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Original Research Article

Resin cast in situ: A technique to demonstrate the vasculature of the Nervous system: In Goat Model

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ABSTRACT

Background: As Anatomical education advances very rapidly, and at the same time, there is huge demand and scarcity of true biological models, mainly brain tissue. In this scenario, in 1977, Guther Von Hagens worked on plastics and experimented voraciously on diffusing various plastics into large specimens and ultimately succeeded and coined the term "Plastination". This technique is very popular in Western countries as the latter greatly minimizes the health hazards due to formalin exposure while dealing with biological tissue. In continuation with the advancement of expensive plastination to cost-effective resin casting, especially studies over the complex structures like the brain and spinal cord. In This study, we emphasize the cost-effective Resin cast-in-situ method to demonstrate the vasculature of the brain and spinal cord.

Materials and Methods: After obtaining the prior permission, we collected the Five (5) Goat heads from the slaughterhouse. Following the standard dissection procedure over the neck region, identified and canulated the major neck vessels. Through the vessels normal saline water, formalin, and pigmented resin were administered and preserved the goat head using routine preservation technique. After 36 to 48 hours, the routine dissection was scheduled to expose the brain and upper spinal cord segments, and finding were captured and recorded.

Results and Discussion: The specimens show good penetration of dye in the artery and veins, and it's easy to appreciate and study the vasculature of the brain and upper spinal cord segments, including the Bastons plexus of veins.

Conclusion: In comparison with regular silicon casting, resin casting is very cost-effective and long-lasting, with good penetration of the resin substance up to the capillary level. Furthermore, similar studies may be conducted using in combination with whole organ plastination using silicon and resin embedding.

KEYWORDS: Resin cast in situ, Brain Vasculature, Plastination, Silicon Casting.

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INTRODUCTION

In Quest for knowledge about the architecture of the human body, especially nervous, respiratory, and cardiac tissues. In the same process, Preservation and visualization of minute details of an organ play an important role in academics, diagnostic, medical, and surgical interventions, and research.

Furthermore, it can be used as an artistic display in museums and educational exhibitions. For many centuries scientists have tried to create effective and health-safe methods of conservation and long-lasting preservation with minute details like vasculature.

The toxicity of formalin is a major health concern. For reducing health hazards of formalin Dr. Guther Von Hagens, began experimenting with a new technique of preservation of specimens and filling the lumen with the opaque medium. He mentioned plastics and experimented voraciously on diffusing various plastics into large specimens and ultimately succeeded and coined the term "Plastination" in 1977 [1,2].

There are three types of plastination whole organ, sheet, and Luminal cast plastination. Luminal plastination can be used to enrich the knowledge of the internal structure of anatomy, which is of profound importance in the present era of advances in therapeutic science [3].

MATERIALS AND METHODS

The study was conducted in the Department of Anatomy, Sri Padmavathi Medical College for Women, SVIMS University, Tirupati, Andhra Pradesh, India. After taking the necessary approvals from the Department of Anatomy.

Specimen Collection: Five (05) fresh goat heads with long necks were procured from the slaughterhouse of SV Veterinary College, Tirupati, Andhra Pradesh; immediately after obtaining the specimen the neck vessels were identified, the neck vessels and heparin is injected to prevent any possible clots in the vessels.

We used Resin cast and hardener; 3 fresh goat heads with long necks were procured from the slaughterhouse.

Criteria to Choose Resin [4]

1. Easy to handle.

2. Transparent resin gel should be clear and of low viscosity.

3. Curing should not be inhibited by the presence of tissue.

4. After curing, it should have appropriate mechanical properties, i.e., Rubber–like- to simulate a natural state.

5. Should be affordable

Casting materials that were procured from the chemical suppliers:

1. Transparent resin gel with low viscosity

2. Resin gel hardeners

3. Pigment Colours (Blue and Red)

Based on the above criteria, we have chosen the chemical from the following manufacturers GLOSSEPOXY Resin and Hardener, Brand: GLOSSEPOXY, form CHEMZEST Enterprises, India, with specific Gravity 1.1 Grams per Cubic Centimetre, water resistance and Tensile Strength 100 PSI. Physical state: resin: low viscous liquid, hardener: low viscous liquid (2) color: clear (3) viscosity (@ 25 degrees C) resin: 1160 maps, hardener: 479 1160 maps (4) mixing ratio: 100: 60 (5) gel time (@ 25 degrees C): 30-45 min (6) set time: 1-2 hrs (7) drying time: 3-5 hrs.

