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Anatomical and Histological Study of the Human Neonate Lungs

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Abstract

The current study aims to describe the normal anatomical structures of neonate lungs (weights, volumes and dimensions) as well as the architectural histology of structure In this study, 20 neonate cadavers collected with age ranging from 0-28 days, all these cadavers were collected from the Forensic Medicine in Baghdad and Kirkuk. Following dissection, the organ weight and gross metrical measurements were measured. Histological study was done on all cadavers enrolled in the study using Periodic Acid Schiff (PAS) Stain The results showed that the weight of neonatal lung was increased proportionally with age and the highest mean weight, volume and dimensions of lungs were found in neonates whose in the age group 22-28 day. The study revealed that dimensions of the left lungs were slightly more than those of right lungs especially in the age group 22-28 days. The study indicated that the volume of neonatal lungs were increased proportionally with age and the highest mean volume of lungs was found in neonates whose in the age group 22-28 days 50.03 cm^3. The tunica media of the blood vessels of small and medium sized were well demonstrated of the thickness of alveolar walls also were obvious with inflammatory cell infiltration, the interstitial C.T. also associated with presence of smooth muscle cells, surrounded by segments of hyaline cartilage which are demonstrated easily, the lumen of bronchus appeared containing exudate, around the lung was containing with collagen bundle the elastic fibers. The basement membrane of the pulmonary blood vessels was demonstrated well by PAS which appeared thickened and the lumen of blood vessels was filled with blood serum and individual inflammatory cell. The interstitial C.T. around the blood vessels were containing dust cell with lymphocyte infiltration .

Keywords: Anatomy; histology; lungs; cadevars.
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دراسة تشريحية ونسيجية لرئة الاطفال حديثي الولادة

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الملخص

تهدف الدراسة الحالية إلى وصف التراكيب التشريحية الطبيعية للرئتين في حديثي الولادة (الأوزان، الأحجام والأبعاد)، وكذلك التشريح النسيجي لها. شملت الدراسة 20 جثة لأطفال حديثي الولادة والذين تراوحت أعمارهم من 0 الى 28 يوم. تم جمع العينات من مراكز الطب العدلي في مدينتي بغداد وكركوك. بعد التشريح، تم قياس الوزن والابعاد. تمت الدراسة النسيجية على جميع العينات التي شُملت بالدراسة باستخدام صبغة حمض شيف دوري. أظهرت الدراسة ان وزن الرئتين يزداد طردياً مع عمر الرضع وأن اعلى معدل من الوزن والحجم والأبعاد وُجد في الجثث التي كانت أعمارهم من 22–28 يوم وأن ابعاد الرئات اليسرى كان اكبر قليلا من الرئات اليمنى وان حجم الرئة كان $50.03\ cm^3$.

وقد أظهرت الدراسة أن الواجهات الضيقة من الأوعية الدموية الصغيرة والمتوسطة الحجم ظهرت جيدا بسمك الجدران السنخية كما كانت واضحة مع وجود الخلايا الالتهابية. أظهرت النتائج ان النسيج الخلالي الضام يرتبط أيضا مع وجود خلايا العضلات الملساء، وتحيط به شرائح من الغضروف الشفاف ان القصبة داخل الرؤية قد اقترنت بالظهارة العمودية المطبقة الكاذبة المحاطة بـ النسيج الضام وقطع من الغضروف الشفاف مع حزم من ألياف العضلات الملساء. وأظهرت الدراسة أن الشعب الهوائية مبطنة بنسيج طلائي عمودي بسيط إلى مكعب محاط بخيوط من ألياف العضلات الملساء وان الحويصلات الرئوية تحتوي على جدار سميك غير منتظم. ظهر الغشاء القاعدي للأوعية الدموية الرئوية باستخدام صبغة PAS سميكاً، وأن تجويف الأوعية الدموية كان مملوءا بمصل الدم والخلايا الالتهابية وكان النسيج الضام محيطاً بالأوعية الدموية التي كانت تحتوي على الخلايا الغبارية مع وجود الخلايا الالتهابية هنالك.

الكلمات الدالة: التشريح، الانسجة، الجثث حديثي الولادة.

