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Original Article

A COMPARATIVE STUDY OF TRACHEOBRONCHIAL PATTERN USING LUMINAL PLASTINATION

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ABSTRACT

Background: The tracheobronchial pattern of human lungs is well known. An attempt was made to compare the pattern with that of sheep lung using luminal plastination of sheep lung. Several similarities were observed between the two patterns, due to which, the sheep lung serves as an ideal experimental model to study the effect of treatment in several human airway diseases.

Objective: The first objective was to compare the two tracheobronchial patterns. Moreover the study also provided an opportunity to the authors to attempt a luminal plastination. The final objective is to highlight the various advantages of advances in luminal plastination in current medical education and research.

Materials and methods: Silicon sealant was injected into the tracheobroncheal tree of sheep after thoroughly cleaning the lungs with saline. After the sealant solidified the surrounding lung tissue was destroyed by boiling. Thus a luminal cast was prepared.

Result: The result was a splendid luminal cast of the sheep lung showing its tracheobronchial pattern.

Conclusion: It was observed that the tracheobronchial division pattern showed significant similarities and a single variation. Therefore the sheep lung is an ideal experimental model and luminal plastination can be applied to comparative anatomical study to identify more such models.

KEYWORDS: Plastination; Silicon sealant; Silicon gun; Bronchopulmonary segments.

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INTRODUCTION

The method of plastination is a novel technique to preserve the body parts without any health hazards like carcinogenicity and contact dermatitis that are associated with formalin. The method was first invented by Gunther Von Hagens who imagined as to what would happen if plastic was impregnated into substances [1]. Thus plastination was first invented and slowly three types of plastination namely luminal, whole organ and cross sectional plastination were developed. Luminal plastination can be used to enrich the knowledge of comparative anatomy which is of profound importance in the present era of advances in therapeutic science that use animal models for testing drugs.

In humans there are two lobes in the left lung and three in the right lung and therefore a total of five lobes where as in the sheep on the right side an additional lobe is noted as shown in figure 1 and hence there are six lobes.

MATERIALS & METHODS

1. A fresh specimen of sheep lung was obtained.
2. It was preserved in saline.
3. The tracheobronchial tree was cleaned repeatedly with saline until all the blood was drained out of the lungs.
4. The silicon sealant was then injected into the tracheobronchial tree using a silicon gun.

5. The specimen was then left to dry until all the sealent solidified.
6. The surrounding lung tissue was then destroyed by boiling.
7. Thus a plastinated luminal cast of the tracheobronchial pattern was obtained which was then cleaned.
8. The specimen was then mounted in a glass jar.

RESULTS

1. The sheep lung shows an additional bronchus on the right side arising directly from the trachea as shown in figure1.
2. Two principal bronchi are seen on each side.
3. Each principal bronchus divides into 3 secondary on right and 2 on left side.
4. Ten tertiary bronchi are observed on each side as in humans.
5. The additional bronchus on the right side again divides into two bronchi.
6. Therefore an additional lobe is seen on the right side.

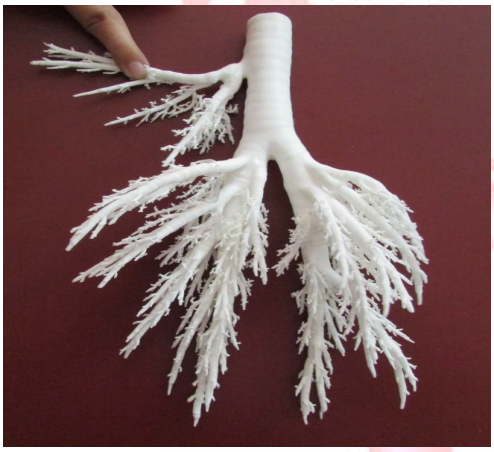

Fig 1: The luminal cast of sheep lung showing the additional bronchus on the right side.

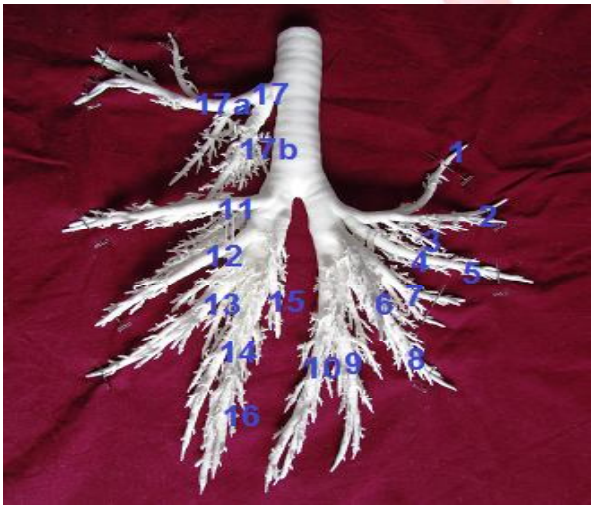

Figure 2: The luminal cast of sheep lung. The various tertiary bronchi are labeled 1 to 10 on each side.