Pigment Color: CHEMZEST Sep Pigments Set (Multicolour) from enterprises, India, used and added 2-4 drops with ink pillar.

Preparation of the Casting Materials: Based on the Chemical instructions normal working time after adding the harder to the resin liquid is about 15-20 Minutes. Hence, we prepared the Resin liquid just before administration of the same.

As per the vendor's instructions, a 10:1 ratio of the resin liquid and hardener was mixed; before adding the hardener, we added 4-5 drops of pigment substance to get the desired colors (Red and Blue).

Procedure

1. Fresh goat head and neck section, procured from the slaughterhouse of SV Veterinary University, Tirupati.

2. Administered the heparin injection through the major vessels of the neck to prevent any clotting of the blood.

3. Immediately specimen was preserved with a 10% formalin solution, and 10% formalin was also injected into the specimen to fix the nervous tissue and other adjacent tissues.

4. Again, administered the heparin injection through the major vessels of the neck to prevent any clotting of the blood.

5. After 3 hours the neck region is dissected following the manual of goat dissection and explored the internal jugular vein and common carotid artery on either side, and they were securely cannulated.

6. After cannulation with the use of the syringe, administered normal saline water into the internal jugular vein and common carotid artery, and the process was continued until clear water came out from the opposite side internal jugular vein and common carotid artery. (Repeated the same process on the other side also). This process is to confirm that the vascular lumens are clean and free from clot.

7. Immediately Injected 10% formalin solution into the internal jugular vein and common carotid artery till the excessive Injected 10% formalin has come out from the opposite side vessels.

8. Thereafter closed, the cannulas on either side to allow the diffusion of 10% formalin into the vessel walls and adjacent tissue.

9. After 15-20 Minutes, open the cannulas are opened to send air through an empty syringe; continued the process until we notice the air bubbles on the opposite side internal jugular vein and common carotid artery. Were noticed (Repeated the same process on the other side also)

10. Red-coloured resin is injected into the common carotid artery until the resin comes out through the opposite side common carotid artery. Similarly, we also injected the blue-colored resin into the internal jugular vein until the blue-colored resin came out through the opposite site internal jugular vein.

11. Closed the cannulas and left the specimen for 36-48 hours at room temperature to cure and solidify Silicone gel in the vessels.

12. Dissected the goat head following the standard dissection manual for goat brain removal, removed the goat brain with upper spinal segments and eyeballs with optic nerve if possible.

RESULTS

Immediately after separating the brain from the goat cranial cavity, it was preserved in 10% formalin to fix the nervous tissue; after 24 hours, removed the remains of dura mater (any) and used the specimen for vascular observations in comparison with the human brain.

Fig. 1: Cannula inserted in the neck vessels (CCA & IJV).

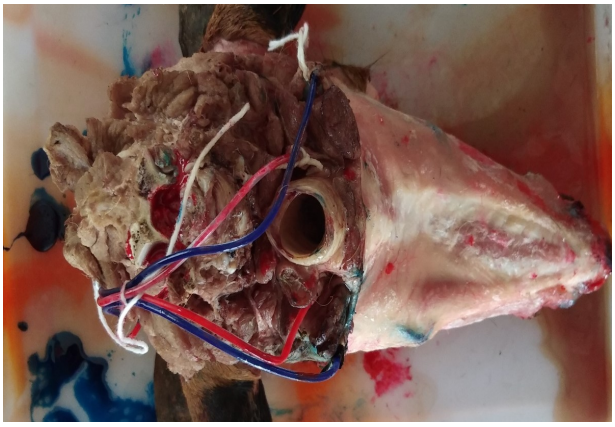

Fig.2: Resin casing with Dye (Blue and Red) injected through the cannula into the neck vessels and securely tied.

