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Cost-Effective Anatomical Models: Utilizing Grapevine Branches to Replicate Bronchial Structures for Enhanced Anatomy Education

Modelos Anatómicos Rentables: Utilización de Ramas de Vid para Replicar las Estructuras Bronquiales y Mejorar la Enseñanza de la Anatomía

Sang Kyu Park[1] & Dongsun Shin[2]

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SUMMARY: In anatomy education, understanding the intricate structure of the bronchial tree is crucial but often hampered by the high cost of traditional anatomical models. This study introduces an innovative, cost-effective alternative using grapevine branches to replicate the bronchial structures. The natural branching patterns of grapevines closely resemble human bronchi, making them an ideal material for creating detailed anatomical models. The methodology involved selecting, preparing, and shaping grapevine branches to accurately represent the main and lobar bronchi of the lungs. The resulting model not only offers a hands-on learning experience but also enhances visual and tactile understanding of bronchial anatomy. Preliminary evaluations suggest that this model could significantly reduce educational costs while maintaining or even improving the quality of anatomy education. Further research is needed to assess its educational effectiveness across different learner groups and its applicability to other anatomical structures. This approach holds promise for increasing the accessibility of high-quality anatomy education in resource-limited settings.

KEY WORDS: Grapevine branches; Bronchial models; Anatomy education; Cost-effective models; Pulmonary anatomy; Educational tools; Anatomical structures.

INTRODUCTION

In anatomy education, pulmonary anatomy occupies a critical role, particularly in aiding students' comprehension of the complex bronchial structures. The bronchial tree is highly intricate, featuring numerous branches and subdivisions that require precise models for accurate understanding. However, traditional bronchial models are costly to produce, posing a significant economic burden on educational institutions and students. To address this issue, we have developed a low-cost bronchial model using grapevine branches.

This research proposes a method for creating bronchial models using grapevine branches to facilitate students' understanding of pulmonary anatomy. The natural branching structure of grapevines closely resembles the bronchial tree, making them effective educational tools. Grapevines inherently possess complex branching patterns, making them suitable for use in bronchial models. By appropriately processing and arranging grapevine branches of various sizes and shapes, we can effectively replicate the actual bronchial structures. Additionally, grapevines are readily available and cost-effective, offering significant advantages in terms of affordability.

Anatomical models play a crucial role in enhancing anatomy education by providing three-dimensional representations of complex structures. Low-fidelity models, despite their simplicity, can effectively teach spatial relationships and anatomical reasoning (Chan & Cheng, 2011). These models can be cost-effective and durable alternatives to expensive commercial options (Nath *et al*., 2021). Creating anatomical casts, such as bronchial tree models, promotes constructivist learning and scientific reasoning among students (Hermiz *et al*., 2011). While low-fidelity models may not closely resemble human anatomy, they serve as valuable memory aids, reduce cognitive overload, and facilitate problem-solving (Chan & Cheng, 2011).

[1] Department of Emergency Medical Technology, Gachon University of College of Health Science, Incheon, Republic of Korea.
[2] Department of IT Design, Sehan University, Dangjin, Republic of Korea.
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The objectives of this study are as follows: To develop a low-cost bronchial model using grapevine branches, thereby reducing the economic burden of anatomy education. To assist students in intuitively understanding the complex bronchial structures through these models. To evaluate the educational effectiveness of these models in order to improve the quality of anatomy education. In conclusion, the bronchial model using grapevine branches has the potential to bring significant innovation to anatomy education.

It not only reduces costs but also enhances students' ability to understand the complex structures of the human body more intuitively, thereby improving overall educational outcomes. Through such research and efforts, we aim to increase the accessibility of anatomy education and contribute to creating an environment where more students can receive high-quality education.

MATERIAL AND METHOD

Selection and Preparation of Grapevine Branches. The initial step in the methodology involved the selection and preparation of grapevine branches (Figs. 1. A, B). Branches were chosen based on their size and thickness, with priority given to those exhibiting complex branching structures and a variety of sizes and shapes. The selected branches were thoroughly cleaned and allowed to air dry naturally (Fig. 1. B). The drying process contributed to the rigidity of the branches, facilitating easier manipulation in subsequent steps.

