

A HISTOLOGICAL STUDY OF HUMAN LUNG

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ABSTRACT

BACKGROUND

The lungs are the essential organ of respiration. Maturation of lung is divided into four stages pseudoglandular, canalicular, terminal sac and alveolar. By 16 weeks, all major elements have formed except those involved with gas exchange. Respiration is not possible; hence, fetuses born during this period are unable to survive. By 26 weeks, the terminal sacs are lined by squamous epithelial cells and scattered among them are round secretory epithelial cells, which secrete surfactant. Respiratory distress syndrome affects 2% live newborn infants, premature are more susceptible. Surfactant deficiency is the major cause of RDS. Sufficient alveolar sac and surfactant should be present to permit survival of a prematurely born infant. Keeping this in view, the present study was done to study the microstructure of lungs in different age groups.

MATERIALS AND METHODS

The study was carried out in the Department of Anatomy, Assam Medical College and Hospital, Dibrugarh, for a period of one year. The study was carried out in specimens, which was collected from adult cadavers obtained for routine dissection of undergraduate students and also from the Department of Forensic Medicine. Specimens was also collected from perinatal cadavers from the Department of Obstetrics and Gynaecology, Assam Medical College and Hospital, Dibrugarh. The study has been carried out on three primary groups- Group 1, Group 2 and Group 3 according to the age.

RESULTS

In each of the groups, we have studied the right-sided and left-sided lungs separately and studied their histological parameters (presence/absence of pseudostratified columnar, columnar, cuboidal and squamous epithelium in the bronchial tree (lung)). The results and observations obtained in the present study are compared with established findings of other workers.

CONCLUSION

Fetuses born prematurely at 24 to 26 weeks after fertilisation may survive if given intensive care; however, they suffer from respiratory distress because of surfactant deficiency produced by type II pneumocytes in alveoli.

KEYWORDS

Lung, Human, Foetus, Adult.

HOW TO CITE THIS ARTICLE: Darshana Bora, Annie Doley, Jyotirmayee Lahon. A histological study of human lung. J. Evid. Based Med. Healthc. 2016; 3(90), 4899-4905. DOI: 10.18410/jebmh/2016/1033

BACKGROUND

The lungs are the essential organ of respiration. They are two in number, placed one on either side within the thorax and separated from each other by the heart and other contents of the mediastinum. Each lung is free in its pleural cavity except for its attachment to the heart and trachea at the hilum and pulmonary ligament, respectively. Maturation of lung is divided into four stages; pseudoglandular (5-16 weeks), canalicular (16-26 weeks), terminal sac (26 weeks - birth) and alveolar (8 months - birth). By 16 weeks, all major elements have formed except those involved with gas

exchange and respiration is not possible. Respiration is possible at the end of canalicular stage because primordial alveoli have developed at the end of respiratory bronchioles and lung tissue is well vascularised. A histological study to see the microstructure of the lung and its maturation was undertaken in Assam Medical College, Department of Anatomy.

AIMS AND OBJECTIVES

To study the microstructure of the lung in different age groups. The present study "a histological study of human lung" was carried out in the Department of Anatomy, Assam Medical College and Hospital, Dibrugarh, for a period of one year July 2013-June 2014.

MATERIALS AND METHODS

The study was carried out in specimens, which was collected from adult cadavers obtained for routine dissection of undergraduate students and also from the Department of Forensic Medicine.

Financial or Other, Competing Interest: None.
Submission 06-10-2016, Peer Review 12-10-2016,
Acceptance 24-10-2016, Published 08-11-2016.
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DOI: 10.18410/jebmh/2016/1033



Specimens was also collected from perinatal cadavers from the Department of Obstetrics and Gynaecology, Assam Medical College and Hospital, Dibrugarh. The study has been carried out on three primary groups- Group 1, Group 2 and Group 3 according to the age.

Selection of Subjects

Group 1: In this group, specimens were taken in between the range of 16-26 weeks.

Group 2: In this group, specimens were taken in between 26 weeks birth.

Group 3: In this group, specimens were taken from adults (8 years onward).

A total of 160 specimens from 80 cases have been included in the study. Out of 160 specimens, 60 specimens were collected from 15 males and 15 females, which was included in the age group 16-26 weeks. Another 60 specimens were collected from 17 males and 13 females in the age group 26 weeks birth. Remaining 40 specimens were collected from 16 males and 4 females in the adult age group were collected from 16 males and 4 females in the adult age group.