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1. Introduction:

The lungs are a pair of organs in the chest that are primarily responsible for the exchange of oxygen and carbon dioxide between the air we breathe and the blood. Air enters the body via the nose or the mouth [1]. The air enters the main windpipe, called the trachea, and continues route to each lung via either the right or left bronchus [2]. The lungs are separated into sections called lobes, two on the left and three on the right. The air passages continue to divide into ever-smaller tubes, which finally connect with tiny air sacs called alveoli [3]. The other half of the respiratory system involves blood circulation. Venous blood from the body is returned to the right side of the heart and then pumped out via the pulmonary artery [3]. This artery splits in two for the left and right lungs and then continues to branch much like the tracheobronchial tree [4]. The capillaries are situated adjacent to the alveoli and are so small that only one red blood cell at a time can pass through their openings [5]. It is during this passage that gases are exchanged between the blood and the air in the nearby alveoli. After passing the alveoli, capillaries then join together to begin forming the pulmonary veins, which carry the blood back to the left side of the heart [6]. The lungs lie either side of the mediastinum, within the thoracic cavity. Each lung is surrounded by a pleural cavity, which is formed by the visceral and parietal pleura. They are suspended from the mediastinum by the lung root – a collection of structures entering and leaving the lungs [7]. Each root contains a bronchus, pulmonary artery, two pulmonary veins, bronchial vessels, pulmonary plexus of nerves and lymphatic vessels [8]. All these structures enter or leave the lung via the hilum – a wedge shaped area on its mediastinal surface [9]. The lungs are roughly cone shaped, with an apex, base, three surfaces and three borders. The left lung is slightly smaller than the right – this is due to the presence of the heart [10]. The lungs' main function is to help oxygen from the air we breathe enter the red cells in the blood. Red blood cells then carry oxygen around the body to be used in the cells found in our body [1]. The lungs also help the body to get rid of CO_2 gas when we breathe out alveoli are the only part of the lung that exchanges oxygen and carbon dioxide with the blood [3].

2. Material and Methods:

In this study, 20 neonate cadavers collected with age ranging from (0-28) days, (40-55) cm length and (2.9 -5.4) kg body weight were examined, all these cadavers were collected from the Forensic Medicine in Baghdad and Forensic Medicine in Kirkuk. The cause of death for each cadaver was due to intra - abdominal catastrophes.

3. Dissection:

For approach to thoracic cavity procedure is the most common anatomical approach to the lungs. This procedure included that, the cadaver must be situated in supine position

4. Gross anatomy :

Following dissection and gross fatty tissue was removed by using a scissor and forceps and ribs, sternum using a bone saw. Then the organ was rapidly removed from the cadaver and The neonate lungs was weighted, using (5.0 Kg SCA-301 Glass Tray The LCD Digital Scale Balance), these measurements were found that the mean ± (SD) length of right lobe of neonate lung 4.15±0.70 and Width of right lobes of neonate lungs 3.15±0.72. and left lung lobe these measurements were found that the mean ± (SD) length for left lobe 4.95±0.78. Width for left lobe 2.66±0.68. by using personal ruler

5. Histology:

After dissecting remove the fresh lungs of according to the lobes of each case was rapidly removed. Then cleaned from plura and another organs (heart) using scissors and forceps. Each specimen of The lung was divided into two lobes. Right lobe; and left lobe. After that each tissue fragment was subjected to the following procedure sectioning and staining by Periodic Acid Schiff (PAS) Stain according to manufacture instruction, The lungs specimen were taken from each part of the lung lobes. specimens were fixed using 10% formalin saline (100ml of 40% formaldehyde, 9gm Sodium chloride and 900ml tap water) for 24 hours. [33,34]. Light microscope could be used for an estimation of the general distribution and organization of the alveolar cells. The light microscopy shows that the blood air barrier and basement membrane. and used photograph the slides (sony cyber-shotDSC-w230 Digital 12.1Megapixal).

6. Statistical Analysis:

Computerized statistically analysis was performed using IBM SPSS V23.0.0 statistic program. Comparison was carried out using F-ratio. The P value>0.05 was considered statistically significant, and for result which its P value was less than 0.01 was considered highly significant, while for those which its P value was greater than 0.05 considered non-significant statistically.

