THORACIC SURGERY DIRECTORS ASSOCIATION BOOT CAMP

SEPTEMBER 12-15, 2019

SECTION: CORONARY AND VASCULAR ANASTOMOSIS

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Location

William and Ida Friday Center for Continuing Education
University of North Carolina, Chapel Hill

SYLLABUS

OVERVIEW

The Boot Camp is an intensive course in selected technical and cognitive components of cardiothoracic surgery. Designed for the first-year traditional and upper level integrated cardiothoracic surgery resident, the Boot Camp provides an environment to understand and practice techniques and parts of procedures performed in the operating room.

Surgery requires the synthesis of technique and cognition, and mastery of the basic technical skills early in one's training will allow the resident to appreciate the complex intellectual components of cardiothoracic surgical procedures. In this coronary and vascular anastomosis section, we focus on techniques of coronary and vascular anastomosis including instrument use and tissue handling based on a didactic lecture, task stations and wet-lab. The didactic component emphasizes the background and strategies during coronary artery bypass grafting, including discussions on the preferences of the Boot Camp faculty recognizing inter-institutional, as well as intra-institutional, differences. The part-task approach to cardiac surgery training in the dry-lab and wet-lab settings will provide initial training and a basis for ongoing deliberate practice. Not surprisingly, in skill acquisition and retention, dedicated practice distributed over time results in markedly improved performance compared to a single intensive practice session.

This course will also allow the faculty and resident to identify and correct areas of weakness in technique. Our goal is to provide the resident with an understanding of the technical aspects of the surgical procedure, followed by direct supervision and formative feedback.

GOALS

Content

- To understand the goal and rationale for various anastomosis techniques
- To know the sequence of events in small and large vessel anastomosis

Skills

- To establish competency in coronary/vascular anastomosis using partial task trainer and porcine model

PROGRESS

Formative assessment

Assessment of the resident's progress with formative feedback
Evaluate surgical skills using part-task trainer and porcine model

Structured sessions

Four-hour session dedicated to anastomosis training.
Instrument use
Graft preparation: vein and arterial
Arteriotomy: epicardial and intramyocardial
Different techniques of coronary anastomosis
Large vessel anastomosis
Graft assessment

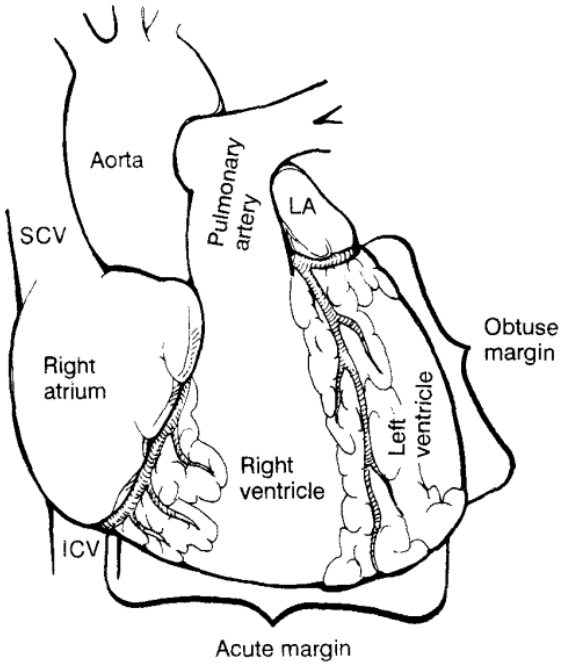
FEEDBACK

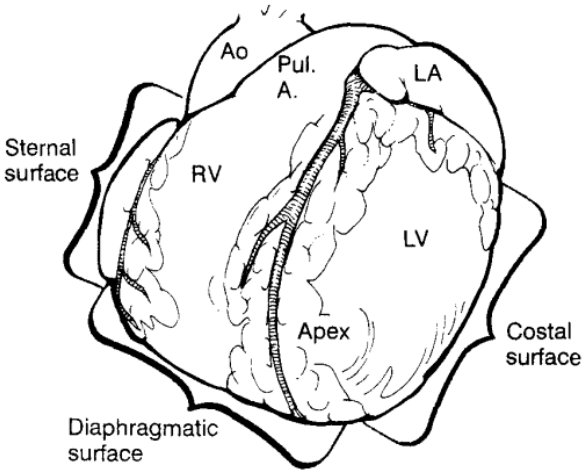
The resident will receive guidance and formative feedback from the faculty during the anastomosis exercises. Likewise, the resident is encouraged to provide feedback regarding the perceived relevance of the assignments. For instance, feedback may include perceived value of the tasks, difficulty of the tasks, perceived improvement and progress, and change in level of comfort performing the procedures. TSDA Boot Camp - Anastomosis Page 4