Age	Males	Females	Total Number
Group 1 (16-26 weeks)	15	15	30
Group 2 (26 weeks birth)	17	13	30
Group 3 adults (8 years onward)	16	4	20

The lung was dissected out and it was prepared for histology by the usual method of tissue processing as mentioned in Carlton. After preparation of block, two sections were taken for histological examination from each block (Carleton, 5th Edit, 1980).

The stained sections were examined in 4 fields for all the slides in X axis and Y axis first under low power microscope and then under high power microscope to observe the presence or absence of pseudostratified columnar, columnar, cuboidal and squamous epithelium of bronchial tree (lung). Motic Software was used to observe the epithelium of the bronchial tree. Results were discussed in terms of percentage.

RESULTS AND OBSERVATION

A total of 160 lungs, 60 lungs from group 1, 60 lungs from group 2, 40 lungs from group 3 collected from 80 cadavers of either sex have been included in the study (table 1 and chart 1).

Age Group	No. of Cadavers	No. of Specimens
Group 1 (16-26 weeks)	30	60
Group 2 (26 weeks-birth)	30	60
Group 3 (8 years onward)	20	40
Total Number	80	160

Table 1. Distribution of Cadavers

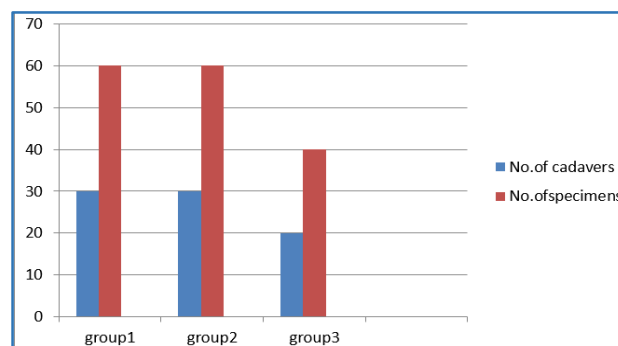


Chart 1. Showing the Distribution of Cadavers

Sex	Total No. of Cadavers	Males	Females	Total No. of Specimens
Group 1	30	15 (50)%	15 (50)%	60
Group 2	30	17 (57)%	13 (43)%	60
Group 3	20	16 (80)%	4 (20)%	40

Table 2. Sex Distribution of Cadavers

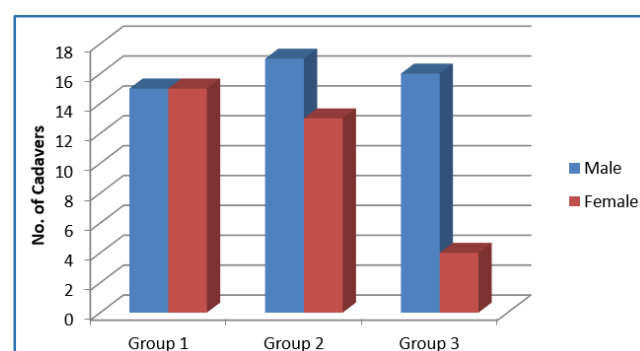
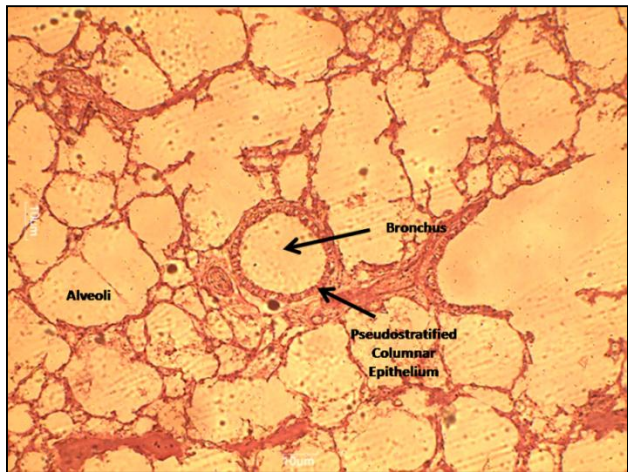