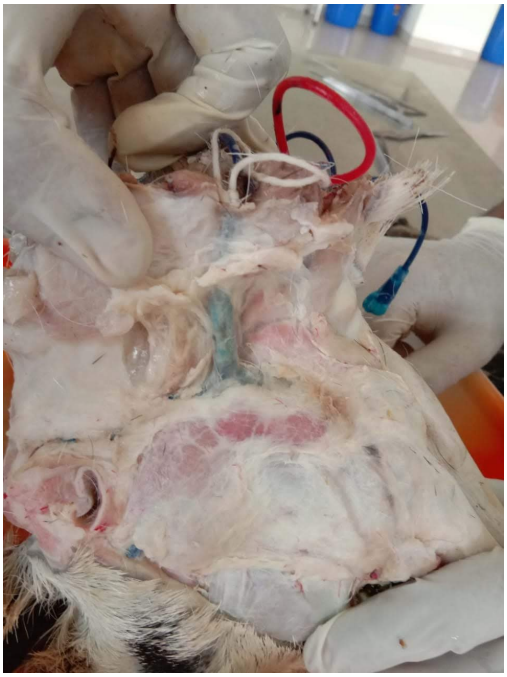

Fig. 3: After injection of resin through the cannula on either side, they were secured with thread and left the specimen at room temperature to cure.

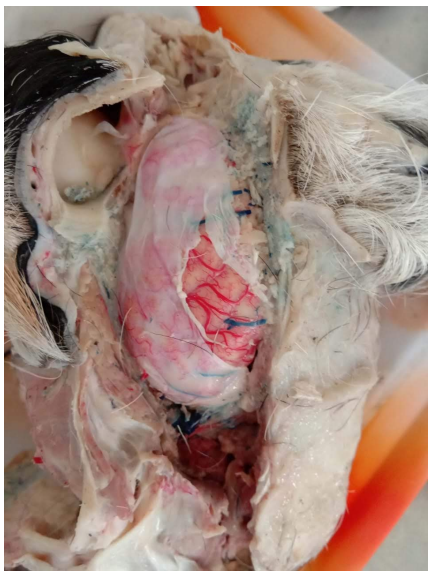

Fig. 4: In situ Brain and spinal cord with well-opacified cerebral Blood vessels (after removing half of the calvaria),

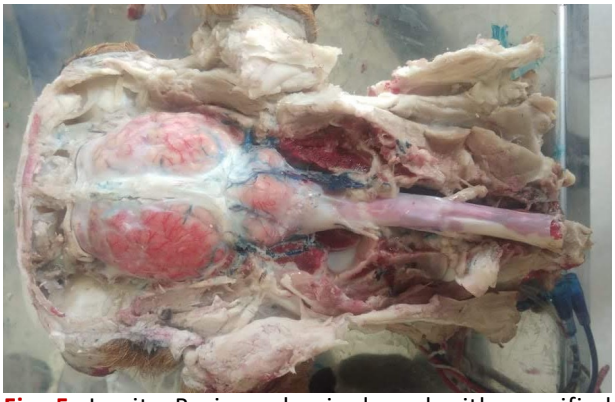

Fig. 5: In situ Brain and spinal cord with opacified cerebral Blood vessels (after removing the calvaria)

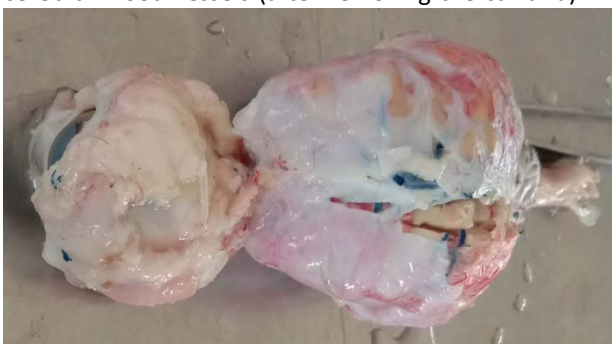

Fig. 6: Removed Brain with Dura mater and eyeball (with intact optic track)

