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Original Article

Effect of earthquakes on spontaneous pneumothorax development

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Abstract

Aim: This study researched the effect of earthquakes, affecting meteorological parameters by causing pressure changes in the atmosphere, on the development of spontaneous pneumothorax (SP) and which periods after earthquakes were risky in terms of SP development.

Material and Methods: The study retrospectively investigated the files of 117 cases, 4 females (3.4%) and 113 males (96.6%) with spontaneous pneumothorax diagnosis in the emergency service of our hospital within a five-year period. The day patients attended hospital was accepted as the day of pneumothorax formation. Meteorological data for the study period was obtained from the Republic of Turkey General Directorate of Meteorology. Earthquake data for the study period were obtained from the Earthquake Department of the Republic of Turkey Disaster And Emergency Management Presidency website. The correlation of the changes in air temperature, humidity and pressure values of the day on which SP occurred compared to the previous day was investigated with SP. Additionally, risk analysis was performed for the correlation of SP formation time with earthquake days and the time interval after earthquakes.

Results: Within the study duration, the number of SP cases on the same day as earthquakes in the region was 27, with earthquake magnitude a minimum of 2.10 and maximum of 4.00 with mean of 2.5±0.47 calculated. Cases attending on days without earthquakes (n=90) were assessed in terms of how many days after the last earthquake they attended and mean duration was 8.14±8.03 days, with attendance due to pneumothorax a minimum of 1 day and maximum 44 days later. As the duration after an earthquake lengthened, there was a statistically significant reduction in the number of attendances.

Conclusion: SP is a clinic that can be diagnosed initially by doctor suspicion. In our study, we identified earthquakes were effective on pneumothorax development. As a result, we believe it is necessary to initially consider SP diagnosis for cases attending the emergency department with dyspnea and chest pain complaints in this risky period.

Keywords: Earthquake; pressure; spontaneous pneumothorax (SP)

INTRODUCTION

The accumulation of air between the visceral and parietal pleura in individuals without any pulmonary pathology is called spontaneous pneumothorax (SP) (1). The etiology of spontaneous pneumothorax is still being researched. Factors known to cause SP include smoking, being a young tall male, and being blond, explosion of subpleural blebs or bullae and development of negative pressure within the pleural cavity (2,3).

The significant natural event of earthquake causes changes in the pressure levels in the air, and is known to affect wind speed, temperature and rainfall amounts (4). The study by Liperovsky et al. proposed that there is gas output to the atmosphere for several days before an earthquake and this may be a new acceptable type of earthquake indicator (5). In Turkey, Western Anatolia, North Anatolia and East Anatolia are affected by fault lines and earthquakes are considered to be associated with meteorological data (6). In the literature it is reported that significant changes in atmospheric pressure may be included in the pathogenesis of spontaneous

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pneumothorax (7). Our study researched the correlation of earthquakes, affecting meteorological events, with SP and which time interval after earthquakes formed the risk period.

MATERIAL and METHODS

During the five-year period of the study a total of 117 cases with SP diagnosis attended the emergency department in our hospital. The patients consisted of 4 (3.4%) female and 113 (96.6%) male. The day patients attended hospital was accepted as the day of spontaneous pneumothorax formation.

The files of patients with SP diagnosis were retrospectively investigated for age, gender, symptoms on attending emergency service, posterior-anterior lung radiography, thorax tomography, and lung lobe with pneumothorax development, treatment methods (medical and surgical), previous SP history and smoking habit.

The mean, minimum and maximum values of temperature in centigrade, atmospheric pressure in millibars and relative humidity in percentages were taken from daily meteorological data for the study period obtained from the Republic of Turkey General Directorate of Meteorology. Additionally, daily minimum values were subtracted from maximum values for atmospheric pressure, temperature and humidity to calculate max-min differences. Days with spontaneous pneumothorax development had the difference compared to the previous day's temperature, atmospheric pressure and humidity rate calculated and the correlation of daily meteorological variations with patients developing SP was investigated.

Earthquake data belonging to the study period were obtained from the Earthquake Department of the Republic of Turkey Disaster And Emergency Management Presidency website, the SP cases divided into two groups as those with SP developing on the same day as earthquakes and those with SP not developing on the same day as earthquakes. For cases with SP not developing on the same day as an earthquake, the number of days since the last earthquake was researched. Additionally, the mean magnitude of the earthquakes was calculated.