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7. Results:

7.1 Anatomical Results:

A thoracic approached to the lungs showed that it was located in the chest on either side of the heart in the rib cage. They are conical in shape with a narrow rounded apex at the top, and a broad concave base that rests on the convex surface of the diaphragm. Fig.1. show that the weight of neonatal lung was increased proportionally with age and the highest mean weight of lungs was found in neonates whose in the age group (22-28) days (58.11 gm) with statistically highly significant relation between lungs weight and age.

In the current study, dimensions (length and width) both lungs of all neonates enrolled in the study were measured using personal ruler. The study showed that there was a highly significant relation mean length and width with age of neonates, both length and width as well as weight of both lung were increased with the increase of the age of neonates, this increasing was statistically significant concerning the age groups. The study revealed that dimensions of the left lungs were slightly more than those of right lungs Table 1 According to the measurement of the whole volume of neonatal lungs enrolled the current study Table 2 show that the volume of neonatal lungs were increased proportionally with age and the highest mean volume of lungs was found in neonates whose in the age group (22-28) days (50.03 cm^3) and the lowest mean volume was recorded among neonates whose age were less than 7 days with statistically significant relation between lungs volume and age of neonates. Fig. 2.

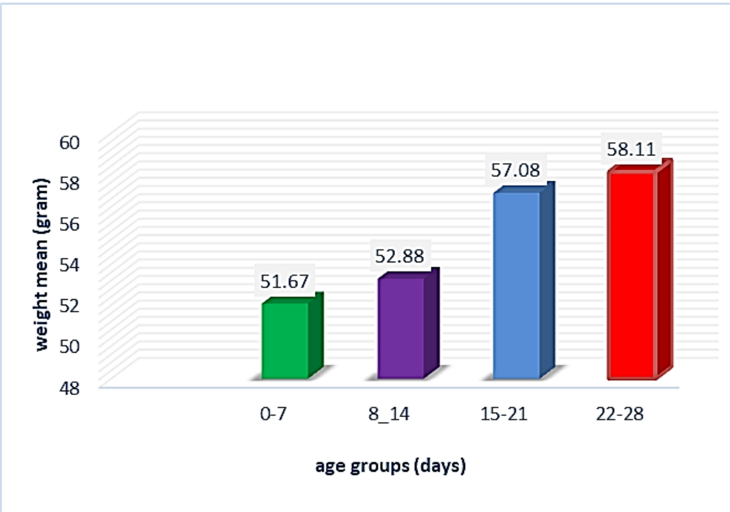

Fig. 1: Relation of weight of neonatal lungs with the age

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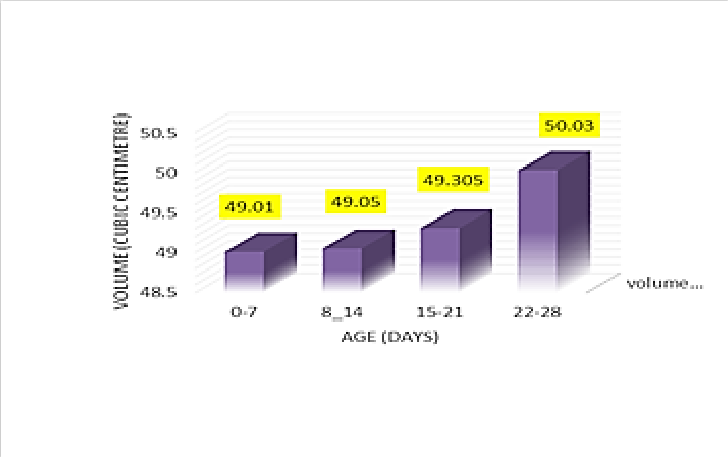

