Pneumomediastinum in Student Aviators: 10 Cases with Return to Flying Duty

Alon Grossman, Ayal Romem, Bella Azaria, Liav Goldstein, and Erez Barenboim

Pneumomediastinum (PnM) is an uncommon phenomenon, though it is one of the most common causes of chest pain in young adults. It may be particularly important among aviators, as it may result in in-flight incapacitation. Spontaneous PnM is a variant usually associated with the Valsalva maneuver, used during high-performance flight. This may increase the risk of PnM recurrence and raises concern regarding the return to flight duties of aviators after an episode of spontaneous PnM. We present 10 student aviators who experienced a single episode of uncomplicated PnM unassociated with flight. All were returned to flying duty following a normal pulmonary evaluation and are still in active duty. Follow-up was conducted for a mean period of 74.7 mo without any adverse consequences. These findings support the return of aviators to flying duty after a single episode of uncomplicated spontaneous PnM.

KEYWORDS: pneumomediastinum, aerospace medicine, aviators.

Presentation of Cases

10 student aviators who experienced episodes of spontaneous PnM were identified between 1977 and 2002. The cases are presented in Table I. All patients were healthy prior to the episode, with no evidence of obstructive airway disease. The clinical presentation was variable and all subjects were hospitalized for observation. The diagnosis was confirmed by chest radiography. Of the subjects, nine were treated conservatively and were discharged after an average of 2 d. A single patient required insertion of a chest tube due to concomitant pneumothorax and was hospitalized for 7 d. Only two of the patients experienced concomitant pneumoperitoneum; in neither was underlying lung pathology confirmed. The episodes occurred during the students’ basic training period and were not associated with flight. In fact, none of the students was involved in flight during the week prior to the episode.

All patients underwent pulmonary workup prior to their return to flight. Of the patients, eight underwent a computed tomography (CT) scan, six of these being high-resolution scans. One of the episodes occurred in 1977, when CT scans were unavailable. All underwent pulmonary function tests, which were found to be normal in nine subjects. A single subject had a decreased forced expiratory volume in 1 s over the predicted vital capacity ratio (FEV1/FVC) and, therefore, underwent a bronchial provocation challenge with metacholine that was found to be normal. Three of the subjects underwent altitude chamber testing without any pulmonary complaints. Following the episode, all were evaluated by a pulmonologist and were returned to active flying duty after an average waiting period of 4 wk.

Follow-up was conducted for an average period of 74.7 mo (range 12–306 mo), during which all remained symptom-free and in active flying duty. Currently, five of them are operating high-performance aircraft, two operate cargo aircraft, and three are rotary wing pilots. Their flight careers were unaffected by the previous episode of PnM. Routine follow-up of these patients, including a flight surgeon examination and spirometry, revealed no abnormal findings.

DISCUSSION

Spontaneous PnM is defined as PnM occurring in healthy individuals with no underlying lung pathology and no antecedent history of trauma. Spontaneous PnM is usually related to the Valsalva maneuver and has been described in various situations where this maneuver...
ver is used, such as labor, seizures, and physical activity (4,5). The relation between this maneuver and PnM is explained by the Macklin Effect, which involves alveolar ruptures with air dissection along bronchovascular sheaths to the mediastinum (8). The incidence of spontaneous pneumomediastinum in persons aged 14–29 is approximately 1:3000, making it second only to pneumothorax as a cause of chest pain in this age group (9). This entity usually requires no intervention unless concomitant pneumothorax is present or in rare cases of tension pneumomediastinum (PnM). The average hospitalization time for patients with uncomplicated pneumomediastinum is 3.3 d and the only treatment necessary is reassurance. Recurrence is also extremely uncommon, since in most cases no lung pathology is present. Yellin and colleagues reported only 1 recurrence in 16 cases followed up for 6–52 mo (9), whereas Abolnik and colleagues reported 2 cases of recurrence among 23 patients after an average follow-up of 87.4 mo (1). The three patients who experienced recurrence had no underlying lung pathology.

PnM may be associated with pneumothorax. Pneumothorax associated with PnM evolves in a different fashion from spontaneous pneumothorax. Spontaneous pneumomediastinum results either from increased intra-alveolar pressure or from decreased interstitial pressure. Air then flows from the alveolar space to the interstitial space. In some cases of spontaneous PnM, the increased interstitial pressure may result in a tear of the parietal pleura leading to the development of secondary pneumothorax. This differs from primary spontaneous pneumothorax, which is caused by tearing of the subpleural blebs (2).

The U.S. Navy reported five cases of spontaneous PnM, which represented an incidence of 1:800 among Marine recruits during the period between September 1974 and August 1975. They attributed this high incidence to the Marine exercise program, which includes frequent marching and yelling. These activities generate high intrapulmonary pressures that may result in alveolar rupture. This is the only report of spontaneous pneumomediastinum among military personnel up to date (3). No cases of pneumomediastinum were reported in association with military aviation. We reported 10 cases of student aviators who experienced spontaneous pneumomediastinum. We cannot report the actual number of student aviators during this time period, but this phenomenon is certainly uncommon. Despite the rarity of this entity, we believe that the lack of previous reports on this topic makes our report crucial. No similar cases were reported in active duty aviators during this same time period in the Israeli Air Force and, therefore, it seems that the underlying mechanism responsible for the formation of PnM in our students is similar to that reported in U.S. Navy Marine recruits. Both groups were engaged in strenuous physical activity and were both subject to frequent marching and yelling.

