The relationship between aluminum and spontaneous pneumothorax; treatment, prognosis, follow-up?

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Abstract

Aluminum is known as a toxic metal today. Aluminum has already been determined to cause asthma bronchial and chronic obstructive pulmonary disease. It was also reported that Shaver disease undergoing fibrosis with large bubbles and the symptoms of potroom asthma had developed in the workers working in the manufacture of aluminum. The aim of the study was to analyze the relationship between aluminum and spontaneous pneumothorax in the patients not working in the industry and also to evaluate its results. Two groups were studied: the patient group and control group. The first group consisted of 30 cases who were admitted to hospital and treated in the clinic. The other group (control group) was composed of 30 healthy individuals who had no complaints. The aluminum level in blood plasma in spontaneous pneumothorax was found significantly higher than that in the control group ($p < 0.001$). In the spontaneous pneumothorax cases, the specificity of the aluminum was determined to be 100% and its sensitivity was determined to be 90%. The aluminum risk level in spontaneous pneumothorax group was determined to be ten times as high as that in the control group. We believe that this study will be helpful for thoracic surgeons in the treatment and follow up of spontaneous pneumothorax.

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Keywords: Pneumothorax; Aluminum; Lung pathology

1. Introduction

Aluminum is the third commonest element after oxygen and silica [1]. Aluminum has recently been shown to have adverse effects upon human health. Contact with aluminum cannot be avoided because it comprises about 8% of the earth’s surface [2].

It was first reported in 1934 that the inhalation of aluminum dusts caused pulmonary diseases. Fourteen years later, as a result of bauxite inhalation, 11 people with vocational pneumo-infections were reported. Pulmonary fibrosis and emphysema are known to have occurred in the workers who were exposed to aluminum oxide and silica smog. In addition, it was reported that some granulomatous lesions developed in the respiratory bronchi in the laboratory animals exposed to high concentrations of aluminum chlorhydrate used as aerosol antiperspirant. It was also reported that Shaver disease undergoing fibrosis with large bubbles and the symptoms of potroom asthma had developed in the workers working in the manufacture of aluminum [3].

In this controlled study of ours, we wanted to evaluate the relationship between spontaneous pneumothorax in the patients not working in industry and aluminum.

2. Patients and methods

Two groups were formed in this prospective study of ours. The first group consisted of the cases that applied to our clinic with the diagnosis of spontaneous pneumothorax in 2002 and 2003, and during the same period the second group was composed of healthy individuals who had no complaints. There were 30 cases in each study group. Physical examinations were given, the anamneses were taken, routine blood investigations were performed, postero-anterior thoracic images and computed thoracic tomographies and blood aluminum analyzes were performed in all of them.
All the aluminum levels were studied in the same laboratory twice. The blood samples were taken after the patients had been admitted to the clinic during the treatment.

The cases in the first group were divided into three groups in terms of the treatment of spontaneous pneumothorax. They are the cases who had pulmonary collapse less than 20%, the cases who had pulmonary collapse between 20 and 40% and the cases who had pulmonary collapse more than 40% or total.

Treatment options of spontaneous pneumothorax are observation, needle aspiration, percutaneous catheter to drainage (heimlich valve, etc.), tube thoracostomy, tube thoracostomy with instillation of pleural irritant, video-assisted thoracic surgery and thoracotomy [4]. In the light of the clinical assessment, our cases had tube thoracostomy and/or thoracotomy (bullous resection and pleural abrasion). Computed thorax tomographies were taken in the cases whose lungs were expanded. The structure of pulmonary parenchyma was evaluated. Postoperatively, morbidity and mortality were appraised. The results of aluminum in the spontaneous pneumothorax were compared with those in the control group and the relationship between aluminum and spontaneous pneumothorax was statistically evaluated.

2.1. Statistical analysis

The statistical analyzes of the data were performed in the Windows package programme using SPSS. In the evaluation, Student’s t-test, one way variance analysis, Spearman Rank correlation analysis, chi-square was made. In addition, receiver operating characteristic (ROC) analysis was performed in order to determine the level which is able to best identify the aluminum levels in both control and patient groups and this level was determined to be 4.5 μg/dl. According to this level, odds ratio (OR) was also given to determine the results of the screening test and the risk.

3. Results

In the first group, the average age of our cases was 30.4 years (16–77). Twenty-six of the cases were males (86.7%). In the second group, the average age of our cases was 27.5 years (22–40) and 70% of the cases were males.

