TECHNICAL REPORT

Technical notes for corrosion casting of a porcine heart

V. Veljanovski

St. Albans Campus, Victoria University, Australia

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OVERVIEW

To prepare a specimen for any resin cast injection requires pre-injection procedures to be completed. Selection of an appropriate specimen for the injection cast needs to be made to ensure the best results. Where possible it is recommended that fresh specimens are used (Cornillie et al 2019) to avoid issues with rigor mortis, post-mortem degradation of the vascular system, or if human tissue, pressure sores which can impact on how well the specimens will be perfused with the injection material.

The next step is dependent on the size and structural integrity of the blood vessels. If working on a large specimen or a specimen with only a small length of blood vessel exposed, an insertion of a cannula may be required. For example, a Foley catheter can be inserted into an artery and the balloon can be inflated to prevent the catheter sliding out of the artery or it can be inflated after injecting is done to close the vessel off and prevent the casting material spilling out. For specimens with small and delicate blood vessels cannulation may not be necessary and injection can be done directly into the vessel.

The next step in the process is the irrigation of the vasculature and this is done to ensure that any blood clots, debris, and any remaining embalming fluid is flushed out of the system. Irrigation can also be used to detect any leaks in the vascular system. For fresh specimens, irrigation is best done using a phosphate buffered saline with or without heparinization (Cornillie et al 2019) to prevent further blood clotting, and for fixed specimens normal tap water can be used. To irrigate the specimen, the water/saline is injected into the arterial system first, as clotted blood in the venous system will cause congestion and increased resistance which can ultimately result in decreased arterial flow.

The casting material needs to be prepared according to the manufacturer's recommendation. It is best to allow the casting material to settle after mixing to ensure all air bubbles have come to the surface. Where possible air bubbles need to be avoided as these may block the casting materials from entering the smaller blood vessels, this process is known an evacuation of air bubbles. Injection can be done manually with a filled syringe or with an injection apparatus that can maintain a constant injection pressure.

When injecting, the user must be cautious of overfilling the arterial system as this can cause issues such as overspill of casting materials into the venous system or leakage of materials from ruptured vessels. It is best to use a steady flow rate when injecting the material and it is advised to never completely empty the syringe as this can introduce unwanted air bubbles. When the arterial system is filled, the user will feel increased resistance on the syringe, and it will feel hard to push the plunger through. To see if the capillary beds have been filled, a

small section of skin can be dissected from the specimens to show the filled sub-cutaneous vessels, or the filled arteries will swell up and can be seen filled with the shiny casting materials on organ specimens. Once the injection has been completed, the injection site needs to be clamped off using a haemostat.

To prevent flat spots and deformed casting from where the specimens has been sitting on a flat surface, it is best to suspend the specimen in the air or alternatively it can be placed in a water bath. It is vital that the specimen be left to cure for the time recommended by the manufacturer.

METHODS

The corrosion casting activity was performed using a fresh porcine pluck containing the heart, lungs and liver that was obtained from the local abattoir. The pluck was laid out in anatomical orientation (Figure 1).

The liver was removed, and the lungs retracted, and the aorta was identified. Using blunt dissection, the surrounding tissue was removed, and the aorta was closed off using a cable tie. The remainder of the aorta was cut off distal to the cable tie and super glued closed. The thymus was reflected and underneath, superior to the atria of the heart, the brachiocephalic artery was identified.

The surrounding tissue was blunt dissected to reveal at least a 10mm section of the artery and a cable tie was looped around but was not secured down. A 15cm piece of silicone tubing was inserted into the brachiocephalic artery but care was taken not to push past the aortic valves. The cable tie was secured down onto the artery and a waxed thread was also used to secure the silicone tube into the artery (Figure 2).

Epoxy resin (*Epoxycast clear casting resin*, Barnes Victoria, Australia) - was used at a 2:1 epoxy/hardener ratio and has a 45-minute curing time. Part A (70 ml) was combined with 35ml of Part B and the resin was tinted with half a teaspoon of Barnes dark red colourant. This was mixed thoroughly. The resin mixture was left to rest for 5 minutes to allow air bubbles to rise to the surface.

A 60ml syringe was filled with the resin mixture and the syringe was held vertical to expel any air bubbles. A small amount of resin was plunged to ensure that there were no air bubbles left in the syringe. The syringe was