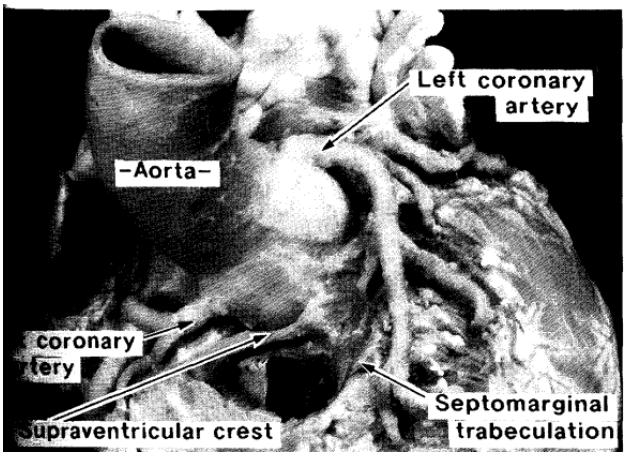
COURSE OUTLINE

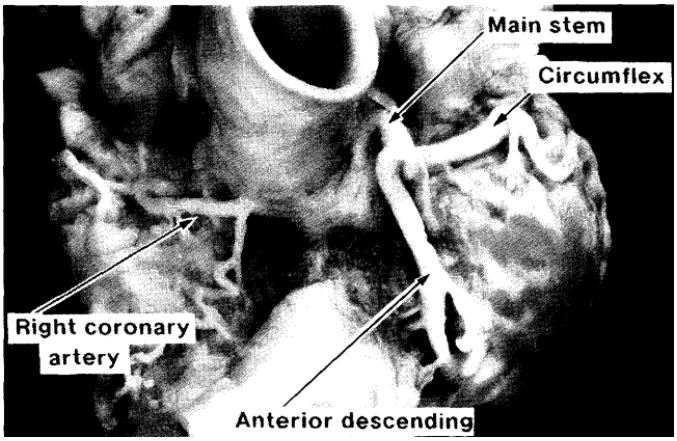
Coronary Anatomy Review:

(From Mill MR, Wilcox BR, Anderson RH, Surgical anatomy of the heart. Cardiac Surgery in the Adult, 3rd Edition, Ed., Lawrence H. Cohn.)