Chart 2. Sex Distribution of Cadavers

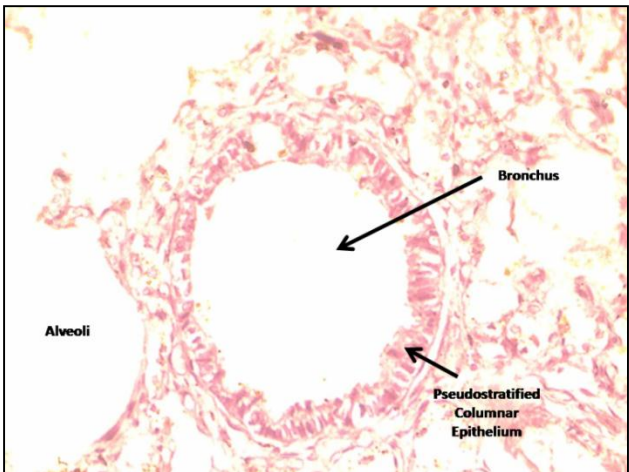
Age	Total No.	Right Lung		Left Lung	
		Pseudostratified Columnar Epithelium Present	Pseudostratified Columnar Epithelium Absent	Pseudostratified Columnar Epithelium Present	Pseudostratified Columnar Epithelium Absent
Group 1	30	30 (100) %	Nil	30 (100) %	Nil
Group 2	30	30 (100) %	Nil	30 (100) %	Nil
Group 3	20	20 (100) %	Nil	20 (100) %	Nil

Table 3. Presence/Absence of Pseudostratified Columnar Epithelium of Bronchial Tree (Lung)

From the above table, it is seen that pseudostratified columnar epithelium is present on both right and left lung in group 1. In group 2, pseudostratified columnar epithelium is present on both right and left lung. In the group 3, pseudostratified columnar epithelium is present on both the right and left lungs.



Photograph 1. Low Power View Showing Pseudostratified Columnar Epithelium (Group 1) Under Motic Software

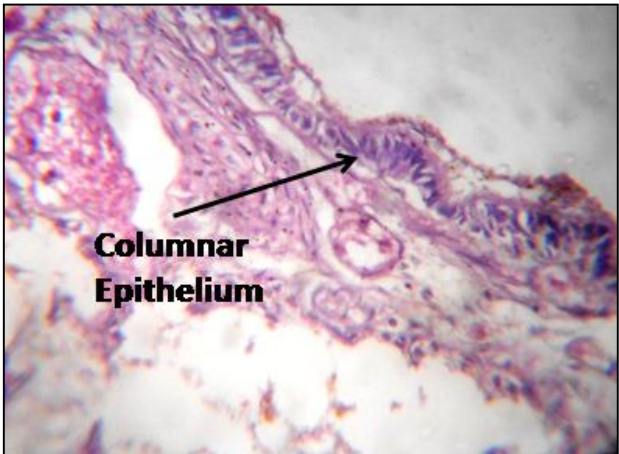


Photograph 2. High Power View of Bronchus (Group 1) Showing Pseudostratified Columnar Epithelium Under Motic Software

Age	Total Number	Right Lung		Left Lung	
		Columnar Epithelium Present	Columnar Epithelium Absent	Columnar Epithelium Present	Columnar Epithelium Absent
Group 1	30	30 (100)%	Nil	30 (100)%	Nil
Group 2	30	30 (100)%	Nil	30 (100)%	Nil
Group 3	20	20 (100)%	Nil	30 (100)%	Nil

Table 4. Presence/Absence of Columnar Epithelium of Bronchial Tree (Lung)

From the above table, it is seen that columnar epithelium is present on both right and left lungs in the group 1 (16-26 weeks). In group 2 (26 weeks birth), columnar epithelium is present on both right and left lungs. In group 3 (8 years onward), columnar epithelium is present on both the sides.

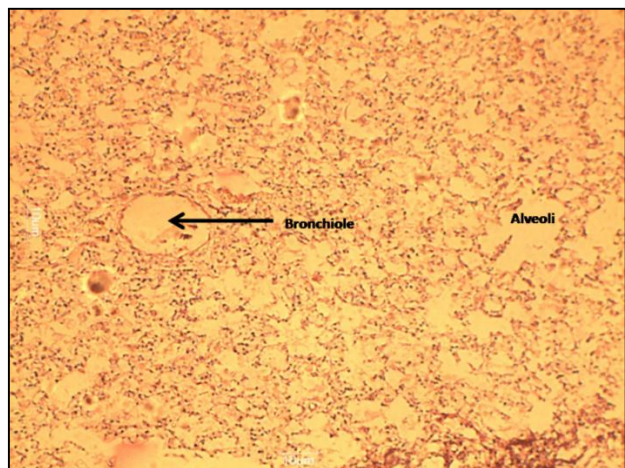


Photograph 3. High Power View of Columnar Epithelium Under Microscope (Group 2)