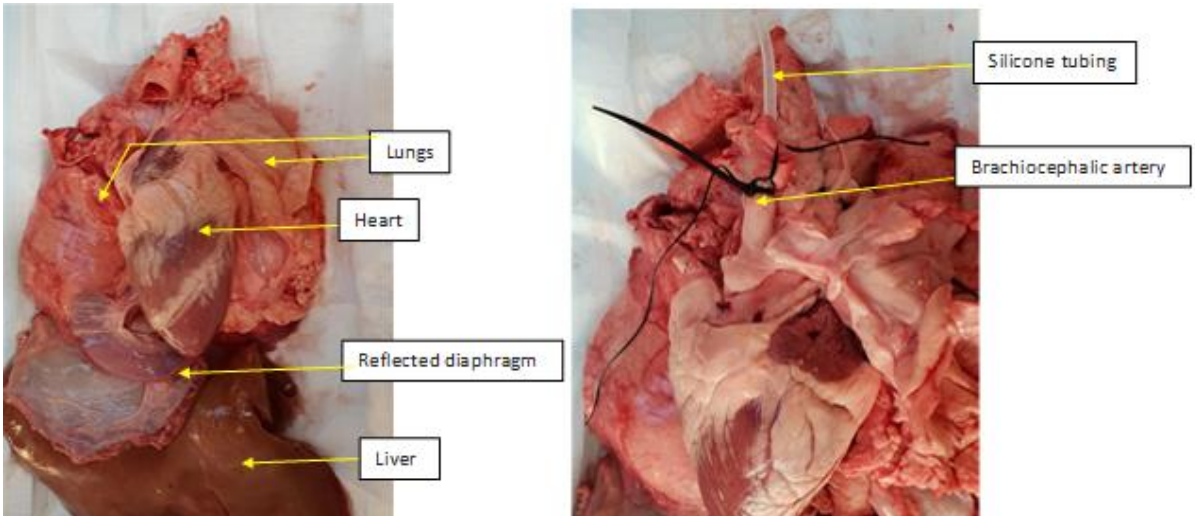

Figure 1 *(A) Porcine pluck in anatomical position. (B) Silicone tubing secured in the brachiocephalic artery*

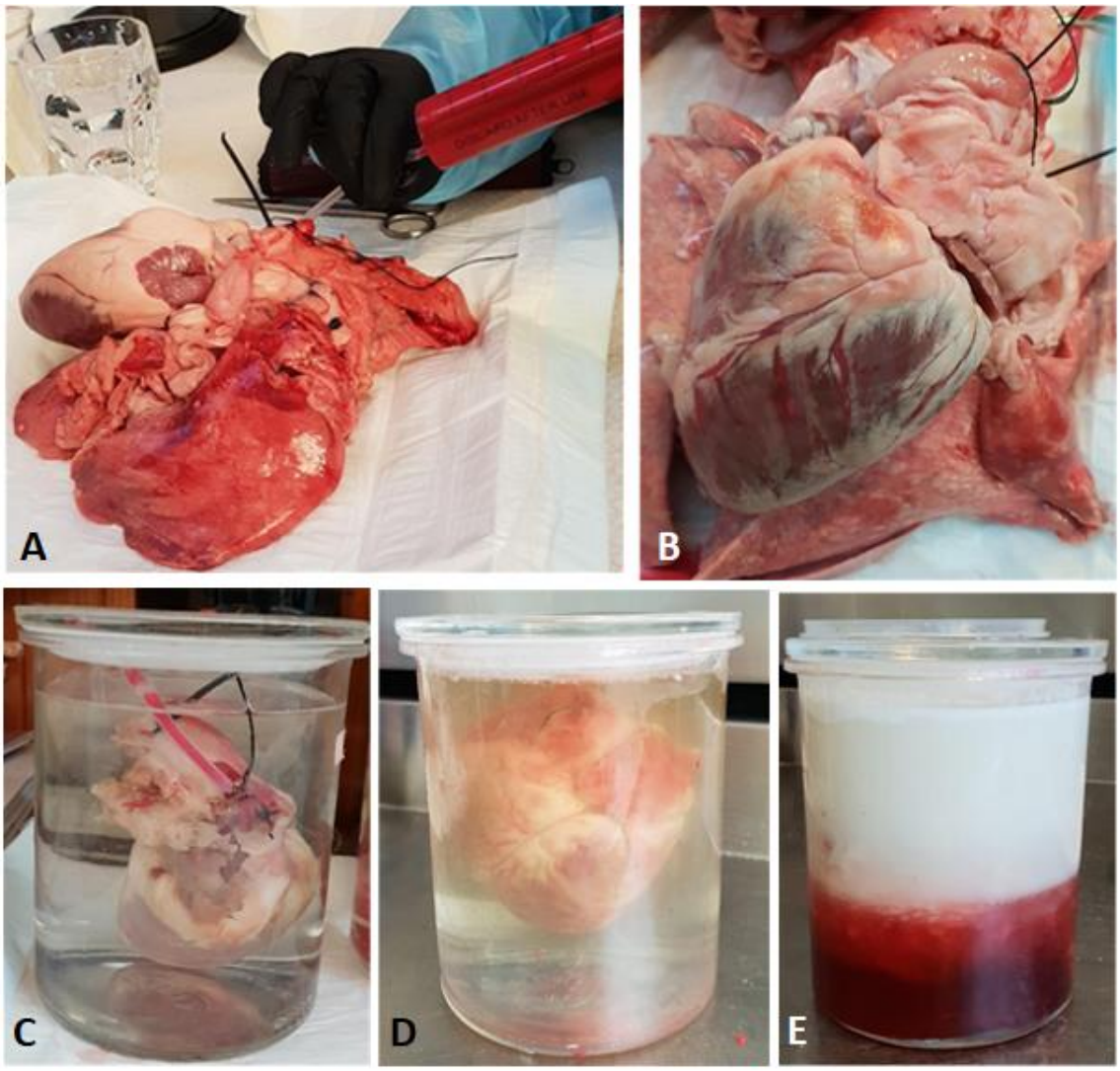

Figure 2 *(A) Resin filling. (B) Completed injection whereby red resin is visible in the coronary arteries. (C) Day 1 the specimen in the potassium hydroxide. (D) Day 2 of the specimen in potassium hydroxide. (E) Day 4 of the specimen in the potassium hydroxide*.

connected to the silicone tube and 15ml was fast injected and then stopped (Figure 2A).

