

# Morpho-Histological Changes Seen in the Lungs of Hanging Victims who Survived for Varying Periods before Death: An Autopsy-Based Study

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## Abstract

The study was conducted in the Department of Forensic Medicine, Government Medical College, Thiruvananthapuram. The period of the study was from January 2013 to June 2014. 50 cases were included among which 25 cases were the hanging cases that survived for varying periods before death and 25 cases were from the non-survived victims of hanging. Macroscopic and microscopic changes in the lungs, were compared to find out the changes resulting from hypoxic insult. The cases were studied in detail and are described below.

**Keywords:** Hanging, Emphysema, Consolidation, Alveolar hemorrhage, Pulmonary edema.

## Introduction

Hanging is a very easy method used for committing suicide. However, survival after hanging and complete recovery without any neurological deficit is an extremely rare event. Many of the hanging victims were brought down immediately and might have survived long enough to reach the hospital and die during their hospital stay. The present study was an attempt to analyze the macroscopic and microscopic changes in the lungs of such hanging victims who survived for variable periods before death. Several macroscopic changes in the lungs of victims who had survived for varying periods before death have been described in the literature. They included pulmonary edema, pulmonary congestion, pulmonary hemorrhage,

consolidation of lungs, and adult respiratory distress syndrome. When constriction occurs at the end of expiration, the maximum quantity of blood will be accommodated in the lung bed, lungs will become congested and edematous. Pulmonary edema has been reported in delayed hanging deaths by several authors.<sup>1-6</sup> Congestion of lungs in survived hanging victims has been reported by a few authors<sup>1,6,7</sup>. Cases of massive pulmonary hemorrhages in delayed hanging deaths have also been reported<sup>1,8</sup>. This could be due to increased hydrostatic or pulmonary venous pressure<sup>8</sup>. Association between near-fatal hanging and adult respiratory distress syndrome has been reported in two cases<sup>9</sup>. In another study, out of 335 survived hanging victims 38 had pulmonary distress with radiological evidence of pulmonary injury post-hanging which had increased the overall

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mortality from 5% to 34.2%<sup>10</sup>. Consolidation of lungs and bronchopneumonia in survived victims are also described in literature<sup>1,11</sup>.

Hypoxia can bring about the following changes in the lungs which can be seen under light microscopy. Vesicular emphysema, congestion, interstitial edema, mobilization and proliferation of alveolar macrophages, formation of polynuclear giant cells, and alveolar phagocytes are seen in edematous pulmonary regions<sup>8,12,13,14</sup>. Histopathological examination of lungs in an adult male who survived for 36 days after attempted hanging revealed alveolar spaces with plenty of edema fluid, macrophages, debris, denatured alveolar epithelium, and inflammatory cells along with heart failure cells<sup>11</sup>. These findings were suggestive of infection or chronic passive congestion followed by pulmonary edema.

### Materials and Methods

The study was conducted in the Department of Forensic Medicine, Government Medical College, Thiruvananthapuram. The period of the study was

from January 2013 to June 2014. A total of 50 cases of both male and female victims aged between 13 and 88 years were included in the study. Cases were divided into two groups. Group I included 25 cases of non-survived victims of hanging and Group II consisted of 25 cases of hanging that survived for varying periods before death. History and other details were collected from the police officer in charge of the concerned dead body, accompanying near relatives, and from clinical case records. Dissections were done in the Modified Rokitansky procedure. Relevant information was recorded in the proforma. Bits of tissues were taken from the lungs using a sharp knife. Tissues were fixed in 10% formalin, processed, and stained with Harris Hematoxylin and Eosin stains. The slides were labeled according to the serial number. Microscopic examination of each slide was done in various powers and the details were noted in the proforma. Gross and microscopic findings of the lungs were compared, and data were analyzed using SPSS 20 trial version.

### Results

**Table 1: Weight of lungs**

Weight of lungs (in grams)	Left lung		Right lung	
	Group I	Group II	Group I	Group II
Maximum	400	1050	450	1000
Minimum	300	200	300	250
Mean	334	470	368	530

Macroscopic findings noted in the lungs were congestion, edema, petechial hemorrhage, and consolidation. Congestion and edema of the lungs were seen in all cases of Groups I and II. Petechial hemorrhages on the surface of the lungs were present

in 32% of cases of Group I and 56% of cases of Group II. It was absent in the other cases. Consolidation of the lung was present in 28% of cases in Group II who had survived for more than 3 days. It was absent in the other cases of Group I and Group II.

