PLASTINATION OF THE HUMAN KIDNEY

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INTRODUCTION

Plastination of the kidney is a moderately difficult undertaking. Perhaps not as challenging as the heart but somewhat more tricky than the placenta. In actual fact, each kidney seems to have its own way of tormenting you.

We will structure this paper as a "how-to-do-it" set of directions. Each step will be addressed in the order in which it is done. This should permit anyone wanting to undertake this project to simply follow the discussion and arrive at an acceptable specimen.

REMOVAL OF THE KIDNEY AND CANNULATION OF VESSELS

Let's start the whole procedure by taking the kidney out of the corpse properly. This is very simple. Just remember to be generous, liberal and careful, all at the same time. Kidneys prefer that their renal arteries and veins stay as long as possible. So cut these as close to the abdominal aorta and inferior vena cava as you can manage. Also, they prefer a generous ureteral remnant, ideally about 20 cm in length. Incidentally, do not deprive them of the shelter of their fat capsule, at least not yet.

Having done all this, we must prepare the kidney for removal of blood. To do so, it will be necessary to cannulate every artery you see. This may amount to just one vessel, if you are lucky. But two, or more, are not uncommon. We would advise that you cannulate the ureter and one of the veins while you're at it. These cannulas will be of no use yet but, since you'll require them later, you might as well get it over with. Try to do all of this without damaging the fat-capsule.

In Heidelberg we make our own cannulas from tubing of different diameter, all of which are derived from infusion systems. We cut these into pieces of about 5 centimeters. At the end of each piece we create a fine, rounded tip by cutting across the tubing obliquely and then trimming it round with a pair of scissors. This facilitates its introduction into a vessel.

REMOVAL OF BLOOD

We are now prepared to rinse out the blood. To do so, we connect all arterial tubing to the water tap. Don't attach the venous and/or ureter tubes by mistake. These cannulas will not be employed until color injection and fixation. Rinsing pressure is limited to 2 meters by the use of an overflow device. It is probably unnecessary to say this, but never, never rinse with warm water. This would only speed up deterioration and weaken the specimen. As rinsing progresses, the kidney will turn extremely pale, proof that the rinse is doing its job.

After about two hours of rinsing it will be really easy to remove the loosened fat-capsule from the kidney. This can be done best by "blunt dissection"; that is: with your fingers. Work from the hilus to the convex margin. Be sure to leave the underlying fibrous capsule intact and be alert for interesting structures hidden in the fat, like cysts. If, upon removing the fat capsule, you discover a pole artery or other accessory artery, you will find that the area of the kidney supplied by this vessel is not being rinsed. At this point, you must stop, cannulate this artery, connect it to the tap and continue. If you fail to do so, this part of the kidney will not receive proper color injection.

After two hours of rinsing via the main renal artery, these accessory arteries can be detected more easily. The problem is not to find them, it's how to get them cannulated. Most of them are too small to fit the infusion tubing. In Heidelberg we insert a piece of tubing with a smaller diameter into the infusion tubing, and tie a ligature around the whole thing to keep this insertion in place. A problem of this kind may demand patience and skill. It may even jeopardize your good mood. As everyone knows since Amundsen: poles are not easy to conquer. Anyway, once you have triumphed over the pole arteries, connect their cannulas to the water tap and rinse until the kidney is appropriately pale.

Another criterion to apply, in addition to the kidney's paleness, is the clearness of the rinse water coming out of the veins. It should not appear the least bit red. It will take about 4 hours to accomplish this. Also, it will save you a lot of blue resin spilling in later stages, if you take this opportunity to detect any leaking veins. Tie off all water-spraying veins except of course the cannulated one, and you'll be just fine.

COLOR INJECTION

And now, we have arrived at the most demanding, but also the most exciting, part of kidney plastination, color injection. Instruments and materials that will be needed for this are as follows:

- assuming that all cannulas have been inserted, we will not include them in this list (or did we just include them by not including them?)
- small hemostats for use in stopping leaks and occluding the cannulas at the end of injection
- syringes
- thread
- scissors
- red and blue epoxy injection mixtures
- acetone (for use as a cleaning agent)

Begin by preparing the blue mixture and injecting it into the vein. The constituents should be added in the sequence listed below and stirred thoroughly for at least 5 minutes. About 10-15 ml of this mixture will be needed per kidney.

BIODUR E 20 blue	100 parts per weight
BIODUR AT 10	20 ppw
MEK	10 ppw (methyl ethyl ketone)
BIODUR E 2	45 ppw

Although this mixture resembles the one used for the placenta, note that they are NOT the same. It is very important to be exact when you weigh these components. Also, be sure to wear gloves because the resin, especially the HARDENER E 2, is a rather strong allergen. It will turn your hands into large, fingered, red-pickled strawberries if you don't take precautions to protect them.

