

# Appropriate Concentration of Glycerin Solution for the Preservation of Fresh Cadaveric Vessels to be Used in Surgical Training: A Preliminary Study

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## Abstract

**Background:** Training neurosurgeons on cadaveric blood vessels poses challenges in maintaining lifelike tissue properties for realistic surgical practice. This study aimed to determine the optimal glycerin concentration for preserving fresh cadaveric arteries while retaining flexibility, consistency, color, and fragility resembling living vessels.

**Methods:** Arterial vessels from two human placentas were harvested, trimmed to  $\geq 5$  cm lengths, and divided into five groups of three arteries each. The groups were embalmed in glycerin solutions of 3%, 10%, 20%, 40%, and 60% concentrations, respectively. After two years frozen at  $-20^{\circ}\text{C}$  and two days at  $5^{\circ}\text{C}$  for slow thawing, the preserved arteries were evaluated by seven neurosurgeons. They performed cutting, suturing, and repair procedures, then rated satisfaction levels across tissue elasticity, handling, consistency, smell, color, fragility, realism, and overall quality.

**Results:** The arteries embalmed in 40% glycerin solution received the highest overall satisfaction ratings from surgeons.

**Conclusions:** A 40% glycerin solution proved most appropriate for preserving placental arteries to achieve lifelike characteristics for neurosurgical training purposes. Further studies using human cadaveric arteries and varying storage durations are warranted.

**Key Words:** Concentration glycerin; Preservation; Fresh cadaver; vessels

## บทคัดย่อ

**หลักการและความเป็นมา:** การฝึกทักษะการผ่าตัดของประสาทศัลยแพทย์ในหลอดเลือดของร่างกายมนุษย์ มีความท้าทายในการรักษาคุณสมบัติของเนื้อเยื่อให้เหมือนจริงสำหรับการฝึก การศึกษา นี้จึงมีวัตถุประสงค์เพื่อหาความเหมาะสมของความเข้มข้นของกลีเซอรินสำหรับการนำมารักษาสภาพหลอดเลือดของร่างกายมนุษย์ให้รักษาความยืดหยุ่น ความสม่ำเสมอ สี และความประาะบางที่คล้ายกับหลอดเลือดที่มีชีวิตจริง

**วิธีการ:** นำหลอดเลือดจากทารกมนุษย์สองชิ้น ตัดเอาหลอดเลือดแดงที่มีความยาวมากกว่าหรือเท่ากับ 5 เซนติเมตรรวม 15 เส้น และแบ่งเป็นกลุ่มห้ากลุ่ม โดยมีหลอดเลือดสามเส้นในแต่ละกลุ่ม ซึ่งนำไปเก็บไว้ในกลีเซอรินความเข้มข้น 3%, 10%, 20%, 40%, และ 60% ตามลำดับ หลังจากสองปีที่ถูกแช่แข็งที่  $-20^{\circ}\text{C}$  และนำออกมารดอุณหภูมิที่  $5^{\circ}\text{C}$  เป็นเวลาสองวัน เพื่อให้เกิดการละลายอ่อนตัวอย่างค่อยเป็นค่อยไป และนำหลอดเลือดที่ถูกแช่ไปประเมินโดยประสาทศัลยแพทย์เจ็ตคัน เพื่อประเมินในดำเนินการตัด เย็บ และซ่อมแซม แล้วให้คำแนะนำระดับความพึงพอใจในด้านความยืดหยุ่นของเนื้อเยื่อ การจัดการ ความสม่ำเสมอ กลิ่น สี ความประาะบาง ความเป็นจริง และคุณภาพโดยรวม

**ผลลัพธ์:** หลอดเลือดที่ถูกแช่ในกลีเซอรินความเข้มข้น 40% ได้รับคะแนนความพึงพอใจรวมสูงสุดจากประสาทศัลยแพทย์

**สรุป:** สารละลายกลีเซอรินความเข้มข้น 40% มีความเหมาะสมที่สุดสำหรับการรักษาสภาพหลอดเลือดที่นำมาจากร่างกายมนุษย์ เพื่อให้ได้คุณลักษณะที่เหมือนจริงสำหรับการฝึกทักษะในการทำหัตถการทางประสาทศัลยกรรม การศึกษาเพิ่มเติมโดยใช้หลอดเลือดจากร่างกายมนุษย์และระยะเวลาการเก็บรักษาที่แตกต่างกันควรได้รับการศึกษาพัฒนาเพิ่มเติมในอนาคต

