

## Normal Human Pleural Surface Area Calculated by Computed Tomography Image Data

Doosang Kim<sup>1</sup>, Hyung-Woon Roh<sup>2</sup>

<sup>1</sup>Seoul Veterans Hospital

<sup>2</sup>IVAI

### Abstract

**Background;** Pleural micro-metastasis of lung cancer is detected by touch print cytology or pleural lavage cytology, but its prognostic impact has not elucidated yet. We hypothesize that recurrence may depend on the amount of tumor cells disseminated in pleural cavity, if the invasiveness of all cancer is the same. To predict the amount of tumor cells disseminated in pleural cavity, we need pleural surface area, distributed pattern of cells and concentration of cells per unit area. Human pleural surface area has not reported yet. In this report, we calculate the normal human pleural surface area using CT image data processing.

**Methods;** Twenty persons were checked CT scan, and we obtained the data from each image. In order to calculate the pleural surface, the outline of lung was firstly extruded from CT image data using home-made Digitizer program. And the distance between CT images was calculated from the extruded outline. Finally a normal human pleural surface was calculated from function between the distance of consecutive CT images and the calculated length.

**Results;** Their mean age is  $65 \pm 12$  years old (range 26~77), body weight is  $62 \pm 9$  kg (48~80), and height is  $167 \pm 6$  cm (156~176). The number of images used is  $36 \pm 7$  (24~51). Pleural surface area is  $211,888 \pm 35,756$  mm<sup>2</sup> (143,880~279,576). Right-side pleural surface area is 107,932 mm<sup>2</sup> and Lt is 103,955 mm<sup>2</sup>. Costal, mediastinal and diaphragmatic surfaces of right-side pleura are 77,483 mm<sup>2</sup>, 39,057 mm<sup>2</sup>, and 8,608 mm<sup>2</sup> respectively, and left-side are 72,497 mm<sup>2</sup>, 35,578 mm<sup>2</sup>, and 4,120 mm<sup>2</sup> respectively.

**Conclusion;** Normal human pleural surface area is calculated using CT image data at first and the result is about 0.212 m<sup>2</sup>.

**Keyword;** Lung cancer, Pleural surface area, CT

### Introduction

Lung cancer is one of the leading causes of cancer deaths. 170,000 new cases of lung cancer are diagnosed in a year and 160,000 patients are died due to lung cancer related diseases in USA. Lung cancer cure rate is not changed recently as a 15%, because of its difficulty of early diagnosis and higher cancer recurrence as much as 50% in spite of early lung cancer. Micro-metastasis of lung cancer is believed the most important cause of cancer recurrence and micro-metastasis is detected in blood, bone marrow, lymph node and pleural cavity of the patient. Pleural micro-metastasis is more sensitive and easier to detect than other micro-metastases. The positive

rate of pleural micro-metastasis is reported from 4% to 60% according to the detection method, but the survival impact of pleural micro-metastasis is not elucidated yet. Therefore, the survival impact or recurrence might be originated from not existence of pleural micro-metastasis, but the amount of pleural micro-metastasis. In amount, bacterial infection needs  $10^5$  micro-organisms in human beings, and lung cancer development needs  $10^7$  cancer cells for experimental nude mouse. So, the optimal amount of pleural micro-metastasis of lung cancer might be existed for constant lung cancer recurrence. To calculate and expect the optimal amount of lung cancer cells disseminated in pleural cavity, it is need to know the pleural surface area in human being. However, there is no report about the surface area of pleura yet. In this study, we estimated the normal human pleural surface area by CT image data calculation at first.

¶ Seoul Veterans Hospital  
E-mail: mdksr@lycos.co.kr

## MATERIALS AND METHODS

Twenty persons were included in this study. They checked 16-slice chest CT scan with enhancement, and we obtained the image data as a jpg files from each image. In order to calculate the pleural surface, the outline of lung was extruded from each CT image data using home-made Digitizer program at first. And the length of outline of the lung is measured using the program at each image. We calculated each surface area from function between the distance ( $H$ ) of consecutive images and the lengths ( $L_{i+1}$ ,  $L_i$ ) of outlines from consecutive two images. And finally, we summed the whole pleural surface area. Our function is as follows;

$$\sum (L_{i+1} + L_i) / 2 \times H$$

The whole pleural surface area is divided as right-side and left-side pleural surface areas, and each side pleural surface area is divided as costal, diaphragmatic and mediastinal pleural surface areas.