### MACROSCOPIC CHANGES IN THE LUNGS WITH PROGRESSION OF SURVIVAL TIME

**Table 2: Macroscopic changes in the lungs with the progression of survival time**

Period Of Survival (Hours)	Number of cases in each group	Petechial hemorrhage s	Edema	Consolidation
		Frequency	Frequency	Frequency
Less than 1 hour	4		4	
1-3 hours	5		5	
3-6 hours	3	1	3	

Continue .....

Period Of Survival (Hours)	Number of cases in each group	Petechial hemorrhage s	Edema	Consolidation
6-12 hours	1	1	1	
12-24 hours	4	4	4	
1-2 days	1	1	1	
2-3 days	1	1	1	1
3-7 days	5	5	5	5
7-12days	1	1	1	1

Microscopic examination of the lungs showed congestion, edema, emphysematous change, interstitial and alveolar hemorrhage, and pneumonic consolidation. Congestion and edema were seen in all cases of Groups I and II. The emphysematous change was seen in all cases of Group I and 56% of cases in Group II had a survival period of fewer than 3 days.

Alveolar and interstitial hemorrhages of the lungs were present in 7 cases of Group I and 18 cases of Group II. Pneumonic consolidation of the lungs was present only in 7 cases of Group II who had survived for more than three days. It was absent in all the other cases.

### MICROSCOPIC CHANGES IN THE LUNGS WITH PROGRESSION OF SURVIVAL TIME

Table 3: Microscopic changes in the lungs with the progression of survival time

PERIOD OF SURVIVAL	Number of cases in each group	Emphysematous change	Congestion	Interstitial Hemorrhage	Alveolar Hemorrhage	Edema	Pneumonic consolidation
		Frequency	Frequency	Frequency	Frequency	Frequency	Frequency
Less than 1 hour	4	3	4	2	2	4	
1-3 hours	5	5	5	2	2	5	
3-6 hours	3	3	3	2	2	3	
6-12 hours	1	1	1	1	1	1	
12-24 hours	4	1	4	3	3	4	
1-2 days	1		1	1	1	1	
2-3 days	1	1	1	1	1	1	1
3-7 days	5		5	5	5	5	5
7-12days	1		1	1	1	1	1

## Discussion

### a. Macroscopic appearances in the lungs

Weights of the lungs were recorded in all cases. The maximum weight of the left lung in Group I was 400g, the minimum weight was 300g and the mean weight was 334 g with a standard deviation of 34.5g. The maximum weight right lung in Group I was 450 g and minimum weight was 300g and the mean weight was 368 g with a standard deviation of 49 g. The rule of thumb states that breathing stops within 20 seconds of cardiac arrest and the heart stops within 20 minutes of stopping breathing. If the heart continues to beat for several minutes after the stoppage of respiration, the weight of the lungs may increase to 450 to 500 g<sup>6</sup>. However, in the present study, the mean weights

of the right and left lungs in non-survived victims of hanging are 368g and 334g respectively. Hence this study is not in agreement with the rule of thumb. In Group II victims, the maximum weight of the left lung was 1050 g, the minimum weight was 200g and the mean weight was 470 g with a standard deviation of 270g and the maximum weight of the right lung was 1000g, the minimum weight was 250g and the mean weight was 530 g with a standard deviation of 197g. The reason for the increased weight of the lungs in Group II was due to the presence of consolidation in the lungs of 7 cases. In consolidation, the weight of the lungs may reach up to 1500g<sup>14</sup>.

**Petechial hemorrhage** on the surface of the lungs was present in 8 cases of Group I and 14 cases of Group II. This was found from 3 hours to 12 days

of survival. A maximum number was seen in the deceased who survived for 3 to 7 days. Among the three cases who survived for 3 to 6 hours only one case had shown petechial hemorrhages. But from 6 to 12 hours of survival, all the cases had shown the finding. Petechial hemorrhage on the surface of the lungs in hanging victims has been described by many authors<sup>15,16</sup>. Sivasuthan in his study has found petechiae in 37% of cases<sup>17</sup>. Petechial hemorrhages noted in the present study are in agreement with the studies mentioned above. It occurs due to the rupture of thin-walled venules especially in the unsupported serous membranes like the visceral pleura due to raised venous pressure from impaired venous return leading to overdistension.

