

High resolution computed tomography findings and pulmonary function tests among mustard gas exposed patients: Is there a Remarkable Relationship?

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ABSTRACT

Objective: High resolution computed tomography (HRCT) and pulmonary function tests (PFT) are the two main methods, currently used for investigation of pulmonary complications in sulfur mustard gas exposed patients. According to different types of injuries in mustard gas exposed individuals, we decided to test the correlation between PFT and HRCT in these victims.

Methodology: Fifty one randomly selected cases from 12000 mustard gas exposed patients during Iran-Iraq war (1983-1989) were studied. HRCT and PFT were conducted based on standard protocols. HRCT scores were tested for correlation to PFT measures.

Results: A significant differences between PFT findings were found within HRCT groups (score ≤ 3 , score 4-6 and score ≥ 7). There was a significant correlation between HRCT scores and FEV1, MMEF and FEV1: FVC ratio ($P < 0.05$) in all subjects.

Conclusion: HRCT and PFT results showed an acceptable correlation in mustard gas exposed patients. It seems to be useful to use each of these two diagnostic tools based on clinical judgment and feasibility.

KEY WORDS: Sulfur Mustard Gas, Lung Injury, High resolution tomography, Pulmonary Function Test.

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INTRODUCTION

Lung parenchymal diseases are seen in more than 60% of sulfur mustard gas exposed patients in long term after exposure.¹ Degradation of pulmonary function, development of chronic bronchitis, bronchiectasis and pulmonary fibrosis have been detected as common findings in these cases.² Chronic bronchitis is the most likely pattern that is seen in them with marked physical disability.^{1,2} Sulfur mustard gas was used many times by Iraqi military forces against Iranian soldiers during Iran-Iraq war (1983-1989).²⁻⁴

High resolution computed tomography (HRCT) and pulmonary function tests (PFT) are the two important methods, currently used for investigation of pulmonary complications in mustard exposed individuals.^{3,5,6} Due to various types of respiratory system damages in mustard gas exposed cases, it

Table-I: PFT results based on HRCT score groups (Mean±SD).

	FEV1 (%predicted)	FVC (%predicted)	FEV1/FVC	MMEF (%predicted)
HRCT Score less than 3 (N=8)	90.1±17.1	91.1±14.9	81.1±8.8	80.7±34.8
HRCT Score 4-6 (N=14)	73.7±26.7	81.9±17.2	72.7±14.1	58.1±39.3
HRCT Score more than 6 (N=29)	62.7±34.6	70.9±27.1	67.2±16.4	48.2±25.1
Total	70.1±31.6	77.1±24	70.9±15.4	56.3±34.1

FEV1: Forced Expiratory Volume in 1 second, FVC: Forced Vital Capacity, MMEF.

seems that different pattern of PFTs and HRCT is seen in them. So, we decided to test the relationship between PFT and HRCT findings in sulfur mustard gas exposed patients in this study.

METHODOLOGY

Subjects: We selected randomly, 51 cases from 12,000 documented mustard gas exposed patients with pulmonary complications that were registered in mustard gas exposure data bank.⁷ All of them had suffered from chemical warfare agents mainly mustard gas used by Iraq during Iran-Iraq war (1980-1987).

Inclusion Criteria: Documented mustard gas exposure patients according to military health services records, defined as single, high dose exposure to chemical warfare agents which causes skin blisters and subsequent transient or permanent disability in the exposed people.

Medical recording refereeing to care as mustard gas victims in local military hospitals during war, including sign, symptoms and detecting mustard gas on their cloths.

Exclusion Criteria: Positive history of cigarette smoking or any other direct, continuously exposure to lung toxic agents such as specific work places. Documented history of any condition with massive lung injuries (e.g. severe pneumonia, lung abscess, lung cancers, tuberculosis).

High Resolution Computed Tomography (HRCT): All subjects were imaged on an axial GE Hi-spnd Advantage CT scanner (FXI-Plus; GE Medical System) at 120 kVp and 200 to 250 mAs with 1-mm collimation an 10 mm intervals from proximal trachea to diaphragm. The scans were done in supine position in two conditions (deep inspiration and deep expiration) at four levels without any IV contrast (Supra-aortic arch, aortic arch, carina and 5 to 10 cm below the carina).⁵

The HRCT films were reviewed by two independent radiologist and their reports were finalized by using mean values of scoring. Age and sex of patients were the only visible data for

reviewers. Air trapping score was reported by using a five-point scale measurement of lung affected cross sectional area at three levels in two lungs (i.e. Zero: no air trapping, 1: 1-25% affected, 2: 26-50%, 3: 51-75% affected, 4: 76-100% affected).⁶ So, the maximum possible score for each lung was 12 (3 levels times 4 points at each level) and for both lungs, 24. Air trapping more than 25% (score>6) was defined as bronchiolitis obliterans (OB) cases.

Pulmonary Function Tests (PFT): Spirometry was performed based on American Thoracic Society criteria.⁷ By using a standard spirometer (Jaeger), FVC and FEV₁ were measured under supervision of a physician. Subjects were seated with a nose clip in place and were asked to do at least three forced expiratory maneuvers. Procedures were repeated until obtaining three satisfactory curves. The largest FVC was used as a reference for indices analysis.⁷

Statistical Analysis: Data was entered to SPSS version 12 and analyzed by parametric and non-parametric tests. Data was adjusted according to age of subjects before any analysis. Pearson ranks correlation was used to estimate the relationship between air trapping scores in HRCT and PFTs parameters. Multiple logistic regression test was used to make a model for prediction of HRCT score by using PFTs parameters. All differences and relationships were statistically significant at P<0.05.