Fig. 2: Relation of volume of neonatal lungs with the age

Table 1: Relation of neonatal lungs weight, length and width with age

Age	Mean and S.D	Weight (gm)	Right lung		Left lung		F ratio	P value
			Length (cm)	Width (cm)	Length (cm)	Width (cm)		
≤ 7	Mean	51.67	3.57	2.05	3.71	2.02	17.967	0.000 HS
	S.D	0.58	0.11	0.02	0.1931	0.02		
8-14	Mean	52.88	4.13	2.29	4.14	2.29	16097	0.000 HS
	S.D	0.56	0.11	0.37	0.10	0.37		
15-21	Mean	57.08	4.426	3.034	4.71	2.99	31640	0.000 HS
	S.D	0.62	0.081	0.021	0.21	0.06		
22-28	Mean	58.11	5.24	3.13	5.45	3.38	31380	0.000 HS
	S.D	0.12	0.21	0.09	0.22	0.53		
Total ages	Total Means	55.088	4.34	2.66	4.50	2.69	12602	0.000 HS
	S.D	2.73	0.76	0.67	0.76	0.68		

HS: highly significant

Table 2: Relation of volume of neonatal lungs with the age.

Age (days)	Volume	
	Mean (cm^3)	S.D
≤ 7	49.01	0.0141
8-14	49.05	0.091
15-21	49.305	0.4634
22-28	50.03	0.029
F- Ratio: 4.415 P. value:0.0202	HighlySignificant (HS)	

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7.2 Histology Results:

In Fig. 1, the blood air barrier was obvious that formed by blood capillary and alveolus with presence of endothelial cell and capillary resting of basement membrane and the squamous cell type-I of alveoli. however, Fig. 2 the blood air barrier could be present by five steps which were demonstrated, the alveolar squamous epithelial type I, its basement membrane, the interstitial tissue, the basement membrane of capillary and finally the endothelial cell. Fig. 3, the intrapulmonary bronchus was associated with pseudo stratified columnar ciliated epithelium surrounded by c.t and segments of hyaline cartilage with bands of smooth muscle fibers. Fig. 4, the bronchiole with simple columnar cuboidal epithelium surrounded by a strands of smooth muscle fibers absence of cartilage and glands smooth muscle becomes the major component of their wall. In Fig. 5, the lung tissue was demonstrating a huge number of RBCs engorged the interstitial C.T. In Fig. 6, it was usually found that, the blood vessels are along the course of alveolar ducts,

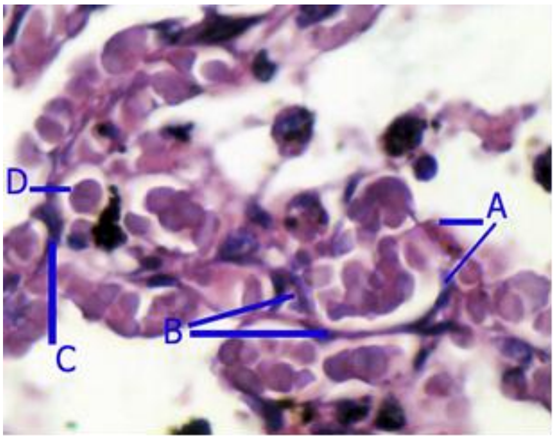

Fig. 1: Blood-Air barrier, endothelial cells of blood capillary (A) basement membrane (B) alveolar cell type-I (C) and of surfactant cell type I (D). (PAS stain, 40X). neonate lung age (8-14) days

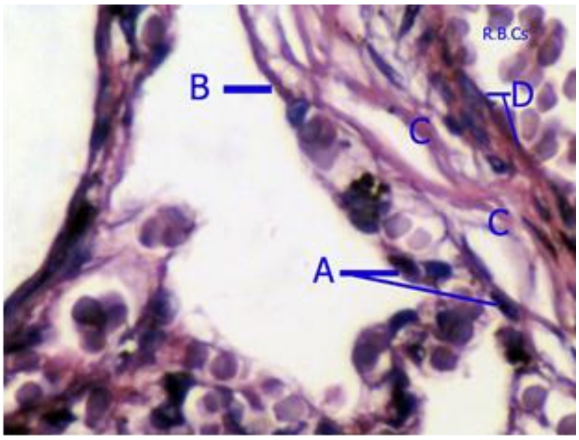

Fig. 2: Blood-Air barrier, squamous alveolar cell type I (A), basement membrane of alveolus (B), interstitial C.T(C) and basement membrane blood capillary (D). (PAS stain, 40X). neonate lung age (0-7) days