**Congestion** of the lungs was seen in all cases of Group I and II. It was a constant finding (macroscopic and microscopic) from less than one hour to 12 days of survival. Congestion had been described as a cardinal feature of asphyxia. Congestion of lungs in victims of hanging who survived for varying periods before death has been mentioned as an autopsy finding in attempted strangulation and hanging victims<sup>7,11</sup>. Congestion of lungs on histopathology following hypoxic insult has been mentioned by authors<sup>8,12,13</sup>.

**Pulmonary edema** was seen in all cases in Group I and Group II. It was a constant macroscopic and microscopic finding from less than one hour to 12 days of survival. Lung edema after attempted hanging has been demonstrated by several authors<sup>1-5</sup>. A case of delayed pulmonary edema following attempted hanging two hours after the incident was also reported<sup>5</sup>. However pulmonary edema in the present study was a constant finding from less than one hour of survival to 12 days of survival. Pulmonary edema microscopically had been demonstrated in an attempted hanging victim<sup>11</sup>. Several authors had demonstrated intra-alveolar edema fluid following hypoxic insult<sup>8,12,13</sup>.

**Consolidation** of the lung was present in 28% of cases in Group II who had survived for more than 48 hours. Pneumonic consolidation was seen in the histopathological examination of these cases. Consolidation following attempted hanging has been described<sup>1,11</sup>. Consolidation of lungs was not seen in the non-survived victims but could be seen in the survived victims beyond 48 hours

of survival. On histopathological examination of tissue bits from the lungs, apart from congestion, edema, and consolidation which were described above, emphysematous changes, and interstitial and alveolar hemorrhages were also seen.

**The emphysematous change** was seen in all cases of Group I and 56% of cases in Group II had a survival period of fewer than 3 days. Vesicular emphysema resulting from hypoxia which can be seen under light microscopy has been described by authors like<sup>8,12,13</sup>. In vesicular emphysema (obstructive emphysema) there is acute overinflation leading to rapid ballooning of the lung, aided by the forced inspiration that these dyspneic patients employ to overcome the obstruction leading to distended alveoli.<sup>14</sup>

**Interstitial and alveolar hemorrhage** was present in 7 cases of Group I and 18 cases of Group II. Interstitial and alveolar hemorrhages were seen in 50% of cases in the survival group in less than one hour to three to six hours. These findings were seen in all cases with a survival time of more than 6 hours up to 12 days. According to certain authors, partial disruption of alveolar septa with distinctive hemorrhage within the alveoli of the lungs can be seen under a light microscope as a sequela of hypoxic insult.<sup>8,12,13</sup>. Increased hydrostatic pressure or increased pulmonary venous pressure is the cause of interstitial and alveolar hemorrhage.<sup>8</sup> The findings in the present study agree with the studies mentioned above.

A previously unknown association between near-fatal hanging and adult respiratory distress syndrome (ARDS) was reported in 2 cases of attempted suicidal hanging<sup>9</sup>. Evidence of ARDS was looked for but was not seen in any of the cases included in this study. Mobilization and proliferation of alveolar macrophages, formation of poly nuclear giant cells alveolar phagocytes or heart failure cells as described by other authors were not present in this study<sup>8,11,12,13</sup>.

## Conclusion

Pulmonary edema was seen in all cases in non-survived and survived victims. In the survived group, it was a constant macroscopic and microscopic finding from less than one hour to 12 days of survival. Consolidation of the lung was present in 28% of

cases in the survived group who had survived for more than 48 hours and on histopathological examination, pneumonic consolidation was present in all these cases. Consolidation of lungs was not seen in the non-survived victims but could be seen in the survived victims beyond 48 hours of survival. In the survived group, consolidation was seen in 7 cases. The maximum weight of the left lung noted in consolidation was 1050 g and the maximum weight of the right lung noted was 1000g. The emphysematous change was seen in all cases of the non-survived group and 56% of cases in the survived group had a survival period of less than 3 days. This might have been due to acute overinflation leading to rapid ballooning of the lung, and the forced inspiration to overcome the obstruction leading to distended alveoli. Lungs showed interstitial and alveolar hemorrhages in 7 cases of the non-survived group and 18 cases of the survived group. They were seen in 50% of cases in the less than one hour to six hours survival group and in all cases with a survival time of more than 6 hours up to 12 days. Increased hydrostatic pressure or increased pulmonary venous pressure might have been the cause of interstitial and alveolar hemorrhage.

**Conflict Of Interest:** We hereby declare that there is no conflict of interest.

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