RESULTS

All subjects were males aged between 43 to 66 (52±6.8) years that had been exposed to mustard gas about 22 years before the time of study (22.3±2.3) during Iran-Iraq war (1980-1987). All of them had been known as cases with respiratory problems.

HRCT score more than 6 were detected in 29 of 51 cases. They were recognized as individuals with obliterans bronchiolitis (OB). Pulmonary function tests (PFT) showed the worsening of lung functions in cases with higher HRCT score (P<0.01) (Table-I).

HRCT scores demonstrated significant correlation with Forced Expiratory Volume in 1st second (Correlation coefficient= -0.49), MMEF (Correlation

Table-II: Mean of Pulmonary Function Tests Values: with or without Bronchiolitis Oblitrans.

<i>Bronchiolitis Oblitrans</i>	<i>FEV1 (%predicted)</i>	<i>FVC (%predicted)</i>	<i>FEV1/FVC</i>	<i>MMEF (%predicted)</i>
Yes	62.7±34.1	70.9±27.1	67.2±16.4	48.7±25.9
No	79.8±24.7	85.2±16.5	75.7±12.9	66.3±35.4

coefficient= -0.43), FEV1: FVC ratio (Correlation coefficient= -0.5) and FVC (Correlation coefficient= -0.5) in the subjects ($P<0.01$). Mean of pulmonary function tests values among patients known as bronchiolitis obliterans was significantly lower than patients without this diagnosis ($P<0.05$), except for MMEF (Table-II).

DISCUSSION

There was significant difference between pulmonary function test values among different groups based on HRCT findings and we found significant correlation between PFT and HRCT score in mustard gas exposed patients. Pulmonary complications are known to occur in over half of the patients exposed to sulfur mustard (SM).⁷

Air trapping, bronchiectasis and mosaic parenchymal attenuation (MPA) are the most common pathologic findings in these patients.⁷ We have some data supporting this fact that mustard gas may have an effect on small and large airways, together.⁸

Severity of respiratory disorders in mustard exposed patients is questionable because of overlapping pathological events during the process of respiratory system damage. HRCT is a standard method for following up the patients with interstitial lung diseases (ILDs).⁹ But, it is recommended to have both of these kinds of diagnostic tools for estimation of prognosis in such cases.¹⁰ Radiologic studies in mustard exposed patients have shown that air trapping is seen as the most common finding in the chest HRCT.⁷

Similar studies among sulfur mustard gas exposed patients have introduced HRCT as a valuable method for detecting, classification and follow up of these cases.¹¹ According to our data there is an acceptable correlation between HRCT and PFT findings and we can use them for diagnosis and follow up of such cases. However, in some cases based on clinical judgment, one might have to prefer one method over another.

REFERENCES

1. Karimi Zarchi AA, Holakouie Naeini K. Long term complications in combatants exposed to mustard gas: A historical cohort study. *Int J Epidemiology* 2004;33(3):579-581.
2. Beheshti J, Mark EJ, Akbari H, Aslani J, Ghanei M. Mustard lung secrets: Long term clinic pathological study following mustard gas exposure. *Pathol Res Pract* 2006;202(10):739-744.
3. Khateri S, Ghanei M, Keshavarz S, Soroush M, Haines D. Incidence of lung, eye, and skin lesions as late complications in 34,000 Iranians with wartime exposure to mustard agent. *J Occup Environ Med* 2003;45(11):1136-1143.
4. Ghanei M, Fathi H, Mohammad MM, Aslani J, Nematizadeh F. Long-term respiratory disorders of claimers with subclinical exposure to chemical warfare agents. *Inhal Toxicol* 2004;16(8):491-495.
5. Ghanei M, Mokhtari M, Mirmohammad M, Aslani J, Alaeddini F. High resolution computerized tomography of chest in patients exposed to sulfur mustard. *Iran J Radiol* 2003;(June): 1-6.
6. Arakawa H, Webb WR. Air trapping on expiratory high-resolution CT scans in the absence of inspiratory scan abnormalities: correlation with pulmonary function tests and differential diagnosis. *AJR Am J Roentgenol* 1998;170(5):1349-1353.
7. Ghanei M, Mokhtar M, Mir Mohammad M, Aslani J. Bronchiolitis obliterans following exposure to sulfur mustard: chest high resolution computed tomography. *Euro J Radiology* 2004;52(2):164-169.
8. Ghanei M, Akbari Moqadam F, Mir Mohammad M, Aslani J. Tracheobronchomalacia and Air Trapping after Mustard Gas Exposure. *Am J Respir Crit Care Med* 2006;173:304-309.
9. Biederer J, Schnabel A, Muhle C, Gross WL, Heller M, Reuter M. Correlation between HRCT findings, pulmonary function tests and bronchoalveolar lavage cytology in interstitial lung disease associated with rheumatoid arthritis. *European Radiology* 2004;14(2):272-280.
10. Nicole S, Sujal R, Srihari Hansell M, Copley J, Maher T, Corte J, et al. Interstitial Lung Disease in Systemic Sclerosis: A Simple Staging System. *Am J Respir Crit Care Med* 2008;177(11):1248-1254.
11. Hefazi M, Attaran D, Mahmoudi M, Balali-Mood M. Late respiratory complications of mustard gas poisoning in Iranian veterans. *Inhal Toxicol* 2005;17(11):587-592.