DISCUSSION

In humans there are two principal bronchi, one for each lung. The right lung has three lobes and hence shows three secondary bronchi and the left has two lobes and hence shows two secondary bronchi. The secondary bronchi divide into several tertiary bronchi and in humans there are ten tertiary bronchi on each side.

Each tertiary bronchus supplies one bronchopulmonary segment and hence there are ten segments on each side [2]. The segments are named as follows:

Right side	Left side
1. In upper lobe	**1. In upper lobe**
a. Apical	a. Apical
b. Anterior	b. Anterior
c. Posterior	c. Posterior
2. In middle lobe	d. Superior lingular
a. Medial	e. Inferior lingular
b. Lateral	
3. In lower lobe	**2. In lower lobe**
a. Apical	a. Apical
b. Anterior basal	b. Anterior basal
c. Lateral basal	c. Lateral basal
d. Posterior basal	d. Posterior basal
e. Medial basal	e. Medial basal

The above mentioned human tracheobronchial pattern is described by standard text books.

When compared to the pattern in sheep we notice that the only difference is in the extra lobe that is observed on the right side. The division of the two principal bronchi follow a common pattern in both, with equal number of secondary and tertiary bronchi.

Bronchopulmonary Segments: (Sheep Lung)

1. Left Apical
2. Left Posterior
3. Left Anterior
4, 5. Superior & Inferior Lingular
6. Left Apical
7. Left Medical Basal
8. Left Anterior Basal
9. Left Lateral Basal
10. Left Posterior Basal
11. Right Superior Lobar
12. Right Middle Lobar
13. Right Anteromedial Basal
14. Right Lateral Basal
15. Right Apical
16. Right Posterior Basal
17. Right Additional Bronchus

17a, 17b- Its two branches

The division pattern in the luminal cast is shown in figure 2.

This brancing pattern similarity between the two species makes the sheep lung an ideal experimental model to study human airway diseases and effect of medication on diseases like asthma (Els N. Meeusen et al, 2009) [3].

Plastination is widely used to preserve anatomical specimens. Luminal plastination and other corrosion cast techniques are used by several anatomists to prepare vascular, gastrointestinal and tracheobronchial casts.

The production of a tracheobronchial cast by injecting the trachea with ERTV silicone has been described by Lee. After the injection the trachea was allowed to cure for twenty four hours. The parenchyma was then removed by maceration and boiling and then bleached in a 10% solution of hydrogen peroxide. The result was an anatomical replica that illustrated the branching pattern of the tracheobronchial tree [4].

Narat et al have provided an insight into the history of preparation of corrosion casts. Their article states that Swammerdam (1670) is believed to be the inventor of the technique of solidifying injected specimens. The article also recollects the contributions of several others involved in preparation of corrosion casts. Frederick Ruysch (1653-1731), Boyle, Pecquet, Leiberkuhn (1748), Hyrtl (1860), Schiefferdecker (1882), Huntington (1897) are a few eminent anatomists who prepared casts by different techniques. Govard Bidloo (1685) was perhaps the first to inject lungs with a complex alloy of bismuth and mercury. In 1906-1907 Robinson prepared paraffin casts of ureteral calyces [5].

The preparation of vascular casts using vinylite resins as injection agents has been demonstrated by Puckett et al. The casts produced are durable, rigid and most valuable in demonstrating vascular channels in anatomy classes. A cast of entire vascular system of cat has also been successfully prepared using vinylite resin and can be displayed in anatomy museums [6].

Silva et al have described a technique for the study of vascular anatomy of the liver by injection & erosion methods. The vascular anatomy of liver of rat was demonstrated by injecting a solution of acrylic into the portal vein and inferior vena cava. The surrounding soft tissues were then eroded using hydrochloric acid. A vascular cast of liver vasculature was thus prepared [7].

Dequeurce et al have stated that Honore' Fragonard the eminent French anatomist had prepared several dry anatomical specimens between 1766 and 1771 that have miraculously survived till today. In the eighteenth century most of the French anatomists injected the vascular system with a coloured mixture of wax, animal fat and plant resins and the body was dehydrated by immersion in a bath of alcohol. However the procedure of the classical technique was not revealed by Honore' Fragonard [8].

CONCLUSION

Plastination is a good replacement for formalin as a preservative as there are no health hazards and solves several ethical and religious issues regarding dissection of dead bodies in some countries. The technique can also be used to prepare luminal casts, sheet plastinated specimens that are comparable to C-T Scans and whole organ plastinations. These specimens can be handled with bare hands without side-effects like contact dermatitis and conjunctivitis. These specimens are also odourless and easy to preserve in contrast to formalin fixed specimens. The luminal casts of gastrointestinal system and tracheobronchial system, if well prepared can be used to practice endoscopic procedures as well. The knowledge of the comparative anatomy of tracheobronchial tree is very useful as patterns that closely resemble human pattern are useful in therapeutic research.

Conflicts of Interests: **None**

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