Statistical Analysis

All data analyses were conducted using the SPSS v25 (IBM Inc., Chicago, IL, USA) statistical software package. Prior to the statistical analyses, the data were tested for normality using the Shapiro–Wilks test and for homogeneity of variance using the Levene's test. Independent samples t-test was used to assessment differences between two groups. Cross-tabulations were generated to describe the relationship between categorical variables, and the independence check was performed on the cross-tabulations using a chi-square test ($\chi 2$) and Contingency Coefficient (CC). Likelihood Ratio Chi-square values (LR $\chi 2$) were calculated for frequencies below 5. The Pearson's correlation analysis test was used to determine the relation between continuous variables. All comparisons were two-tailed and P-value less than 5% was considered statistically significant.

RESULTS

During the five-year duration, of the 117 pneumothorax cases attending the emergency service of our hospital 3.4% were female (n=4) and 96.6% were male (n=113). The mean age of cases was 37.08±18.80 years with the youngest case 16 and the oldest case 98 years. Of our cases, 80.3% (n=94) smoked. Additionally, when the history of patients is investigated, 23.9% (n=28) had previous history of pneumothorax.

When the symptoms on attendance in the emergency department are investigated, 96.6% (n=113) had shortness of breath and 70.9% (n=83) had chest pain. Of cases, 82.9% (n=97) had tube thoracotomy administered for treatment, while 17.1% (n=20) were monitored with medical treatment (oxygen, analgesia, etc.).

The difference between meteorological data for the days when spontaneous pneumothorax developed and the previous day in terms of temperature, atmospheric pressure and relative humidity in percentages was investigated. Temperature variation was minimum -9 °C with maximum variation 8 °C and mean variation identified as 0.04±3.05 °C. Pressure variation was minimum -10 HPA (Hectopascal) with maximum variation 8 HPA and mean of 0.04±2.69 HPA calculated. Humidity variation was minimum -15% and maximum 8% with mean of -0.07±2.29% calculated. When those attending on the same day as earthquakes and those attending on non-earthquake days after earthquakes are compared, the air pressure, temperature and humidity values were compared. When temperature, pressure and humidity variables were compared with SP on earthquake days and

Table 1. Comparison of air values on days with and without earthquakes when pneumothorax cases were admitted

	SP With Earthquake days			SP Without Earthquake days			t	p	*CI
	n	average	S.S	n	average	S.S			
Temperature	27	-0.25	3.41	90	0.13	2.94	-0.58	0.56	-1.72 - 0.93
Pressure	27	-0.88	2.69	90	0.16	2.66	-1.80	0.07	-2.21 – 0.10
Humudity	27	-0.55	14.35	90	1.47	9.90	-0.83	0.40	-6.83 – 2.78

*CI :Confidence Interval * t: temperature change, p: statistical value

non-earthquake days, it was found that these variables did not affect SP development statistically (p≥0.05) (Table 1).

During the study period in the region, the number of cases with SP on the same day as earthquakes was 27 (23.07%), with the number of SP cases not on the same day as earthquakes identified as 90 (76.93%). The smallest magnitude earthquake on the same day as SP was 2.10, the largest was 4.00 with mean magnitude calculated as 2.54±0.47.

Another parameter assessed in our study was the number of days after the last earthquake that the cases with SP not on earthquake days attended. The mean value was 8.14±8.03 days with attendance due to pneumothorax minimum 1 day after earthquake and maximum 44 days after earthquake. The trend was investigated with the chi-square test and as the duration since earthquakes lengthened, the number of applications was observed to statistically significantly reduce (trend x2=22.44 p ≤0.05) (Figure 1).

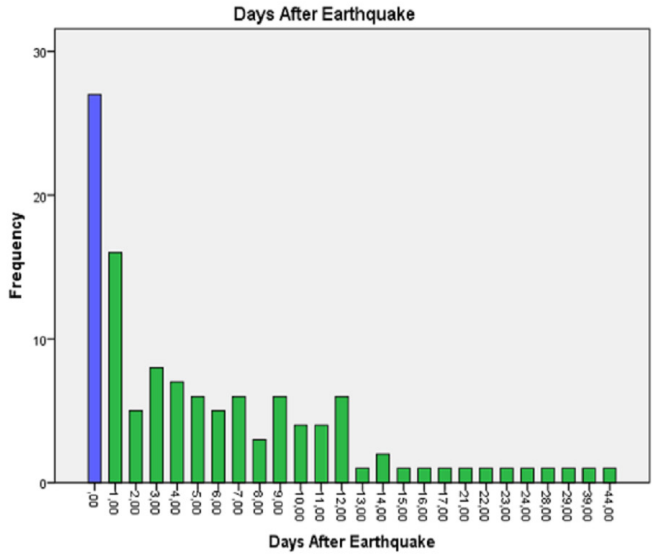

Figure 1. Time Relationship With Earthquake

Limitations of the study are considered to include not obtaining the expected values due to the small size of the sample. Additionally, as all-weather parameters were not analyzed during the study, and only values for days pneumothorax cases attended and the previous day were studied, so the inability to sufficiently determine changes in weather patterns is a limitation of our study.