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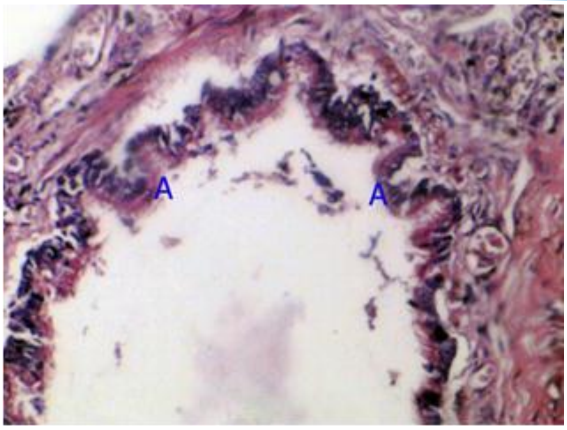

Fig. 3: Intrapulmonary bronchus with Psedostratified columnar . (A), epithelium (A) (PAS stain, 20X) neonate lung age (15-21)

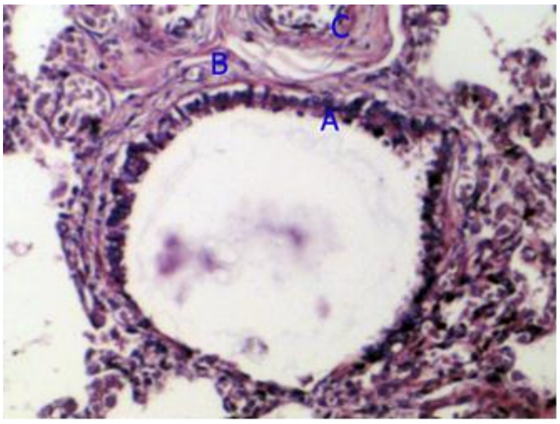

Fig. 4: Bronchiole with simple cuboidal to columnar epithelium smooth muscle fibers (B) and arterioles (C), (PAS . . . . stain, 20X).lung neonate age (15-21)

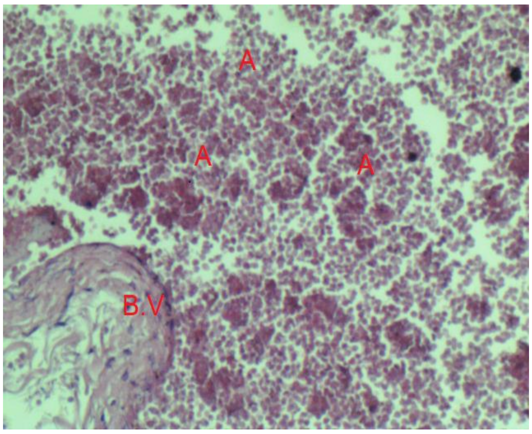

Fig. 5: Lung tissue demonstating a huge number of RBCs in alveolar space (A) and blood vessel (B) .. (PAS stain, 20X).

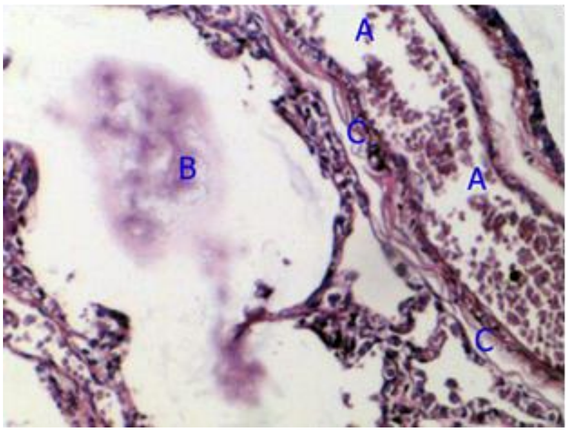

Fig. 6: Blood vessels present longitudinally (A), alveolar duct (B) and interstitial C.T.(C). (PAS stain, 20X). neonate lung age(22-28).