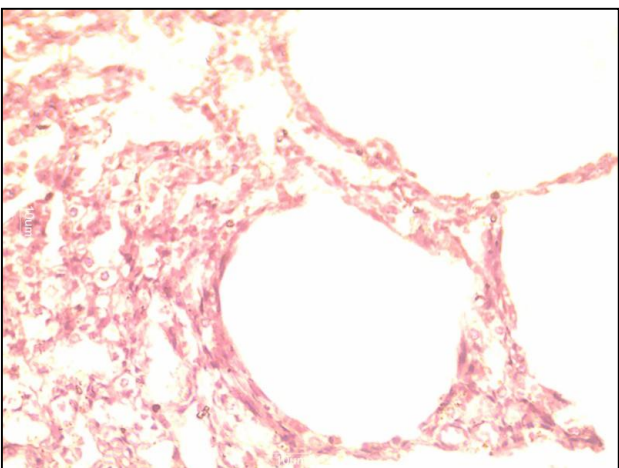
Age	Total Number	Right Lung		Left Lung	
		Cuboidal Epithelium Present	Cuboidal Epithelium Absent	Cuboidal Epithelium Present	Cuboidal Epithelium Absent
Group 1	30	Nil	30 (100) %	Nil	30 (100) %
Group 2	30	30 (100) %	Nil	30 (100) %	Nil
Group 3	20	20 (100) %	Nil	20 (100) %	Nil

Table 5: Presence/Absence of Cuboidal Epithelium of Bronchial Tree (Lung)

From the above table, it is seen that cuboidal epithelium is absent on both right and left lung in group 1 (16-26 weeks). In group 2 (26 weeks birth), cuboidal epithelium is present on both right and left lungs. In group 3 (8 years onward), cuboidal epithelium present on both the sides of the lung.



Photograph 4. Low Power View of Bronchiole Showing Cuboidal Epithelium (Group 2) Under Motic Software

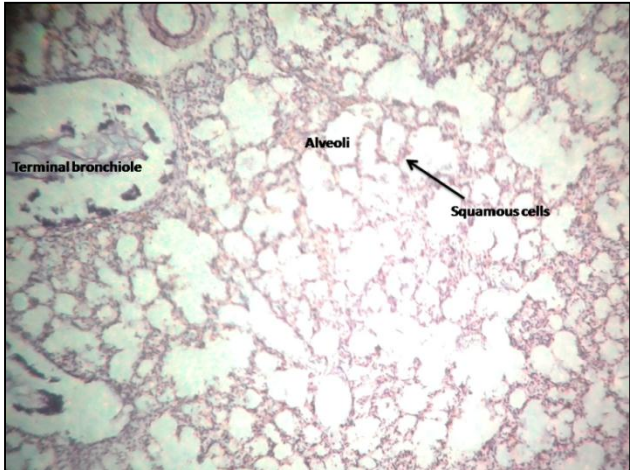


Photograph 5. High Power View of Bronchiole with Cuboidal Epithelium (Group 2) Under Motic Software

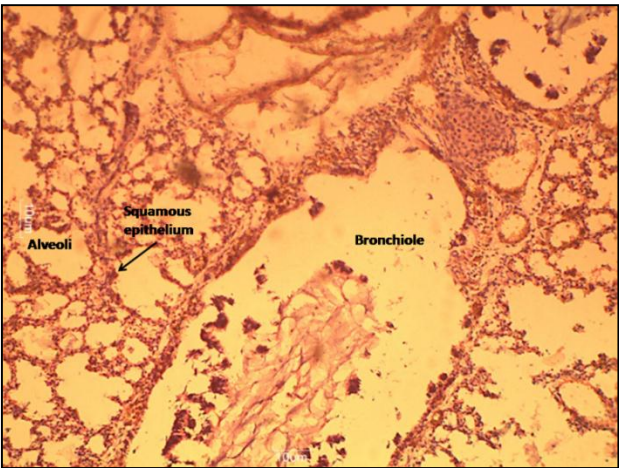
Age	Total Number	Right Lung		Left Lung	
		Squamous Epithelium Present	Squamous Epithelium Absent	Squamous Epithelium Present	Squamous Epithelium Absent
Group 1	30	Nil	30 (100) %	Nil	30 (100) %
Group 2	30	13 (43.30) %	17 (56.6) %	12 (40) %	18 (60) %
Group 3	20	20 (100) %	Nil	20 (100) %	Nil