Cutting and Shaping of Branches. Following the preparation, the branches were cut and shaped according to the desired specifications (Fig. 1. B). Sharp scissors were utilized to trim the grapevine branches to the appropriate size and shape, with careful consideration of the main branching points and detailed structures of the bronchi (Fig. 1. B). The cut branches were then systematically arranged to form a bronchial model (Fig. 1. C). Each branch was positioned to replicate the bronchial structure of the lungs as accurately as possible (Fig. 1. C). This assembly process did not involve the use of adhesives or additional materials, only the trimmed branches were employed to construct the model.

Review and Final Adjustments of the Model. Upon completion of the assembly, the bronchial model was meticulously reviewed to ensure that its structure and shape closely resembled that of actual bronchi (Fig. 1. C). Any necessary adjustments were made to enhance the model's accuracy. Once finalized, the model was prepared for use in educational settings (Fig. 1. C).

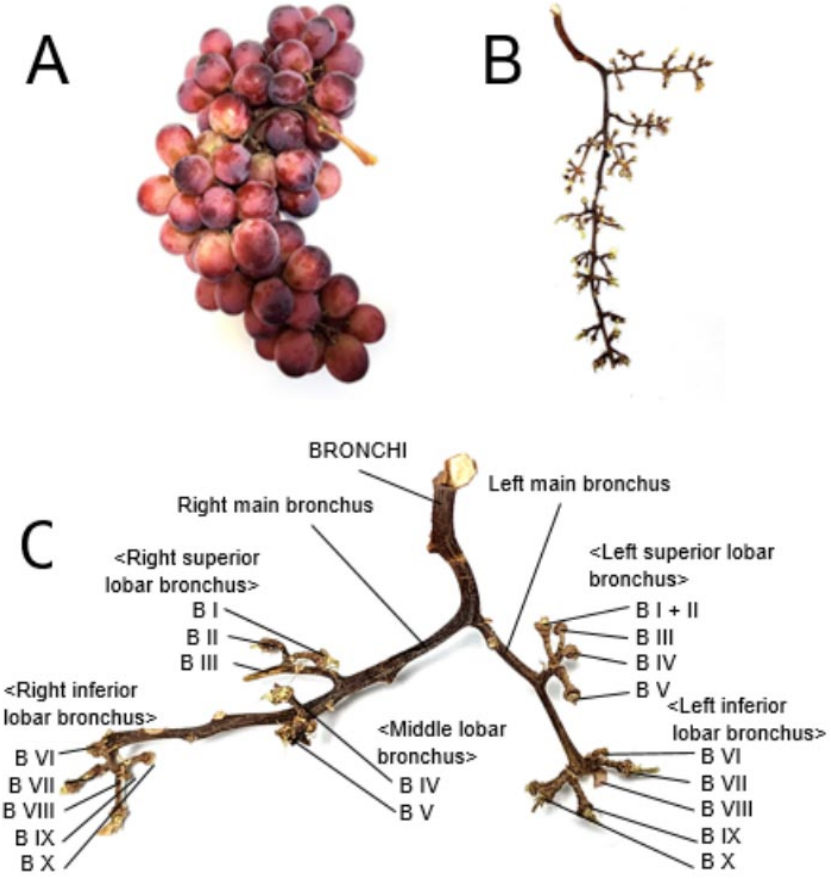

Fig. 1. A. Preparation of Grapevine This figure shows the prepared grapevine used to create the bronchial model. The grape clusters possess natural branching structures, making them suitable materials for mimicking the bronchial structure of the lungs. B. Grape Branches Only This figure displays the state of the grapevine after removing the fruits, leaving only the branches. The branching structure of the vine is very similar to the bronchial tree of the lungs, making it appropriate for use as an anatomical model. C. Bronchial Model Using Grapevine Branches This figure illustrates the bronchial model of the lung constructed using grapevine branches. The natural branching structure of the grapevine effectively mimics the bronchial structure of the lungs. The model includes several key structures: the right main bronchus represented by a branch showing the right main bronchus, the left main bronchus by a branch showing the left main bronchus, the right superior lobar bronchus by a branch dividing into B I, B II, and B III, the right inferior lobar bronchus by a branch dividing into B VI, B VII, B VIII, B IX, and B X, the middle lobar bronchus by a branch dividing into B IV and B V, the left superior lobar bronchus by a branch dividing into B I+II, B III, B IV, and B V, and the left inferior lobar bronchus by a branch dividing into B VI, B VII, B VIII, B IX, and B X.

RESULTS

In this research, we created a bronchial model of the lung using grapevine branches. The constructed model closely resembles the actual bronchial structure, successfully replicating various detailed structures.