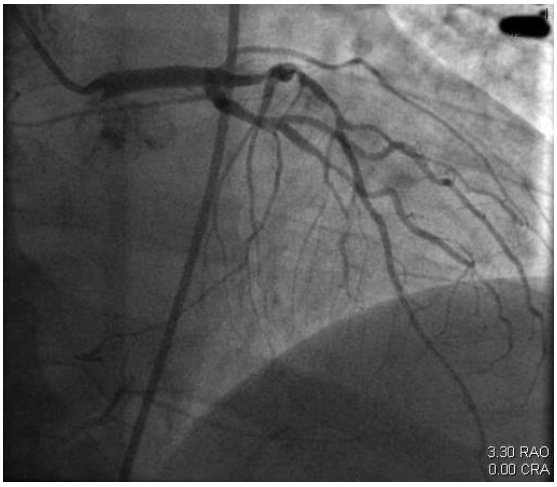


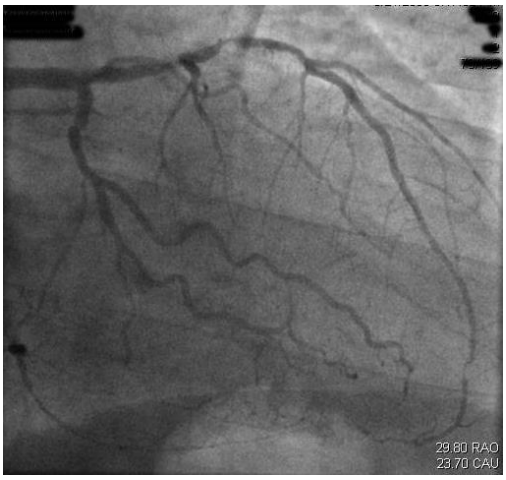


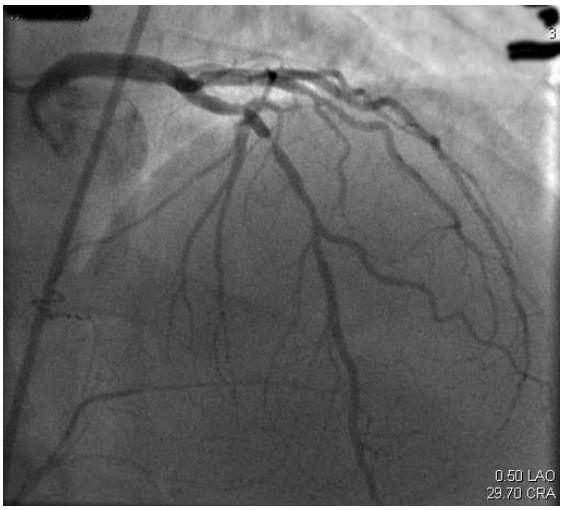


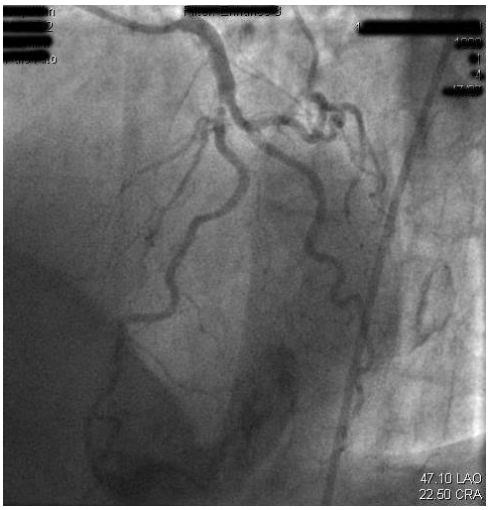


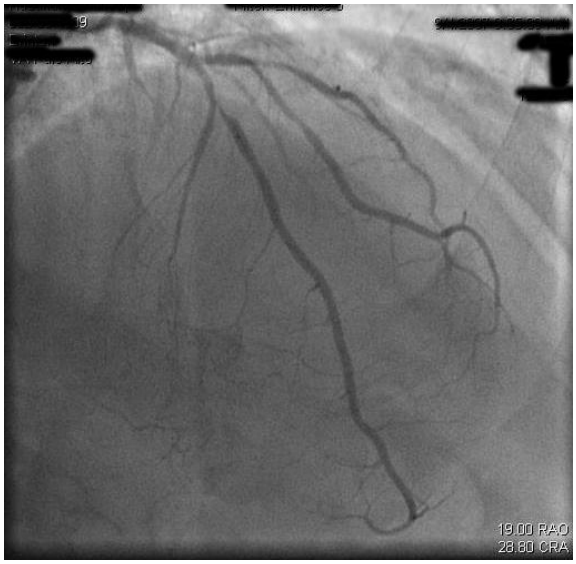
Angiography Review:

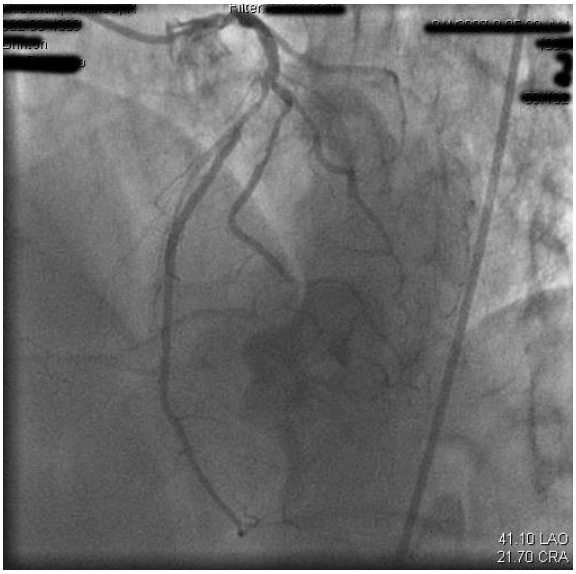








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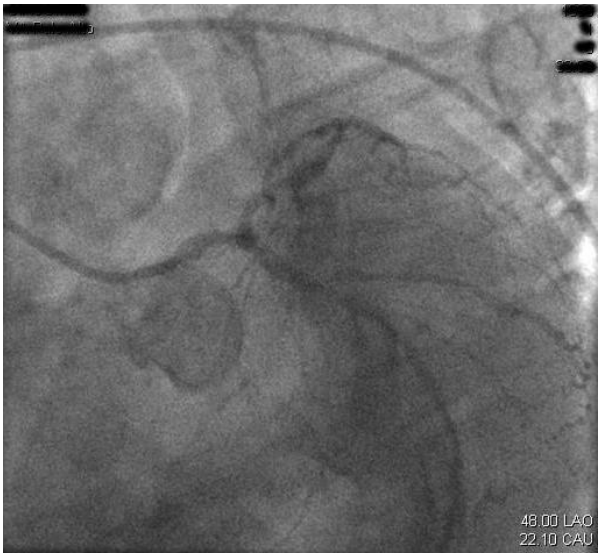
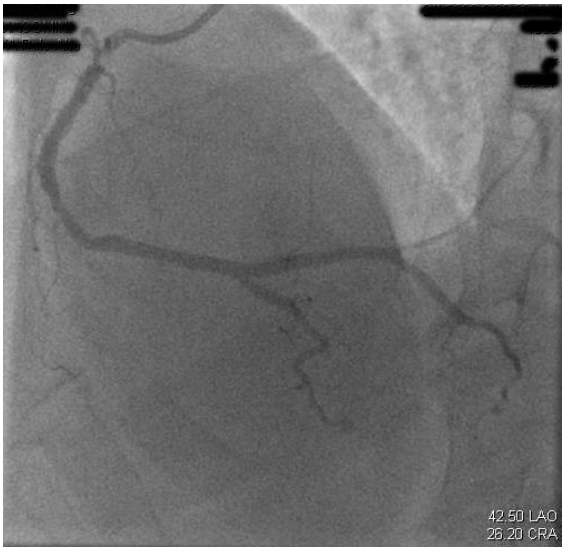
21.70 CRA

