotrauma varies slightly, dependent on the type. Arterial embolisation requires immediate recompression and the use of a full therapeutic decompression table plus ancillary treatment such as intravenous fluids, vasopressors, steroids, IPPV or even hypothermia for cerebral manifestations (Winter, 1971). Mediastinal emphysema may require prolonged inhalation of oxygen at atmospheric pressure, with possible retrosternal take-off being considered. Treatment of a pressure-induced pneumothorax differs in no way from that of a normo-baric pneumothorax, vis. release of gas by intrathoracic wide bore underwater drainage and pulmonary reinflation, with bronchoscopy if necessary.

In conclusion, the unusual feature of this case is tension pneumothorax due to pulmonary rupture with the main gaseous component being oxygen and thus representing an ‘oxythorax’. The possibility that this lady also suffered a small oxygen arterial embolus resulting in a change of consciousness should also be considered but which was absorbed very rapidly and required no treatment.

REFERENCES

1. Golding FC et al. *British Medical Journal* 1960; 17: 167
2. Liebow AA et al. *US Armed Forces Medical Journal* 1959; 10: 265
3. Dermksian G and Lamb LE *Ann. Int. Med.* 1959; 51: 31
4. Winter PM et al. *JAMA.* 1971; 215: 1786

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6. RECOMPRESSION CHAMBERS IN QUEENSLAND

Information supplied by Dr Peter Nicoll, 26 January 1972

A. 1. SUBMARINE ENGINEERS
(Main branch - Perth). Local operators - Alan CARR
Jack LAWSON.

2. At present sited at 5 Jobson Street, BREAKFAST CREEK, but is portable and taken to diving sites around the state. Portable on skids (1 ton approx.)

3. Rated at 133 WP which we presume to be 133 psi.

4. Internal Dimensions
2 chambers. Doors open in "O" ring seals
Internal diameter 4 feet.

5. One major lock only as shown.

6. The operators state inner chamber will hold four at a "squeeze" but I think even two people would be a little cramped.

7. Manufacturer: "Downey Welding and Manufacturing Coy of California".
Date: 9/1966

8. Chamber can be operational in an hour or two, dependent on supplies of medical air and oxygen. There is a small compressor adequate for maintenance and venting but not sufficient for rapid recompression.

B. 1. THE HORNIBROOK GROUP

2. Brisbane

3. Current rating is being investigated, but might be only 100 feet.

4. Size similar to URGO chamber.

5. Remaining information and more detailed information on above to follow if and when available.

This chamber would need about 2 weeks' work to renew all perishables. It is possible that this group might set up the chamber (if in fact it would go deep enough) but would move it to job sites when necessary approximately six months in every five years.

Editor’s note: Thanks Peter. When we have the information from each state, we shall prepare an appendix to the Newsletter showing sites and conditions of all Australian Chambers.