## Introduction

In Thailand, most of them are Buddhists<sup>1</sup>, where bodies are donated to be a cadaver for use. Residents and medical students receive a great deal of training in surgical practices. Nowadays, the training of neurosurgeons using the cadaver has greatly increased due to the increased safety of the treatment.<sup>2</sup> Neurosurgery, especially on arteries, is currently on the rise and is a necessary procedure especially for connecting blood vessels together in the world of cerebral aneurysms and chronic ischemic stroke such as Moyamoya's vessels disease.<sup>2</sup> Preparing arteries

realistically for use in surgical practice and suturing practice requires it to have the most realistic toughness and flexibility characteristics. In order for the preserved arteries from the cadaver to remain fresh, flexible, and realistic in size, it was necessary to keep the preserved arteries moisturized as close to reality as possible and to be able to preserve them without decay. Placing blood vessels in freezing temperatures causes the cells in the blood vessels to break down and lose their elasticity.<sup>3</sup>

Glycerin is a substance used to retain moisture, especially in skin cosmetics to reduce water loss from

the skin. It is usually a component of 60–70% of body lotions. Some studies have found that glycerin mixed with water at a ratio of approximately 2 to 1 can lower the freezing point of the solution as low as -40 degrees Celsius that stop the bacterial growth.<sup>4</sup> The glycerin solution is a solution that can maintain the moisture of the tissue and can make the temperature of the solution in the embalmed process have a very negative freezing point, so that the cells will not break down even if the temperature is negative, 5 which is the appropriate temperature, that will prevent microorganisms from growing.<sup>4</sup> The research studied to determine the appropriate concentration of glycerin solution for embalmed vascular tissue from cadaver for preservation in neurosurgery training.

## Material and Method

The human placenta is the leftover specimen after birth. It is easily found in hospital as leftover

specimen. This research uses two placenta tissues. The vessels were dissected to harvest the arterial vessels. The arterial from the placenta was trimmed and found 15 strands with a size of not less than 5 centimeters in length. The arteries were divided into 5 groups of 3 each and then embalmed in different solutions with glycerin concentrations of 3%, 10%, 20%, 40% and 60% respectively (Table 1). The arteries in the 5 bottoms of solution were then placed in a freezer at -20 °C for two years, then placed at 5 °C for 2 days to slowly increase the temperature from -20 Celsius to 5 Celsius. The results were given to seven neurosurgeons to test and practice arterial cutting and suturing and repairing and to rate their satisfaction in various aspects as follows: tissue elasticity, tissue handling, tissue consistency, smelling, color, tissue fragility, reality, overall satisfied score (Figure 1).

**Table 1** Summary of Glycerin concentrations with satisfaction of parameters

Parameter	Group 1	Group 2	Group 3	Group 4	Group 5
Glycerin concentration	2%	10%	20%	40%	60%
Tissue elasticity	2.3	3.8	4.5	5	5
Tissue handling	2.5	3.1	4.6	5	4.7
Tissue consistency	2	3.5	4.5	5	5
Smelling	3	3	5	5	5
Color	2	4	5	5	5
Tissue fragility	2.1	3.5	5	5	4.5
Reality	2.2	3.5	4.7	5	5
Others satisfied	2.3	3	4.7	5	5
Overall score	2.3	3.58	4.75	5	4.9

Note: Participant satisfactions (1=Not at all Satisfied, 2=Partly Satisfied, 3=Satisfied, 4=More than Satisfied, 5=Very Satisfied).



**Figure 1** The image shows the process of collecting placental blood vessel samples, immersing them in solutions of varying concentrations, and evaluating of their usability by neurosurgeons.

## Results

From a preliminary study of the satisfaction of the seven surgeons in those issue, it was found that they were most satisfied with the blood vessels embalmed in the 40% concentration glycerin solution (Table 1).

## Discussion

In chemical science, when using 99% concentration glycerin solution, when the temperature drops to about 15 degrees Celsius, a semi-solid glycerin consistency is formed, which is not suitable for embalming, while 60% concentration glycerin solution in our research found as the same situation.<sup>6</sup> The

results of this study demonstrate that a 40% glycerol solution is an appropriate concentration for embalmed of blood vessels for use in neurosurgery practice that can maintain the condition of blood vessels to remain flexible, consistent, and have an odor and color similar to the real condition. Including the fragility of the tissues at an appropriate level. This is consistent with previous research that found that glycerin solutions help preserve tissue without coagulation.

However, this study has limitations in using placental blood vessels as a surrogate for human cadaveric blood vessels. They may be different from blood vessels from actual human cadavers used in surgery. In addition, the 2-year sampling period may

cause some changes in the properties of the blood vessels. Therefore, in the next study consider using real blood vessels from cadaver and test shorter retention periods or longer as desired. This preserving of cadaveric blood vessels can increasing opportunities for residency training practice, result in higher skills and expertise.<sup>7,10</sup> Leads to better quality medical services.<sup>8,9</sup>

## Conclusions

A 40% glycerin solution proved most appropriate for preserving placental arteries to achieve lifelike characteristics for neurosurgical training purposes. Further studies using human cadaveric arteries and varying storage durations are warranted.

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