Table 6. Presence/Absence of Squamous Epithelium of Bronchial Tree (Lung)

From the above table, it is seen squamous epithelium of lung is absent on both right and left lungs in the group 1 (16-26 weeks). Squamous epithelium is present in 43.30% on right lung and absent in 17 (56.6) % on right lung (26 weeks - birth) and squamous epithelium is present in 40% on left lung and absent in 60% of left lung in group 2. However, in group 3 (8 years onward), squamous epithelium is present on both right and left lungs in all the specimen.



Photograph 6. Low Power View of Squamous Epithelium (Group 3) Under Motic Software



Photograph 7. High Power View of Squamous Epithelium (Group 3) Under Motic Software

DISCUSSION

The present study was done to study the microstructure of lungs in different age groups. The results and observations obtained in the present study are compared with established findings of other workers.

Presence/absence of pseudostratified columnar epithelium of bronchial tree (lung), Michael H. Ross (2011)¹ states that the mucosa of intrapulmonary bronchus is composed of pseudostratified epithelium. The height of cells decreases as the bronchi decreases in diameter. The intrapulmonary bronchi are lined by pseudostratified columnar epithelium as mentioned by Michael H. Ross.

Eliot Weisenberg (2011) states that lung parenchyma consists of airways (bronchi, bronchioles) and alveoli. The entire respiratory tree except alveoli is lined pseudostratified, tall, columnar ciliated cells with neuroendocrine (Kultschitsky) cells, mucus secreting goblet cells in walls of bronchi, basal cells, brush cells, clara cells and inflammatory cells. In the present study, the intrapulmonary bronchi are present from 16 weeks onwards lined by pseudostratified columnar epithelium. Some primordial alveoli have developed at the ends of the respiratory bronchioles, but they are not lined by pseudostratified columnar epithelium. Squamous epithelium lining the alveoli are not fully formed. These finding is similar to the finding mentioned by Eliot Weisenberg.

Craigh R. Rackley (2012)² states that proximal conducting airways are lined by a pseudostratified epithelium extend from the trachea to the distal bronchioles of human airways.

In the present study, the intrapulmonary bronchi are lined by pseudostratified columnar epithelium from 16 weeks onwards till adult. The lumina of bronchi become larger during 16-26 weeks. Each terminal bronchiole gives rise to respiratory bronchiole each of which divides into primordial alveolar ducts. Some primordial alveoli have developed at the ends of the respiratory bronchiole. The intrapulmonary bronchi are lined by pseudostratified columnar epithelium, but the squamous epithelium lining them are not formed.

B. P. Dickey (2012) states that the conducting passage way of respiratory system (nasal cavity, bronchi, bronchioles) are lined by pseudostratified columnar epithelial tissue, which is ciliated and which includes mucus secreting goblet cells. In the present study, the intrapulmonary bronchi are lined by pseudostratified columnar epithelium, which is similar to the findings of B. P. Dickey.

Presence/Absence of Columnar Epithelium of Bronchial Tree (Lung)

Alison and Reid (1974)³ mentioned at 16 weeks of gestation, airways are blind tubules lined by columnar or cuboidal epithelium.

In this study, airway tubes have appeared from 16 weeks onwards and are lined by columnar epithelium.

Chinoy MR (2003)⁴ mentioned that ciliated, goblet and basal cells appear in the central airways. In pseudoglandular stage, the airway tubes are lined by very high columnar epithelium.

Inderbir Singh (2011)⁵ the larger bronchi are lined by pseudostratified columnar epithelium. As bronchi becomes small, epithelium first becomes simple ciliated columnar, then non-ciliated columnar and finally cuboidal in respiratory tree. The present study is supported by I. B. Singh in that the larger bronchi are lined by pseudostratified columnar epithelium. The epithelium of the bronchioles is cuboidal.

Victor P. Eroschenko (2012),⁶ the bronchioles subdivide into terminal bronchioles whose diameter maybe 1 mm or less. The terminal bronchioles are lined by simple columnar epithelium. The cartilage plates, bronchial glands and goblet

cells are absent from the terminal bronchioles.

It supports the present study in that the terminal bronchioles are lined by simple columnar epithelium and goblet cells are absent.