First, we utilized one of the main branches of the grapevine to recreate the right main bronchus and another main branch to construct the left main bronchus (Fig. 1. C). The right main bronchus included the branching structure of the right superior lobar bronchus, which divides into B I, B II, and B III. The right inferior lobar bronchus was further subdivided into B VI, B VII, B VIII, B IX, and B X. Additionally, the middle lobar bronchus was accurately represented by branching into B IV and B V (Fig. 1. C).

On the left side, the left superior lobar bronchus was divided into B I + II, B III, B IV, and B V. The left inferior lobar bronchus included the branching structures of B VI, B VII, B VIII, B IX, and B X (Fig. 1. C).

By leveraging the natural branching structure of grapevine branches, we were able to faithfully replicate the complex form of the actual bronchi. This model demonstrated significant potential in aiding students to intuitively understand the anatomical structure of the lungs. Furthermore, the model proved to be cost-effective to produce, highlighting its potential for economical use in educational settings.

DISCUSSION

The bronchial model developed using grapevine branches in this study has demonstrated its effectiveness in replicating the actual bronchial structure, providing substantial benefits for anatomy education. This model, crafted by cutting grapevine branches with scissors, is highly cost-effective. Traditional plastic anatomical models are expensive, and 3D models fail to provide a tactile experience. In contrast, the grapevine branch model is inexpensive and offers students a hands-on experience that closely simulates real structures, enhancing their learning experience. This model presents an excellent alternative to costly models, offering more students the opportunity to receive high-quality anatomy education.

Furthermore, the grapevine model can be expanded using adhesive to add branches, enabling the reproduction of more intricate bronchial structures. This allows students to learn more detailed and precise bronchial anatomy. Additionally, the model can be enhanced with coloring to improve visual understanding. Coloring can recreate the diverse colors and shapes of the actual bronchi, thereby increasing learners' comprehension.

The grapevine model significantly enhances both visual and tactile learning. Students can handle and manipulate the model, gaining experiential understanding of the bronchial structure and form. Such tactile learning strengthens memory and comprehension, facilitating more effective anatomy education. Recent studies highlight the effectiveness of tactile and visual learning in anatomy education. Clay modeling has been shown to significantly enhance mental representation of anatomical structures, particularly improving spatial comprehension and textural discernment (Yachou *et al*., 2024). Similarly, creating anatomical casts promotes constructivist learning, encouraging inquiry-based and problem-solving activities (Hermiz *et al*., 2011). A web-based 3D lung anatomy learning environment utilizing gamification techniques has been developed to improve understanding of complex structures like the bronchial tree (Vagg *et al*., 2016). Furthermore, a haptico-visual observation and drawing method has demonstrated improved cognitive understanding and memorization of 3D anatomical forms, with participants reporting the development of a "mental picture" as central to deep learning (Reid *et al*., 2019). These multisensory approaches, incorporating tactile experiences and visual aids, have been found to strengthen memory, comprehension, and overall effectiveness in anatomy education.

Alongside economic efficiency, the grapevine model offers various educational advantages. It can be produced at a low cost, reducing the financial burden on educational institutions while providing more students with the opportunity to learn anatomy. This is particularly useful for institutions with limited budgets.

Using everyday objects like grapevine branches to explain complex anatomical concepts increases learning accessibility. Familiar materials help students easily grasp complex structures and enhance their interest in learning. The branching process of grapevine branches is also analogous to the bronchial branching process, which can aid in understanding developmental biology. Bronchi undergo multiple branching and growth stages during development, similar to grapevine growth. This similarity helps students understand the developmental processes of the bronchi more easily, using grapevine branches to metaphorically explain the complex developmental mechanisms of the bronchi.

Moreover, the grapevine model has potential applications beyond bronchial anatomy. For example, the shape of tree branches can be adapted to create models of

vascular or neural structures. This versatility expands the scope of anatomy education and provides opportunities for diverse learning tools. Grapevine branches' natural branching and form can effectively mimic vascular and lymphatic structures, explaining the branching structures of major arteries and veins. They can also visually represent major neural branching structures, useful for explaining peripheral nervous system branching and connections. Recent studies have explored innovative approaches to teaching branching anatomical structures. Mattingly *et al*. (2015), developed a 3D modeling tool for creating interactive, anatomically accurate representations of branching structures, such as retinal cells. Franchi (2021) proposed using pipe cleaners as a low-cost, versatile tool for teaching vascular anatomy. Hermiz *et al*. (2011), described a constructivist learning activity where students create anatomical casts of rat bronchial trees and coronary arteries using Silastic® sealant. Petersson *et al*. (2009), introduced a web-based virtual reality technique using "virtual contrast injection" to create 3D vascular models from medical imaging data. This method was integrated into an Educational Virtual Anatomy program, which students found beneficial compared to traditional textbooks. These diverse approaches demonstrate the potential for innovative tools and methods to enhance anatomy education, particularly for complex branching structures like vascular and respiratory systems.