The injection should be carried out with a light, constant pressure in order to avoid extravasation of the resin. When about 5 ml of the blue resin has been injected, the kidney begins to show a blue tint. Now press the kidney softly and squeeze it a little bit, so as to massage the blue resin through the veins. Inject some more and massage it again. When you see some small, star-shaped venous patterns at the surface, you probably have injected sufficient blue polymer. A good rule of thumb is to quit

when you can count about 5 of these so-called "stellata" veins at the surface. At this point, you should bend the cannula double and clamp it with one of the hemostats.

Next, of course, is arterial injection. But don't forget to protect your valuable kidney from drying whilst you mix the red resin. You might submerse it in water and cover it with a wet cloth. The red injection mixture consists of:

BIODUR E 20 red 100 parts per weight 20
BIODUR AT 10 ppw 20 ppw 45 ppw
MEK BIODUR
E 2

You'll need about 25 to 30 ml of this mixture per kidney. Again, it is important to weigh the components accurately, add them in the order given, and mix them thoroughly.

If you have detected any accessory arteries, you ought to inject them first. There are three reasons for this:

> Accessory arteries are difficult to inject. In fact, you may fail to get any resin into them at all. If so, you should know this at the beginning so you can decide whether to continue.
>
> You'll have to watch only a small area to arrive at the right reddish color; it's easier to adjust the rest of the color of the kidney to this area than the other way around.
>
> There may be more, yet-undiscovered pole-arteries. It is easier to discover these if you inject the pole arteries you know about first, and the rest of the kidney later.

The arteries should be injected with red resin until the kidney surface shows uniformly distributed red spots. The most serious problem encountered while injecting a kidney with more than a single artery is that the area supplied by one artery is difficult to match to the area supplied by another. It's rather troublesome to get both areas equally red. You'll need to employ a lot of "Fingerspitzengefuehl" to get the balance just right. Once we have finished arterial injection we bend the tube and clamp it. Only then is it permissible to lean back and admire the beautiful kidney you have just created.

FIXATION

And so we've arrived at fixation! It is important to carry out fixation, without delay, after color injection. In fact, it should be done the same day. The reason for this is that fixation should start before the colored resin becomes cured within the kidney or it will be impossible to use fixation as a means of dilating the renal pelvis. Fixation of the kidney is done in two steps, dilation-fixation and immersion.

DILATATION-FIXATION: This is performed with 20% formalin, flushed through the kidney via the ureter. To do so we place a container, filled with this rather strong solution, about 2 meters above the specimen, thus creating a constant hydrostatic pressure for dilatation. The advantage of using such a concentrated solution of formalin is that it will quickly provide a very firm fixation. We can use a percentage this high only in the dilatation technique, i.e., the organ needs to be hollow and must be under pressure. If we were to use 20% formalin for simple immersion fixation, we would create a thoroughly fixed outer layer that would act as a diffusion barrier for the rest of the fixative. Penetration would be inhibited and the inner tissue would not become fixed.

IMMERSION: After 1 day of dilatation-fixation, we begin immersion. Put the kidneys in a 5% solution of formalin and diffusion from the inside and the outside will take care of the rest. Since we have created a concentration gradient between the inner tissue, where we deposited 20% formalin, and the outer tissue, which is surrounded by 5% formalin, fluid will be propelled from the immersion bath into the kidney.

There are two places in the process of kidney plastination, at which one might divide the kidney into halves. The one you will choose depends on the equipment you have to accomplish this. If you do NOT have a band saw, and will have to do this with a knife, your perfect moment has arrived. One day after the start of fixation the tissue will be firm enough to retain its shape, but not too firm to cut. Immersion fixation will take about 3 weeks. If you want to store the kidneys for a while, there are no objections to leave them in the 5% formalin slightly longer.

DEHYDRATION

By the time a kidney is colored and fixed, it usually gets very eager to become dehydrated. Since we have grown fond of this kidney, we will subject it to a sophisticated process called, freeze substitution. Rather than repeat what will be contained in another paper, We refer the reader to the article by Prof. Klaus Tiedemann that will appear in this very same issue.

FORCED IMPREGNATION

Actually, forced impregnation is what plastination is all about. If you are familiar with the Heidelberg Plastination Folder, you'll know how to do it. If you are not, you should plan to get a copy and read all about this step. Impregnating one kidney will consume between 100 and 250 grams of resin. But, of course, you will need much more than that to immerse it properly.

CURING

Curing of the kidney is carried out in much the same way as curing of any other organ impregnated with S 10. We can do no better than to recommend the Heidelberg Plastination Folder for the details of this step as well.

You will remember that we mentioned that the proper time for cutting the kidney into halves with a knife is one day after the beginning of immersion fixation. If you use a band saw, the proper time is after about 9 or 10 days of curing. Having cut the kidney, you will see the result of your unflagging industry. The splendor and charm of the renal pelvis will shine upon you and your collegues will flock to admire your artistry.

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