Twenty-three of the patients (76.7%) smoked. Pneumothorax was on the right in 21 patients (70%). No cases had bilateral pneumothorax. The ratio of pneumothorax was less than 20% in five patients (16.7%), between 20 and 40% in four cases (13.3%) and more than 40% in 21 patients (70%) and/or total. Twenty-one of the cases had bullous lesions in their computed thorax tomographies and no cases in the control group had bullous lesions and the other results of control group had normal. The level of aluminum in blood plasma was mean found to be 2.66 ± 0.811 μg/dl (1.6–4.0) in the control group and mean 18.43 ± 0.628 μg/dl (2–62) in the patients with spontaneous pneumothorax.

The period of symptoms in the patients with spontaneous pneumothorax was mean 8.9 days (1–150). It was 1 day in 53.3% of the cases. Recurrent pneumothorax developed in eight cases (26.7%). We performed thoracotomies in six cases (20%). There was neither postoperative complication nor mortality.

The level of aluminum in blood plasma in both groups was found significantly high in the patients with spontaneous pneumothorax (P < 0.001). The specificity was determined to be 100% and the sensitivity was determined to be 90%. According to ROC analysis performed, the level which was able to best identify the patient and control groups was 4.5 μg/dl. The risk that the level of aluminum was higher than 4.5 μg/dl in the patient group was found to be ten times as high as that in the control group (OR = 10, 95% confidence interval, CI; 3.42–29.26). In the patient group, there was not a significant difference between the amount of aluminum in males and females. The level of aluminum in blood plasma in the spontaneous pneumothorax patients who smoked was 19.9 μg/dl but the level was 13.7 μg/dl in the non-smoker. The difference between them was not statistically significant. The level of aluminum in the patients with spontaneous pneumothorax on the right was 20.3 μg/dl and it was 14.1 μg/dl in the patients with spontaneous pneumothorax on the left (P > 0.05). The level of aluminum in the blood plasma was 11.8 μg/dl in the patients with 20% pulmonary collapse, 12.3 μg/dl in the cases between 20 and 40% and 21.2 μg/dl in the cases with total collapse. Although the level of aluminum in the cases with total collapse was found to be high, it was not statistically significant (P > 0.05). The level of aluminum was 19.2 μg/dl in the patients in whom the period of symptoms was 1 day and it was 17.5 μg/dl in the cases in whom the period of symptoms was longer. The level of aluminum was 19.18 μg/dl in the patients who had relapses and 16.37 μg/dl in the patients who had no relapses. The level of aluminum in the operated patients was 22 μg/dl when compared with those who had no operations whose aluminum level was 17.5 μg/dl (Table 1).

4. Discussions

It was first reported in 1934 that the inhalation of aluminum dusts caused pulmonary diseases. Fourteen years later, as a result of bauxite inhalation, 11 people with vocational pneumo-infections (Shaver disease) were reported [3]. Pulmonary fibrosis and emphysema are known to have occurred in the workers who were exposed to aluminum oxide and silica smog. In addition, it was reported that some granulomatous lesions developed in the respiratory bronchi in the laboratory animals exposed to high concentrations of aluminum chlorhidrate used as aerosol antiperspirant [5]. Some clinical changes which occurred
during the exposure to aluminum dusts and which cause fatal pulmonary fibrosis have been reported. The clinical table occurs in the form of dyspnea, cough and pneumothorax and nodular interstitial fibrosis develops as a histopathologic sign. In the workers exposed to pure aluminum, it has been reported that pulmonary fibrosis develops and it has been called as aluminosis [5,6]. In the workers working in the manufacture of aluminum, it is really very high to have chronic obstructive pulmonary disease. Aluminum may also cause shaver disease which causes fibrosis and respiratory problems with large bullae, and spontaneous pneumothorax or nodular interstitial fibrosis is a frequently occurring complication [7]. In the workers who worked in the manufacture of aluminum, potroom asthma symptoms had been reported to develop and its exact etiology is not clear. In a 32-year-old worker working for 8 years in an atmosphere containing aluminum dusts, a sarcoid-like pulmonary granulamotosis was reported to have developed [6].

Because of its physical and chemical properties, aluminum has a very wide area of usage, including drug and cosmetic industries. The contact with aluminum occurs with mainly food and kitchen utensils and through a lot of ways such as dietary, environmental and therapeutic procedures [8]. It is reported that the highest level of the aluminum is found in the lungs and it is 20 mg/kg in terms of age and weight. The reason why the aluminum level is high in the lungs is attributed to the accumulation of the insoluble compounds entering the lungs through respiration. Pulmonary aluminum concentration increases with the age, depending on the continuation of the environmental contact and physiological changes [9,10].

