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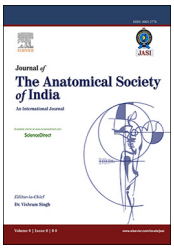

Original Article

Preparation of low cost bronchopulmonary airway cast☆

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ABSTRACT

Introduction: The study of tracheo-bronchial branching pattern and formation of bronchopulmonary segments is of great importance in understanding lung anatomy and physiology. While teaching this subject to first year medical students, teachers often take help of atlases and digital images. Preparation of a cast of tracheo-bronchial airways would be of great help to make the students understand the three-dimensional branching and relation between various segments of lungs and thus to better understand pulmonary anatomy.

Materials and methods: This article discusses a simple and very low cost method of preparation of bronchopulmonary airway cast by using LAPOX™ Epoxy resin and a goat lung which are comparatively cheaper and easily available.

Results and conclusion: Many different methods and materials are described in textbooks for the preparation of tracheo-bronchial casts. This method can be employed in institutes where major funding for better advanced methods are unavailable or for students themselves as a method of self-study.

1. Introduction

The understanding of the internal anatomy of lungs, the branching pattern of the tracheo-bronchial tree and the formation of bronchopulmonary segments is of great importance in medical and surgical management of lung disorders. Students of first year medical school often find the subject a matter of difficulty to understand and comprehend because they fail to visualize the three-dimensional anatomy of the internal structure of the lungs from either the textual descriptions given in the books or the two-dimensional images used as teaching aids or from digital images. The best way to demonstrate the intricate branching pattern of the bronchial tree is by means of three-dimensional models of the airways. It is a fact that when students themselves undertake practical methods and prepare for themselves, they tend to get keener interest and also better understand the subject they study. Thus, if it is possible to prepare a solid cast of the airways in their own dissection lab, the students would better appreciate the subject. It was with this aim that an attempt was made to try a simple and very cost-effective method to prepare a cast of the bronchopulmonary airways in our dissection lab. The following factors were kept in mind in conceiving the idea:

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(a) The procedure must be very cost-effective, so that even individual students could carry out the entire procedure from their pocket expense.
(b) It must be very simple and not involving any harmful or dangerous chemicals, thus being safe.
(c) The final product achieved must be durable, easily obtainable and give the exact replica of the hollow of the organ, thus giving a three-dimensional solid model.

Since the size of the bronchioles continuously diminish as the division progresses, and the material that is used to fill the tracheo-bronchial tree is too viscous, it would fail to reach the alveoli. Also, the material used must be such that while injecting it must be a liquid with low viscosity and should solidify over time and also after hardening, when the living tissue is destroyed away, the remaining cast obtained must be solid, resilient and not brittle. Thus, with these factors in consideration, a trial to prepare a cast of tracheo-bronchial tree was made using epoxy resin, a material available in general hardware shops, which is used as a household adhesive agent.

2. Materials and methods

(1) LAPOX^{TM} Epoxy resin – cheaper variant of araldite, comes in combination of resin (250 mg) and hardener (200 mg), costing approximately Rs. 200.
(2) Fresh human or animal lung. Generally due to unavailability of human organ in fresh state, this trial was undertaken on freshly obtained goat lungs. The organ, being generally not used as meat, is easily available at throwaway rate from meat shops.
(3) Plastic disposable syringe of 50 ml capacity.
(4) Vessels and spatula.

The technique of resin corrosion cast is nothing new to the anatomical fraternity. But the aim of this attempt was to try the feasibility of using household materials, which are also cost-effective so that even students of undergraduate or pre-graduation can prepare them in their not so equipped laboratories. The casting material is a colourless liquid resin, which on mixing with a hardener solution that comes along with it, solidifies in variable time, based on the proportion of the resin and hardener. Thus, the lesser the proportion of hardener, the more is the time required for hardening. In this case, the hardener is more viscous than the resin and thus the lesser the proportion of hardener, thinner would be the injectable material and thus more would it penetrate the tracheo-bronchial airway. But inversely, the time taken for it to solidify would also be proportionately more than the one with greater proportion of hardener. The reaction between resin and hardener is mildly exothermic.

3. Procedure

3.1. *Stage I: preparation of organ*

The organ was repeatedly washed in forcefully running water and inflating the lung with water from hose at pressure so that the lung got filled with water and then pressed to remove the water, thus cleaning the airways. No fixation of organ in formalin or dehydration using spirit or acetone was done. The washing was repeated 6–8 times so that the frothy materials and blood in the airways was removed and the organ cleaned.

Water collected in the organ was removed to the maximum possible extent by squeezing the organ. Just before filling, the organ was inflated with air to the fullest extent and allowed to deflate.

3.2. *Stage II: preparation of resin for injection into trachea*

The two parts of LAPOX^{TM} epoxy resin were mixed in a plastic vessel. Resin and hardener were mixed in a ratio of 1:1 and thoroughly stirred to get uniform mixture.

3.3. *Stage III: method of injection of resin into trachea*

The resin was forcefully injected into the trachea by means of plastic syringe (with needle removed) to the maximum possible extent that the organ filled up to the trachea. In this case, the organ was held in the hand. Weight of the organ was supported at the tracheal bifurcation and the top of the tracheal tube. About 400 ml resin was filled and the organ was suspended in air from a string tied at the top of the trachea overnight. During the procedure, the filling of alveolar spaces in polygonal shape can be observed with the naked eye. It can be observed that all the lobes fill up including the apical region. The organ was inverted in between to fill the apical region and the resin was mildly pushed down the trachea with the hands and the trachea tapered with fingers frequently to facilitate the downward flow of resin.

(Alternately, the organ can also be immersed in water with trachea held outside by means of artery forceps and the resin filled slowly through the trachea by gravitational method. The resin dropped into the trachea would fill the organ from below upwards. The lungs, which initially float over the water, by the time it gets filled, would start sinking to the bottom. The top part of the trachea needs to be clamped with the artery forceps to prevent temporary back flow if the organ overturned. Total procedure takes about 1 h.)

3.4. *Stage IV: destruction or corroding of the lung tissue to obtain the cast*

Specimen was immersed in dilute nitric acid the next day and washed in running water and kept in a water bath for decomposition. Natural decomposition occurred in 5–6 days and the tissues were washed off in running water leaving the cast of the airways. Specimen can also be kept for natural decomposition and after some degree, treated with concentrated potassium hydroxide for slow alkali corrosion.

3.5. *Precautions*

During the procedure, following precautions are to be taken care of:

(a) Always use gloves to protect hands from direct contact with resin and to protect hands from exposure to infections from the organ during the entire procedure.