Presence/Absence of Cuboidal Epithelium of Bronchial Tree (Lung)

Boyden (1971) in his study mentioned at 28th week's gestation, three generations of respiratory bronchiole are present, though this number may vary. Their lining at this age includes both cuboidal and in parts flat epithelium, distal to respiratory bronchiole, one or two generations of transitional ducts are present that are short, straight airways lined by flattened epithelium.

In the present study, respiratory bronchiole can be seen from 26 weeks till adult. They are lined by cuboidal epithelium as mentioned by Boyden.

Alison and Reid (1974) at 16 weeks of gestation, airways are blind tubules lined by columnar or cuboidal epithelium. Airways lined by cuboidal epithelium are seen after 26 weeks, which supports the above-mentioned worker.

B. Young (2000)⁷ mentioned the epithelium of respiratory bronchioles is devoid of goblet cells and consists of ciliated cuboidal and non-ciliated cells called clara cells. In the most distal part of respiratory bronchiole, clara cells predominate.

In the present study, epithelium of the bronchial tree lining the respiratory bronchiole is cuboidal and devoid of goblet cells.

In the present study, the respiratory bronchiole is lined with a simple cuboidal epithelium. The present study supports the study results of Dwight M Palmer (1936)⁸ that described a human foetus at 152 mm stage (in fifth month). The tracheobronchial tree at this stage is a continuous intact epithelium and maximum number of generation of tubules forming the tree is seventeen. The lining of the terminal tubules was cuboidal epithelium enclosing a close lumen.

Presence/Absence of Squamous Epithelium of Bronchial Tree (Lung)

Strandring S. Grays (1995)⁹ in his study found that alveoli can be seen at 32 weeks and present in all foetuses at 36 weeks, which he recommends as beginning of alveolar stage.

Alveoli are present from 26 weeks and is present in all foetuses at 36 weeks in this study. By 26 weeks-28 weeks, sufficient alveolar sacs are present. Though, squamous epithelium are seen from 26 weeks fully formed squamous epithelium are present from 32 weeks.

Gail H. Deutsch (2007) observed that in by 20 to 22 weeks gestation, type I and type II alveolar cells can be differentiated from the cuboidal epithelial cells in the most peripheral parts of the lung. Continual differentiation of type I and II alveolar cells occurs in 28th-35th weeks so that the alveolar epithelial cells become the most abundant epithelial cells in the lung. The flattened type I alveolar cells make up the majority of these cells. It is seen by 26 weeks, the terminal sacs are lined by squamous epithelial cells across,

which gas exchange occurs.

Davidson College of Biology Department (2010) stated simple squamous epithelium makes up alveoli in lung. Simple squamous epithelium cells are thin and flat, which allows them to have a large surface area that is exposed to the lumen on one side (apical surface) and to basement membrane (i.e., basal lamina) on the other (basolateral surface). These cells scale like in appearance, tend to have larger elliptical-shaped nuclei. Simple squamous epithelium is one cell layer thick and thus every cell of the tissue comes in direct contact with the basement membrane.

In the present study, the alveoli of adults (8 years onwards) and fetuses after 26 weeks are lined by squamous epithelium. They are thin and flat, one cell thick, have elliptical-shaped nuclei as mentioned by the above workers.

Lutz Slomianka in (2009) described that the wall of alveoli is formed by a thin sheet of tissue separating neighbouring alveoli. Sheet is formed by epithelial cells and intervening connective tissue. In the present study, the wall of alveoli is formed by a thin sheet of tissue separating neighbouring alveoli. Sheet is formed by epithelial cells and intervening connective tissue.

Dr. Karen Bernd (2010) said that simple squamous epithelium makes up alveoli in lungs where rapid gas exchange occurs as oxygen enters the blood streams through alveolar blood vessels and carbon dioxide exits as waste. Squamous cells are present in the alveoli of lungs towards the end of 26 weeks onward till adult. This finding is similar to the finding of Dr. Karen Bernd as mentioned by him oxygen enters blood stream through alveolar blood vessels and carbon dioxide exits as waste.