## RESULTS

The subjects, twenty persons are all male. Mean age of the subjects is  $65 \pm 12$  years old (range; 26~77), body weight is  $62 \pm 9$  kg (range; 48~80), and height is  $167 \pm 6$  cm (range; 156~176). The number of images used is  $36 \pm 7$  (range; 24~51). Mean pleural surface area is  $211,888 \pm 35,756$  mm<sup>2</sup> (range; 143,880~279,576). Right-side pleural surface area is 107,932 mm<sup>2</sup> and left-side is 103,955 mm<sup>2</sup>. Costal, mediastinal and diaphragmatic surfaces of right-side pleura are 77,483 mm<sup>2</sup>, 39,057 mm<sup>2</sup>, and 8,608 mm<sup>2</sup> respectively, and left-side are 72,497 mm<sup>2</sup>, 35,578 mm<sup>2</sup>, and 4,120 mm<sup>2</sup> respectively. The detailed data is tabulated at table 1.

## DISCUSSION

Pleural cavity is a closed potential cavity within thin-walled sacs of serous membrane. Pleural surface is composed of three parts, 1) the costal pleura, which lines the costae; 2) the mediastinal pleura, applied to the mediastinum; 3) the diaphragmatic pleura. Normal pleural space is nearly absent, but the fluid shift along the pleural space is a measurable amount. If the lung collapsed due to hemothorax or pneumothorax, the pleural space is appeared apparently. When the lung cancer is developed and the tumor size increase, cancer cell is disseminated to

pleural cavity and spread to lymph node and adjacent organs. Tumor size and lymph node metastasis are accepted generally as useful prognostic factors for survival and recurrence. However, micro-metastasis in lymph node, blood, bone marrow and pleural cavity is not accepted yet, because of their lower sensitivities. Pleural micro-metastasis is easily detected during operation, but the significant impact is still unknown. It is need to elucidate the survival impact of pleural micro-metastasis. To do this, we must have basic data of pleural surface area in human being. In this study, we calculated the normal human pleural surface area using CT image data, and reported it. Mean human pleural surface area is about 0.212 m<sup>2</sup>.

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Table 1. Calculated pleural surface areas from twenty subjects were shown. The pleural surface area is divided as right-, left- side and costal, diaphragmatic, mediastinal pleural surface area.

	sum	RHS	LHS	Costal S.A (mm)		Mediastinal S.A (mm)		Diaphragm S.A (mm)		Age	Weight (kg)	Height (cm)
				RHS	LHS	RHS	LHS	RHS	LHS			
1	257,881	133,644	124,238	94,532	85,573	48,467	41,413	9,355	2,748	72	55	167
2	173,377	91,836	81,541	64,725	55,111	33,920	28,605	6,809	2,175	70	69	156
3	247,491	119,713	127,778	84,100	83,762	43,281	45,598	7,669	1,582	72	52	168
4	245,694	126,710	118,985	97,202	89,917	38,663	34,569	9,155	5,501	58	55	169
5	230,681	116,383	114,298	87,458	83,836	38,212	33,902	9,287	3,440	71	48	160
6	160,896	80,844	80,053	55,604	54,799	26,783	26,403	1,543	1,148	72	60	169
7	216,907	108,742	108,165	81,249	80,622	34,247	30,195	6,755	2,652	57	52	169
8	214,599	108,836	105,763	76,892	71,364	43,991	41,832	12,047	7,433	61	73	170
9	174,620	89,595	85,025	54,901	49,594	41,113	39,804	6,418	4,373	76	80	168
10	184,202	92,169	92,033	69,878	67,485	27,719	26,814	5,428	2,266	60	64	164
11	230,197	111,882	118,315	88,536	88,452	38,333	37,360	14,986	7,497	74	62	159
12	208,967	111,278	97,689	73,013	62,306	45,608	39,803	7,343	4,420	58	64	176
13	207,015	103,165	103,850	70,015	68,949	40,158	36,701	7,008	1,800	77	54	165
14	143,880	83,175	60,705	57,013	46,377	31,521	18,455	5,360	4,127	62	62	161
15	256,139	126,754	129,385	92,635	91,006	44,500	43,107	10,381	4,728	69	58	165
16	214,997	113,356	101,642	79,675	70,271	41,839	36,798	8,159	5,428	58	60	165
17	221,238	108,872	112,366	79,459	81,961	34,344	35,164	4,931	4,759	71	63	170
18	188,774	100,556	88,217	76,713	63,730	37,596	28,727	15,753	4,240	26	77	176
19	279,576	140,717	138,859	102,123	94,560	53,502	51,241	14,909	6,941	76	74	176
20	180,622	90,421	90,201	61,946	60,260	37,345	35,074	8,870	5,134	59	63	159
Me an	211,888	107,932	103,955	77,483	72,497	39,057	35,578	8,608	4,120	65	62	167
S.D.	35,758	16,679	19,736	14,052	14,808	6,646	7,609	3,617	1,896	12	9	6
max	279,576	140,717	138,859	102,123	94,560	53,502	51,241	15,753	7,497	77	80	176
min	143,880	80,844	60,705	54,901	46,377	26,783	18,455	1,543	1,148	26	48	156

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