None of our patients in our study group had any vocational histories related with aluminum and they mostly lived in the urban areas. But aluminum is used in so large an area that it is impossible not to have contact with it. It is clear that aluminum has got a pathologic effect on the lungs and other systems as shown in the previously made studies. In the study of ours we determined that aluminum was significantly higher in the spontaneous pneumothorax cases compared with those in the control group. The level of aluminum in blood plasma was mean found to be 2.66 ± 0.811 µg/dl (1.6–4.0) in the control group and it was found mean to be 18.43 ± 0.628 µg/dl (2–62) in the patients with spontaneous pneumothorax (P < 0.001). In the spontaneous pneumothorax cases, the specificity of the aluminum was determined to be 100% and its sensitivity was determined to be 90%. The aluminum risk level in spontaneous pneumothorax group was determined to be ten times as high as that in the control group (OR = 10, 95% CI; 3.42–29.26). The aluminum level was found considerably higher than in the cases who had air leaks for a long period in whom relapses developed and who underwent operations than the aluminum level in the others. The level of the aluminum was 19.18 µg/dl in the patients who had relapses and it was 16.37 µg/dl in the patients who had no relapses. The level of the aluminum in the operated patients was 22 µg/dl when compared with those who had no operations whose aluminum level was 17.5 µg/dl. It has been seen as a parameter which may be important in the prognosis and follow-up.

5. Conclusions

As may be seen in this study of ours, the aluminum level in blood plasma in the patients with spontaneous pneumothorax is significantly higher than that in the cases of the control group (P < 0.001). The aluminum level was found considerably higher than in the cases who had air leaks for a long period in whom relapses developed and who underwent operations than the aluminum level in the others. The aluminum level in the blood plasma in the patients with total collapse is higher than that in the other patients with spontaneous pneumothorax. Aluminum plays a role in spontaneous pneumothorax etiology causing the development of subpleural bleb, bullous lesions and chronic obstructive pulmonary disease. It also gives us information about the patients who may relapse and who may undergo operations. In addition, it is obvious that it will give us a clear idea in the prognosis and treatment of spontaneous pneumothorax.

Yet, we need to have further and larger studies in order to make these data clearer.

References

Appendix A. ICVTS on-line discussion

Author: Dr. Sameh Sersar, Assistant lecturer, Mansoura University, Department of Cardiothoracic Surgery, Mansoura 125, Egypt

Date: 22-Oct-2003

Message: I have 3 questions. Firstly, how can you size the pneumothorax as 20%? Secondly, have you measured the postoperative aluminum level? Do you expect it to change?

Response

Author: Dr. Serdar Han, Ankara Numune Education and Research Hospital, Department of Thoracic Surgery, Manak Caddesi 43/11 Demirlibahce, Ankara, 06340 Turkey

Date: 27-Oct-2003

Message: 1. We can usually size the rate of pneumothorax with postero-anterior chest graph clinically. But we know that this method is not reliable. CT which is more effective is used in our study. 20% collapse: minimal (small or mild), 20−40% collapse: moderate and up to 40%; severe collapse. 2. We could not measure the postoperative aluminum level. Because we didn’t have any financing for this study and our hospital wasn’t able to support us financially. We are planning to go ahead and much further if we can find enough financial support.

3. We think that it isn’t changed, because we don’t have anything about aluminum of blood and tissue. However, it is obvious that it will give us a clear idea in the prognosis and treatment of spontaneous pneumothorax. We hope to see its relation with the aetiology if we can find enough financing in our further studies.

Author: Dr. Ravindranath Tiruvoipati, Clinical Research Fellow, Glenfield Hospital, ECMO, 66, Glenfrith Close, Leicester, Leicester LE3 9QO, UK

Date: 02-Jan-2004

Message: The article by Han et al. is interesting. I have a few questions regarding the article.

In the first group (patients with spontaneous pneumothorax) there were twenty-three smokers (76.7%). I would like to know the number of smokers in the control group, as smoking is one of the associated factors for the development of spontaneous pneumothorax.

Was there any difference in the levels of aluminum in patients who had bullous lesions on CT scan as compared to those patients who had no bullous lesions on CT scan?

Was shaver disease a diagnosis in any of the patients who had bullous lesions on the CT scan?

The levels of aluminum were more in patients who smoked (19.9 micrograms per decilitre) than those who did not smoke (13.7 micrograms per decilitre). Do the authors believe that smoking would increase the levels of aluminum?

Response

Author: Dr. Serdar Han, Ankara Numune Education and Research Hospital, Department of Thoracic Surgery, Ankara, 06100 Turkey

Date: 11-Jan-2004

Message: 1. The number of smokers in the control group was 10%. The control group were the personnel in our hospital.

2. There wasn’t any difference in the levels of aluminum in patients who had bullous lesions on CT scan as compared to those patients who had no bullous lesions on CT scan. (Nothing statistically significant.)

3. Our series didn’t have shaver disease.

4. We believe that smoking would increase the levels of aluminum.