The heart was inspected for any leakage. If there were no leakages, the remainder of the resins was slowly injected through the silicone tube. The injection was stopped when there was at least 10ml of resin left in the syringe. The silicone tube was clamped off using a haemostat while the syringe was being refilled with resin. Once filled, the haemostat was unclamped, and resin injection continued. The injection was deemed complete when the aorta was firm and sausage-like.

On completion of the injection, red resin was visible in the coronary arteries on the surface of the heart (Figure 2B). The silicone tubing was again clamped to prevent resin leakage and the heart was placed upright in a glass jar. The specimen was left in this position for 24 hours to allow the resin to fill the capillary beds and harden. After 24 hours the lungs were cut off the specimen and discarded.

To corrode the surrounding tissue, the resin-filled heart was placed in a 5% potassium hydroxide solution (Figure 2C). To speed up the rate of reaction, the glass jar containing the resin-filled heart was placed in an incubator at 40°C.

The specimen was left in the incubator for 24 hours and at this stage the colour of the solution had changed (Figure 2D). The heart tissue had changed to a greenish colour and there was a thin layer of fat deposit that have floated to the surface of the solution. The heart was carefully lifted out of the solution and a fresh batch of 5% potassium hydroxide was decanted into the glass jar. The heart was submerged into the solution and placed back into the incubator for another 48 hours.

At the end of day 4, there had been further changes (Figure 2E) there was a thick white fat layer on the surface, with a thin layer of red solution at the bottom. Most of the fat had detached from the specimen and there was only a small amount of muscle tissue surrounding the artery cast. Another fluid change was completed at day 4.

At day 6 the resin cast was gently removed from the solution and carefully rinsed under running water. The resin cast was placed on a clean tray and allowed to air dry for a further 24hours. Using a small paint brush, the cast was cleaned to remove excess resin and extra small branches that were not required for the final desired cast.

The silicone tube was removed, and a mounting rode was glued into the back of the aorta. For final presentation, a small hole was drilled into the wooden base of a glass dome and the mounting rod was secured onto the base and the glass dome placed over the cast (Figure 3).

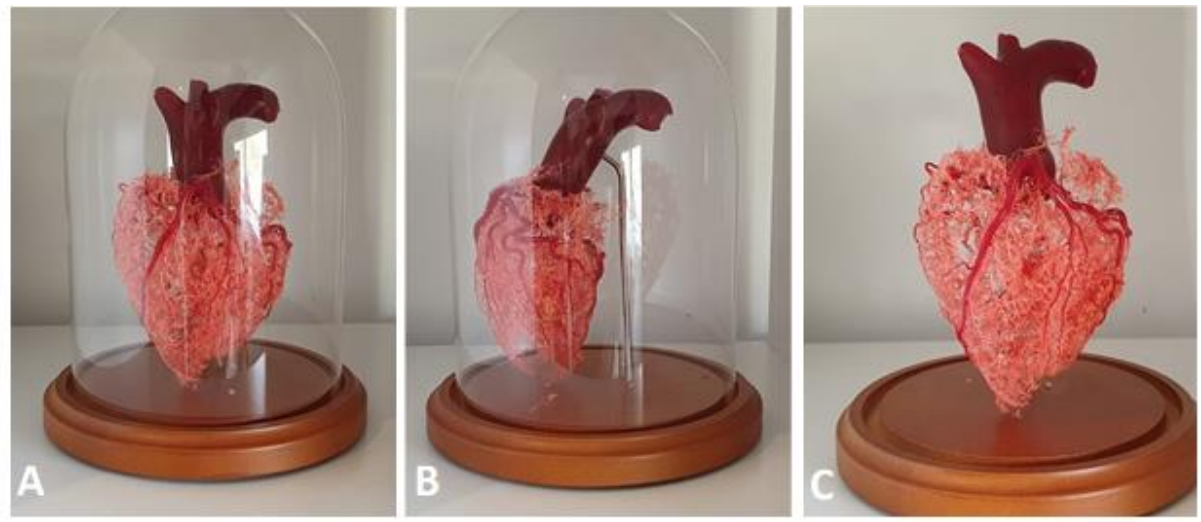

Figure 3. *(A) Frontal view of completed mounted cast. (B) Side elevation showing the mounting rod holding the specimen. (C) Dome removed to show detail of the coronary vessels.*

REFERENCES

Cornillie P, Casteleyn C, von Horst C, Henry R (2019). Corrosion casting in anatomy: Visualizing the architecture of hollow structures and surf ace details. Anat Histol Embryol. 48:591–604.