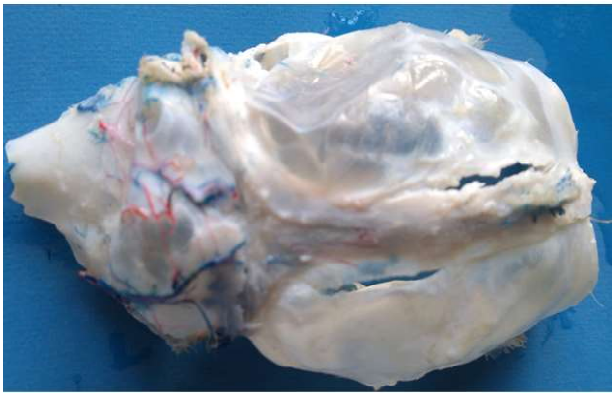

Fig. 7: Opacified blood vessels within the Dural folds.

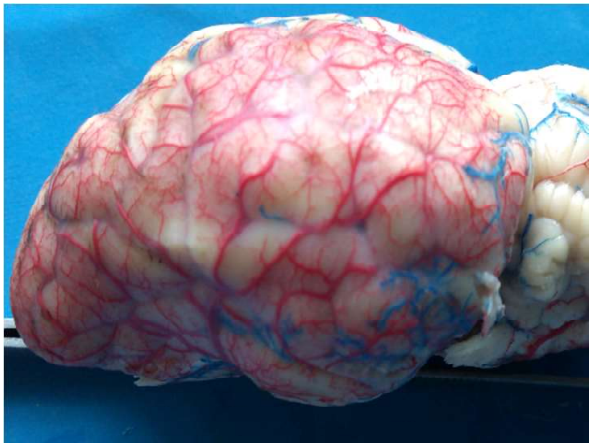

Fig. 8: Opacified cerebral arteries with their terminal branches at the lateral surface of Brain.

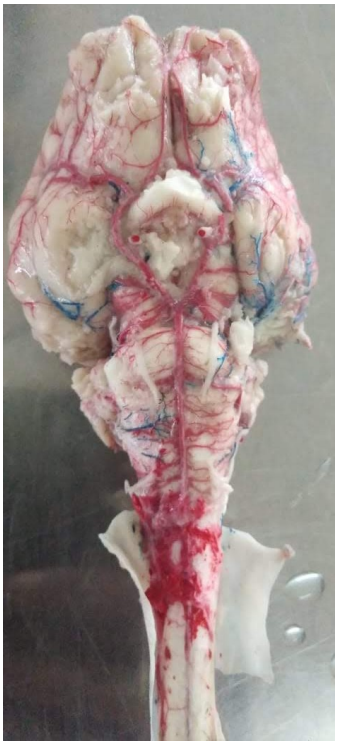

Fig. 9: Opacified cerebral blood vessels in the Base of the Brain (Circle of Willis)

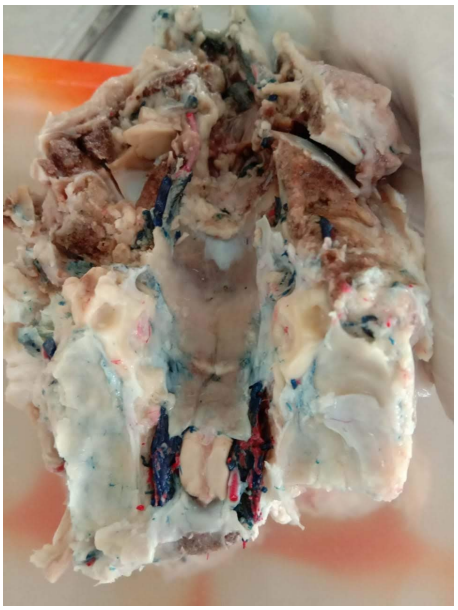

Fig. 10: Opacified Batson's plexus of the vein in the vertebral canal after removing the brain and spinal cord