Elliot Wiesenberger (2011) states that lung parenchyma consists of airways (bronchi and bronchioles) and alveoli. The pulmonary lobule, also known as acinus or terminal respiratory unit contains 3-5 terminal bronchioles, alveolar ducts and alveoli; it is the smallest anatomic unit delineated by connective tissue. In the bronchi, there is no clear distinction between the mucosa and submucosa. The entire respiratory tree except alveoli is lined by pseudostratified, tall, columnar, ciliated epithelial cells with neuroendocrine (Kultschitsky) cells, mucus secreting goblet cells in walls of trachea and bronchi, basal cells, brush cells, clara cells and inflammatory cells. In more distal airways, there are fewer goblet cells and more clara cells. Alveolar capillary basement membrane fuses with alveolar epithelium to form a single membrane for oxygen and carbon dioxide diffusion. Alveoli are lined almost exclusively by type I and II pneumocytes. Type I (squamous) pneumocytes consists of 95%, flattened cells and type II (cuboidal) pneumocytes are 5%.

In the present study, the alveoli are lined by flattened squamous cells, which lines almost 95% of the alveolar surface.

Baba MA, Choudhary AR (2008),¹⁰ Cormack (1987) reported of common septa between the adjacent alveoli formed the interalveolar septa. The septa were covered on both sides by alveolar epithelium and were internally supported by fine elastic, reticular and collagen fibres. These

delicate interalveolar walls were provided with very extensive capillary network. The connective tissue fibres were continuous with the surrounding interstitial tissue in human.

In the present study, adjacent alveoli are also seen to be separated by a common septum. The alveolar walls are provided with extensive capillary network.

Victor P. Eroschenko (2013) mentioned that alveoli are evaginations or out pocketing of respiratory bronchioles, alveolar ducts, alveolar sacs, the terminal ends of alveolar ducts. The alveoli are lined with a layer of thin squamous, alveolar cells (pneumocytes). It supports the present study that the alveoli of group 2 and group 3 (photograph 7) are lined by simple squamous epithelial cells. In group 1 though alveoli are seen, the squamous cells lining them are not fully formed (photograph 1).

The Observations Made in the Present Study are Summarised as Follows

- The epithelial lining of the bronchial tree (lung) is pseudostratified columnar in bronchus present in all three age groups.
- The epithelial lining of the bronchial tree (lung) is columnar in terminal bronchiole and is seen in all three age groups studied.
- The lining epithelium of respiratory bronchiole is cuboidal in Group 2 and Group 3 while it has not developed in Group 1.
- The alveoli are fully developed in group 3 and fully formed squamous cells are present in the alveoli whereas squamous cells are not formed in group 1 and group 2, although some alveoli have developed in them.

CONCLUSION

By 26-28 weeks, the foetus weighs approximately 1000 g and sufficient alveolar sacs and surfactant are present to permit survival of a prematurely born infant. The development of an adequate pulmonary vasculature and sufficient surfactant is critical to the survival and neurodevelopmental outcome of premature infant. Consequently, fetuses born prematurely at 24 to 26 weeks after fertilisation may survive if given intensive care; however, they suffer from respiratory distress because of surfactant deficiency produced by type II pneumocytes in alveoli.

This study hopes to impart some knowledge, which will be of some help to clinicians and to all the medical professionals as a whole.

REFERENCES

1. Michael RH, Pawlina W. Histology: a text and atlas: with correlated cell and molecular biology. 6th edn. Wolters Kluwer/Lippincott Williams & Wilkins Health 2011:677-679.
2. Rackley CR, Stripp BR. Building and maintaining the epithelium of the lung. J Clin Invest 2012;122(8):2724-2730.

3. Hislop A, Reid L. Development of the acinus in the human lung. *Thorax* 1974;29(1):90-94.
4. Chinoy MR. Lung growth and development. *Front Biosci* 2003;8:392-415.
5. Singh I. Textbook of human histology with colour atlas and practical guide. 6th edn. New Delhi: Jaypee Brothers Medical Publishers 2011:p. 223.
6. Victor EP. DiFiore's atlas of histology with functional correlations. 12th edn. Lippincott Williams & Wilkins 2012:p. 406.
7. Young B, Heath JW. Wheaters functional histology. 4th edn. Churchill Livingstone 2000:227-335.
8. Palmer DM. Early developmental stages of human lung. *Ohio Journal of Science* 1936;36(2):69-79.
9. Strandring S. Grays anatomy. 38th edn. Edinburgh: Churchill Livingstone 1995:1664-1671.
10. Baba MA, Choudhary AR. Histomorphology of the pulmonary alveoli of goat (*Capra hircus*). *Veterinary World* 2008;1(10):312-313.