8. Discussion:

Cadavers are still the best means to study all the domains of anatomy. Many researchers have reported the anomalous anatomy of the lungs in human cadavers [11-15]. Hence the present study was undertaken on neonatal cadavers to determine the morphology of lungs. The lungs are located a little toward the posterior part of the human body, just below the collarbone, extending down to the diaphragm, the muscular partition that separates the chest and abdominal cavities. The left and right lungs are situated on the two sides of the body with

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the heart, another vital organ in the thoracic cavity, located a little in front of, and at the middle of them [12]. They are also surrounded by the rib cage, along with other organs in the chest cavity. The lungs stretch from close to the backbone in the rib cage to the front of the chest and downwards from the lower part of the trachea to the diaphragm The right lung was divided into superior, middle and inferior lobes by two fissures, an oblique and a horizontal [13]. The upper, oblique fissure separates the inferior from the middle and superior lobe and corresponds closely to the left oblique fissure although it is less vertical, crossing the inferior border of the lung [16]. The left lung has a deep indentation, referred to as the cardiac notch, along its mediastinal surface to make space for the apex of the heart. These two surfaces meet each other at the apex, the costal surface and the mediastinal surface meets, is marked as the posterior border. Newborn infants, especially if born premature, have fewer and larger alveoli than older children and adults [17]. Alveolarization, that is, the growth and development of alveoli, continues into childhood and adolescence [18]. Collateral connections between alveoli (pores of Kohn and bronchoalveolar canals of Lambert) are not present until the first years of life [19]. The absence of accessory interalveolar communications in neonates increases the risk of atelectasis in dependent lung areas. Production of pulmonary surfactant begins by 23 to 24 weeks gestational age and reaches sufficient levels after about 35 weeks of gestation [20]. However, surfactant production can be delayed under certain conditions such as maternal gestational diabetes or perinatal asphyxia [21]. During foetal life as the lung develops, the spaces of fissures that separate individual bronchopulmonary buds or segments become obliterated except along the oblique and horizontal fissures [17].

In relation of weight of neonatal lungs with the age, the weight of neonatal lung was increased proportionally with age and the highest mean weight of lungs was found in neonates whose in the age group 22-28 days (58.11 gm) with statistically highly significant relation between lungs weight and age. Needham et al [22] demonstrated that adult lung weight was 850 gm with right 3 and 2 lobes. Hislop, et al [23] showed that the weights of the lungs were in increased with the increasing of the age and the right lung is bigger than the left, which shares space in the chest with the heart and resented that the lungs together weigh approximately 1.3 kilograms and the right is heavier .

Crapo, et al [24] demonstrated in his study that the average fixed lung volume of adult human lungs cadavers was 4.300 ml while Horsfield [25] presented in his study that the

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volume of the fresh adult lung ranged from 2157 to 5225 ml and varies with a person's size, age, gender, and respiratory health. Stand included, size: 20" × 14" × 13".

9. Histology of Lungs:

In the present study the neonate lung the muscular coat of the bronchioles thins and is lost altogether in the terminal and respiratory bronchioles. This is thought to occur in a manner similar to fingers extending through a mitten glove, namely that the muscle coat stays where it is as the airways grow through them. Horsfield et al. [25] examining bronchial casts, suggested that peripheral airways in infancy are relatively large and indeed of adult size by age 1 yr. Hislop et al. [26], in contrast, concluded that growth of the airways was symmetrical with the rest of the lung, something so rare in biology as to be somewhat implausible.

The alveoli form the basic structural and functional unit for gas exchange in the lung parenchyma. Cormack [26] In the present investigation, the alveoli were generally small, roughly spherical structures that opened into the alveolar ducts, alveolar sacs or into the respiratory bronchioles wherever present. The alveolar sacs were completely surrounded by alveoli [24]. Almost similar descriptions were given by Maina [27], Plopper and Adams [28] in domestic animals, Eurell et al [30], Gartner et al and Cormack [27] in humans.

The alveolar wall was composed of a thin single layer of epithelium. A very thin layer of connective tissue composed of fine elastic, reticular and collagen fibers underlay the epithelium. [26]. According to Plopper [28], type-II cells were secretory in nature, possessing well developed cell organelles. When the secretion is liberated onto the epithelial surface, it lowers the surface tension thereby preventing the alveoli from collapsing during expiration [29,30]. Kahwa and Purton [31], reported that the alveolar epithelium of the goat was of simple squamous type only, whereas Kahwa et al [31], demonstrated both type-I and type-II cells in the same species and Rybicka et al [32].

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