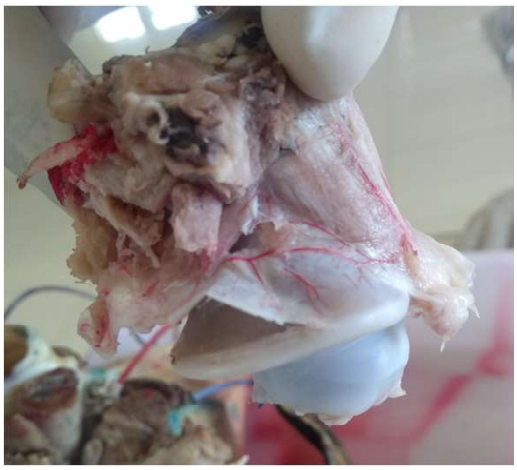

Fig. 11: Injected dye perfuse into the adjacent vessels through its collateral circulation (in the image: blood supply to the larynx)

DISCUSSION

Studying the vasculature of the nervous system using pigmented resin casting in situ prior to radiological and surgical interventions may have a great impact on accurate diagnosis and management.

A study by Parkinson Soubam et al. 2018 [3] concluded that goat heads could provide a convenient and suitable model for developing and refining vascular injection techniques required for preparing cadaveric human heads for microsurgical dissection.

Parkinson Soubam et al. 2018 stated that Silicon injection for the opacification of cranial vasculature enhances the visual impression and appreciation of the anatomical relationships during the dissection of human cadaver heads [3].

The technique of preparing these cadaver specimens can be mastered on the heads of freshly sacrificed goats, as these can be easily sourced, possess similar tissue characteristics, and are sufficiently inexpensive to permit repeated trial and error.

Our study used low-cost resin casting, which is very inexpensive and affordable to all while compared with Parkinson Soubam et al. 2018 [3]. Sanan A. et al. 1999 [5] studied using expensive silicon casting. Our study findings agree with the earlier researchers who worked on epoxy resin [6,7,8]

Disadvantages: The anatomy of the goat's brain is different from the human brain, and it may not contribute to understanding more about the human brain. However, the color, texture, and handling of the goat's brain are similar and advantageous to adopt the newer microsurgical dissection skills for residents and trainees in neurosurgery.

CONCLUSION

To adopt the newer techniques, it should be practiced and perfected over a biological model, which is inexpensive, easily available, and ethically permissible. A goat's head procured from the slaughterhouse fulfills all the requirements for such a biological model. The goat model offers an opportunity to test locally available polymers used in dye preparation, to standardize the procedure, which will aid in the smooth execution of silicon dyes in the cadaver model. In situ, casting has the advantage of zero to minimal leakage as there is no cut over the vessels in the selected system.

Opacified and resin-casted specimens are an excellent alternative to opacified and silicon casted specimens and aid in quick review before planning interventions. Easy to demonstrate the vasculature of the external and internal structures. Opacified vessels have a great future in all fields of medical and surgical interventional therapies, teaching, and research [6,7].

The same specimens we used to demonstrate to undergraduate medical students and kept in an exhibition at the regional science center and neurosurgery workshop and feedback was taken. They all appreciated and mentioned that it's very easy to form the concept to understand cerebral vasculature [6].

Author Contributions

Ravindra Kumar B: Concept and design of the study, acquiring the necessary specimen and study materials, Execution of the study protocol and recording the findings, interpreting the results, preparing the first draft of the manuscript, and critical revision of the manuscript.

K Thyagaraju: Designing the study, acquiring the necessary specimen and study materials, Execution of the study protocol and recording the findings, and comparing same with literature.

Subhadra Devi Velichety: Design of the study, study findings analysis, interpretation, preparation of the manuscript and revision of the manuscript.

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Conflicts of Interests: None

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