CONCLUSION

The grapevine bronchial model is an economical and practical educational tool that can enhance the quality of anatomy education. Further evaluation and improvement of this model's educational effectiveness are necessary to explore its application as a learning tool for various anatomical structures. This can improve the accessibility of anatomy education and contribute to creating an environment where more students receive high-quality education.

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RESUMEN: En la enseñanza de la anatomía, comprender la intrincada estructura del árbol bronquial es crucial, pero a menudo se ve obstaculizado por el elevado costo de los modelos anatómicos tradicionales. Este estudio presenta una alternativa innovadora y rentable que utiliza ramas de vid para replicar las estructuras bronquiales. Los patrones naturales de ramificación de las vides se asemejan mucho a los bronquios humanos, lo que las convierte en un material ideal para crear modelos anatómicos detallados. La metodología consistió en seleccionar, preparar y dar forma a las ramas de vid para representar con precisión los bronquios principales y lobulares de los pulmones. El modelo resultante no solo ofrece una experiencia de aprendizaje práctica, sino que también mejora la comprensión visual y táctil de la anatomía bronquial. Las evaluaciones preliminares sugieren que este modelo podría reducir significativamente los costos educativos, manteniendo o incluso mejorando la calidad de la enseñanza de la anatomía. Se necesita más investigación para evaluar su eficacia educativa en diferentes grupos de estudiantes y su aplicabilidad a otras estructuras anatómicas. Este enfoque promete aumentar la accesibilidad a una educación anatómica de alta calidad en entornos con recursos limitados.

PALABRAS CLAVE: Ramas de la vid; Modelos bronquiales; Educación anatómica; Modelos rentables; Anatomía pulmonar; Herramientas educativas; Estructuras. anatómicas.

REFERENCES

Chan, L. K. & Cheng, M. M. W. An analysis of the educational value of low-fidelity anatomy models as external representations. *Anat. Sci. Educ., 4(5)*:256-63, 2011.

Franchi, T. Pipe cleaners as a low-cost and versatile educational tool for teaching vascular anatomy. *Med. Sci. Educ., 31(2)*:309-11, 2021.

Hermiz, D. J.; O'Sullivan, D. J.; Lujan, H. L. & DiCarlo, S. E. Constructivist learning of anatomy: gaining knowledge by creating anatomical casts. *Anat. Sci. Educ., 4(2)*:98-104, 2011.

Mattingly, W. A.; Chariker, J. H.; Paris, R.; Chang, D. J. & Pani, J. R. 3D modeling of branching structures for anatomical instruction. *J. Vis. Lang. Comput., 29*:54-62, 2015.

Nath, S.; Anuradha, B. & Dilip, B. A study on making models in anatomy. *PARIPEX Indian J. Res., 10(6)*:85-7, 2021.

Petersson, H.; Sinkvist, D.; Wang, C. & Smedby, O. Web-based interactive 3D visualization as a tool for improved anatomy learning. *Anat. Sci. Educ., 2(2)*:61-8, 2009.

Reid, S.; Shapiro, L. & Louw, G. How Haptics and Drawing Enhance the Learning of Anatomy. *Anat. Sci. Educ., 12(2)*:164-72, 2019.

Vagg, T.; Ronan, N.; Plant, B.; Eustace, J. & Tabirca, S. A Web-Based 3D *Lung Anatomy Learning Environment Using Gamification*. Conference. Bucharest, The 12th International Scientific Conference eLearning and Software for Education, 2016.

Yachou, Y.; Samson, O. & Lasvergnas, O. Prospective comparative study on enhancing geometrical mental representation and anatomical learning in medical students through modeling clay as an assessment tool. *Anat. Sci. Educ., 17(4)*:779-95, 2024.

Corresponding author:
Dongsun Shin
Department of IT Design
Sehan University
Dangjin
REPUBLIC OF KOREA

E-mail: sdssoft@gmail.com