DISCUSSION

If SP diagnosis is not made or made late, it is a disease with increasing morbidity and mortality. The incidence rate of SP varies according to gender. The annual incidence of spontaneous pneumothorax is reported as 18-28/100,000 in males and 1.2-6/100,000 in females (9). A study by Bozkurt et al. reported the incidence of SP was greater in males compared to females (91.6% vs. 8.4%, respectively) (10). In our study of 117 pneumothorax cases, 3.4% were females (n=4) and 96.6% were males (n=113).

Smoking is known to be among etiologic factors of SP. Smokers are reported to have increased incidence of SP and it is reported that 71.7% of cases developing SP smoke (11). Another study reported that people who smoke have more than 20 times SP compared to those who do not smoke (12). In our study, similar to the literature, 80.3% (n=94) were identified to smoke.

Cases with SP attend the emergency service with different clinical symptoms like sudden chest pain, dyspnea, tachycardia, sweating, hypotension, pallor and cyanosis (10). However, the most common symptom is chest pain and there are studies reporting attending symptoms are independent of clinical progression (12). In our study, when symptoms on attendance in the emergency department are investigated 70.9% (n=83) had chest pain, 29.1% (n=34) did not have chest pain and 96.6% (n=113) had shortness of breath, while 3.4% (n=4) did not have shortness of breath.

There are different treatment methods like observation, oxygen, catheter drainage, chest tube drainage and surgery for SP (13). In the literature, the choice of initial management for treatment of SP is controversial; however, a study reported tube thoracostomy was used more than observation (14). In our study, 82.9% of cases (n=97) were treated with tube thoracotomy, while 17.1% (n=20) were monitored with medical treatment (oxygen, analgesia, etc.).

There are publications stating there is a correlation between meteorological changes and SP, while there are also publications reporting the opposite (8). The study by Özpolat et al. reported atmospheric and temperature variations were associated with the development of SP (15). Ozenne et al. reported that the incidence of CP increased with decreasing moisture (16) and also Bense reported an increase in the frequency of SP development when atmospheric pressure decreased (17). In our study, 27 patients admitted with SP on earthquake days and 90 patients admitted on non-earthquake days. When temperature, pressure and humidity variables of these patients were compared for SP on earthquake days and non-earthquake days, it was found that these variables did not affect SP development. In the literature, it is reported that variations in atmospheric pressure increase the incidence of SP (18). However, there are studies in the literature reporting no correlation between temperature, humidity and atmospheric changes with SP (19). In our study, when comparisons are made between those attending on the same day as earthquakes and those attending on non-earthquake days, the air pressure, temperature and humidity values were compared in these categories. There was no significant statistical correlation identified in air values according to earthquake days and non-earthquake days (p ≥ 0.05)

The important natural event of earthquake is known to affect atmospheric pressure, increase wind speeds, create clouds, affect jet stream areas, determine currents, affect temperature, and rainfall amounts (4). According to

the study by Sındırgı et al. there is a correlation reported between earthquakes and meteorological events (18). Another study reported meteorological variations occurred before the Livorno earthquake in Italy in 1742 (4). In the literature there are other references reporting correlations of earthquakes with meteorological variations (19,20). In our research, the correlation of SP, affected by changes in atmospheric pressure, with earthquakes causing changes in atmospheric pressure was investigated for the first time. Of all SP cases, 23% (n=27) attended on the same day as earthquakes. For the remaining SP cases, the duration since an earthquake was researched. Of the 90 cases not on earthquake days (73%), they attended a minimum of 1 day and maximum of 44 days after earthquakes, with mean of 8.14 days (SD:8.03). The chi-square test of the trend observed that as the duration after an earthquake lengthened, there was a statistically significant reduction in number of applications ($x2=22.44$ $p \leq 0.05$ for the trend).

The pressure changes were not reflected in the study data sufficiently because of the small sample size. This situation is a limitation of our study.

CONCLUSION

To our knowledge, there was no similar study like our study in the literature. In our study, it has been shown that earthquakes are among the etiologic factors of SP. First of all, the occurrence of the SP have a high incidence on the earthquake days and the first 8 days after earthquakes. As a result, we believe it is necessary to initially consider SP diagnosis for cases attending the emergency department with dyspnea and chest pain complaints in this risky period.

Competing interests: The authors declare that they have no competing interest.

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