**Aeromedical Concerns**

PnM may pose a particular risk to aviators because it may contribute to in-flight incapacitation. The severe pain and dyspnea induced by PnM may interfere with optimal aircraft operation. PnM may also lead to secondary pneumothorax. This, as stated earlier, is caused by a parietal pleural tear secondary to increased interstitial pressure and is not due to the rupture of subpleural blebs. The recurrence rate for primary spontaneous pneumomediastinum, which is usually associated with underlying lung pathology, is much higher than spontaneous pneumomediastinum. The probability of a recurrence of spontaneous pneumomediastinum is approximately 50% after the first episode, 62% following the second, and 80% following the third (6). Aviators who experienced spontaneous pneumomediastinum should have thoracoscopic surgery recom-

### TABLE I. PATIENT CHARACTERISTICS AND CLINICAL COURSE.

<table>
<thead>
<tr>
<th>#</th>
<th>Age</th>
<th>Clinical presentation</th>
<th>Additional imaging studies</th>
<th>Pulmonary function tests</th>
<th>Length of hospitalization (d)</th>
<th>Time to return to flight (wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>20</td>
<td>Chest pain and dysphagia</td>
<td>HRCT-normal</td>
<td>N (DLCO normal)</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>II</td>
<td>23</td>
<td>Chest pain and dyspnea</td>
<td>HRCT-normal</td>
<td>N (DLCO normal)</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>III</td>
<td>23</td>
<td>Dyspnea</td>
<td>HRCT-normal</td>
<td>N</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>IV</td>
<td>20</td>
<td>Chest tightness</td>
<td>Not performed</td>
<td>N</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>V</td>
<td>19</td>
<td>Dyspnea</td>
<td>HRCT-normal</td>
<td>N (DLCO normal)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>VI</td>
<td>20</td>
<td>Dyspnea</td>
<td>HRCT-normal</td>
<td>N</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>VII</td>
<td>22</td>
<td>Dyspnea</td>
<td>CT-normal</td>
<td>N</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>VIII</td>
<td>19</td>
<td>Dyspnea</td>
<td>HRCT-normal</td>
<td>N (DLCO normal)</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>IX</td>
<td>19</td>
<td>Chest pain</td>
<td>Chest X-ray</td>
<td>N</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>X</td>
<td>19</td>
<td>Chest pain and dysphagia</td>
<td>CT-small opacifications at the left lung apex</td>
<td>Decrease in FEV1/FVC</td>
<td>Normal provocation test</td>
<td>1</td>
</tr>
</tbody>
</table>

HRCT—high resolution computed tomography, N—normal, DLCO—diffusion capacity, FEV1—forced expiratory volume in 1 s, FVC—forced vital capacity.
mended, both because of the risk of barotrauma and because of the risk of sudden incapacitation. Following thoracoscopic surgery, aviators may be returned to flying duty since the recurrence rate following this procedure is extremely low, ranging from 0 to 1.6% (7). Since the recurrence rate of spontaneous PnM reported in the literature is similar to that of treated pneumothorax, we believe patients may be returned to flying duty following a single episode of spontaneous PnM. Yet, because of the dreaded potential for incapacitation due to PnM recurrence, we believe that lung evaluation should be conducted in all patients in order to rule out lung pathology. This should include examination by a pulmonologist, performance of a high resolution CT scan to rule out the presence of bulla, and pulmonary function testing to rule out hyperinflation. We believe that aviators should be returned to the cockpit after a minimal waiting period. In our series, 2 wk were arbitrarily chosen.

Only two aviators experienced an episode of concomitant pneumothorax in our series. One of them underwent pulmonary function testing and hypobaric chamber testing before his return to active duty. He did not undergo a CT examination due to the fact that his symptoms developed in 1977, when CT was unavailable in Israel. The other underwent a high-resolution CT examination and pulmonary function testing, which were found to be normal.

Military aviators frequently use the Valsalva maneuver. Since PnM is usually related to this maneuver, fear exists regarding the chances of recurrence. High altitude flight and sudden decompression are additional factors that may contribute to the formation of PnM. All these factors might, theoretically, increase the chance of recurrence of PnM among aviators, but this has not been proved in previous reports as well as in ours.

In our series, 10 aviators with a history of PnM were followed for an average of 7.47 mo with no evidence of recurrence or pulmonary complaints. Of these aviators, five serve as rotary wing or cargo pilots, where the Valsalva maneuver is rarely used and where there always is a second crewmember that can operate the aircraft in cases of sudden incapacitation. The other five serve as high performance aviators and thus are theoretically at a higher risk of recurrence. A thorough evaluation was performed in all student aviators to rule out underlying lung pathology, specifically subpleural blebs. Once this had been ruled out, they were returned to unlimited flying status, their flying career unaffected.

CONCLUSIONS

PnM is a self-limited condition with a very low recurrence rate. Therefore, we believe that aviators may be returned to flying duty after a single episode of spontaneous PnM. Despite the hypothetical increased risk of recurrence among high performance aviators, our follow-up showed no recurrences. Even though the incidence of lung pathology among patients with spontaneous PnM is extremely low, we believe that all should undergo evaluation by a pulmonologist, pulmonary function testing, and high-resolution CT to rule out rare but potentially lethal underlying lung disease.

REFERENCES