

## HOW I DO IT

# A Simple Training Model for Coronary Artery Anastomoses

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### ABSTRACT

To provide supplementary training for trainee cardiac surgeons, a simple method is required to simulate coronary anastomoses. By stretching 2 gloves over a towel, a model can be made that can be used to simulate a small coronary arteriotomy (including anterior and posterior walls). The graft can also be simulated using the fingers of the gloves.

### INTRODUCTION

Trainee cardiac surgeons have to learn how to perform coronary artery anastomoses, as this is an essential surgical skill. In Japan, the number of cases of cardiac surgery performed at cardiac surgical institutes is extremely low: 68% of institutes operate on fewer than 100 open heart cases per year [Kazui 2005]. This small number is probably due to the country's unique healthcare policy, which allows for the existence of many small institutes. In addition, the number of people actually being trained is not controlled, as many training programs have been introduced by various small groups. This lack of control is rapidly becoming an issue. Although some effort is being made to solve these problems, the current situation means that some trainees are not receiving sufficient exposure to cardiac surgery techniques. To provide a practical solution to this situation in the interim, it may be possible to utilize a simulation model to supplement the training provided for certain aspects of procedures—in particular, coronary anastomoses.

Of course, there is no doubt that real operations are the best way to acquire real surgical skills. However, it is also important to have a comprehensive training method for microvessel anastomoses available that will allow trainees to practice, in their own time and in a reproducible way, the skills they require.

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We present here our simple simulation model of coronary anastomoses. This model is simple to make using materials that are easily available in hospitals. A modification for simulating anastomoses on the beating heart is also presented.

### MAKING THE MODEL

A towel is wadded to form a ball. A medical glove is then stretched over the towel. This glove is considered to be the posterior wall of the coronary arteries. Another glove is put over the previous glove and this is considered to be the surface of the heart. It should also be considered to represent the anterior wall of the coronary arteries (Figure 1). The outline of the coronary arteries should be drawn on the surface of the second glove. This model of the heart is then placed into a box of the same depth as the chest cavity and fixed appropriately.

To practice anastomoses, trainees can trim and clean the surface of the drawing of the coronary artery and then make an incision with a sharp blade. They should cut through the surface of the outer glove without cutting through the inner glove. This simulates a coronary arteriotomy, including the need to avoid cutting the posterior wall (Figure 2).

If remnants of human saphenous veins from actual procedures are not available, preparation of the conduits can be simulated using the fingers of the gloves. The trainee should cut into the finger of the glove using an incision as small as that which would be used with an actual conduit, simulating the fact that the conduit will be small. The side into which this incision is made should be considered to represent the anterior wall of the conduit. The opposite side of the glove's finger should be considered to represent the posterior wall of the conduit and should not be cut. The glove's finger usually collapses, bringing one side very close to the other. Of course, the finger of a glove is usually larger than the actual conduit; however, the close proximity of the 2 sides helps to simulate the fact that the anterior and posterior walls of a conduit will be close to each other.

Once the coronary arteriotomy and the conduit have been prepared, anastomoses can be performed in the usual manner (Figure 3). As this model simulates the anterior wall and the posterior wall, trainees should practice precise suturing without putting occlusive stitches through the posterior wall.



Figure 1. A towel is wadded to form a ball. Two medical gloves are then stretched over the towel. The inner glove is considered to represent the posterior wall of the coronary arteries and the outer glove is considered to represent the anterior wall.



Figure 3. The anastomosis is being performed. The graft is also simulated using the fingers of the gloves. Precise suturing should be practiced without putting occlusive stitches through the posterior wall.

Diamond-shape sequential anastomoses can be also practiced. Once the anastomosis is finished, the conduit can be cut and the shape of the anastomosis can be checked.

If trainees want to practice off-pump techniques, anastomoses can also be practiced on a simulation of a beating heart. For this practice, an intra-aortic balloon pumping system is required. The towel and 2 gloves are put over the balloon to represent the beating heart. Because the intra-aortic balloon is designed to work under systemic blood pressure, the towel should be placed around the balloon securely with reasonable pressure, otherwise the balloon will overexpand. After the 2 gloves are put over the towel, the simulated heart with the balloon inside should be fixed to the box securely. Balloon pumping is then started and the trainee can practice, using a suction positioner, anastomoses on a moving target (the beating “heart”) in the same manner as described above.

## DISCUSSION

There is increasing acceptance of the use of simulations for practice to augment the learning processes that lead to surgical



Figure 2. The surface of the outer glove (the anterior wall) has been cut. Note the close proximity of the anterior and posterior walls.

competence. Some studies have already described simulations of coronary anastomoses using complex models [Calderon 1999; Reuthebuch 2002]. These are commercially available; however, they are also expensive. Another option is to conduct a workshop using an animal’s heart [Ramphal 2005], which would act as an ideal simulation model. However, this is not always possible due to lack of availability. The model described in this study offers a good, easily available solution, as it is both very simple and easy to make. Trainees can make this model by themselves at minimal cost, and can practice microvessel anastomoses repeatedly until a satisfactory level of skill and confidence is attained. This kind of simulation-based training should be performed repeatedly; the simplicity and availability of this model makes doing so possible.

To make the model more reflective of real-world experiences, the model can be modified by using a thicker glove as the outer glove. Using gloves of 2 different thicknesses will more closely approximate the process of suturing a coronary artery and conduit. Alternately, a piece of thin-walled surgical tubing can be used instead of the outer glove. The use of such thicker-walled materials may more accurately reflect the difficulties encountered in trying to suture thick-walled or calcified coronary arteries.

Although the model can be modified as above to simulate a beating heart, it must be remembered that an intra-aortic balloon pump system (including the balloon) is not always available for teaching purposes. In such cases, platelet agitators can be used to generate the side-to-side vibration, usually at 70 times per minute. Although the agitators generate only horizontal movements, they are almost always available in an intensive care unit. Another option to simulate a beating heart could be using a glove attached to a foot-pumped bellows, inserted into the glove to be sutured. It must be also remembered that the suction positioner is usually required to perform the anastomoses on these “beating heart” models.

Our unit is a typical very small cardiac surgery institute in Japan, with 2 doctors (an attending surgeon and a trainee) performing surgery on fewer than 100 open heart cases per year. Even in a small unit like ours, challenging cases such as multi-vessel off-pump bypass can be taught to younger trainees under

appropriate supervision. However, we believe that supplementing the experience gained by performing real operations is important, and that simple simulations should be carried out to boost learning in an environment such as our unit.

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