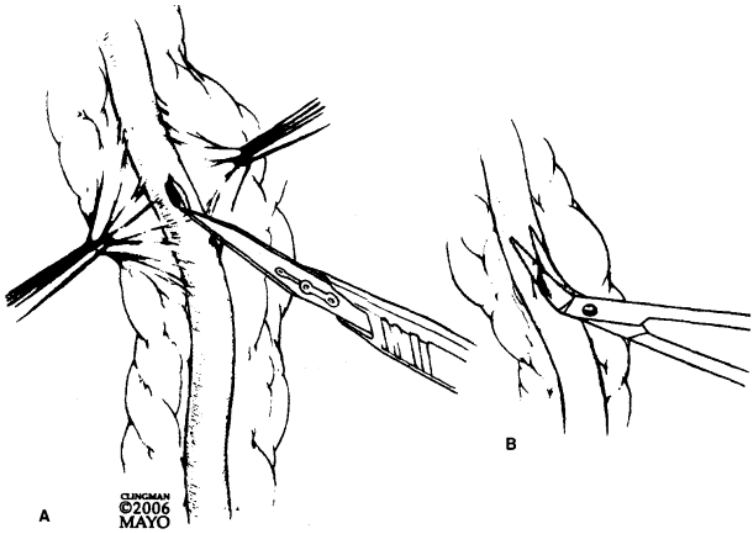

29.00 LAO
32.00 CAU

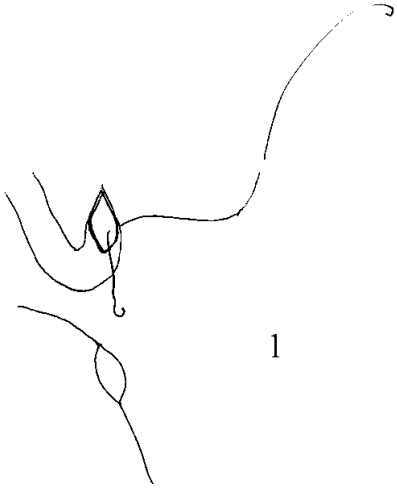

48.00 LAO
22.10 CAU

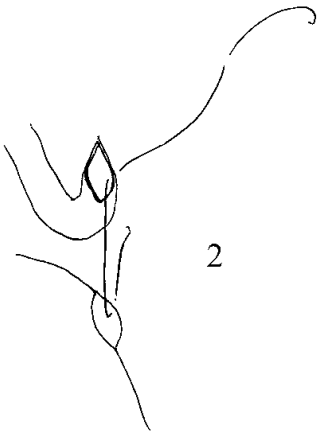

0.40 LAO
29.70 CRA

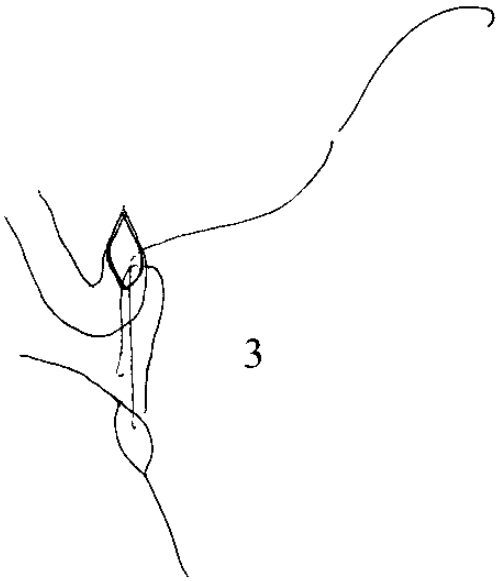

42.50 LAO
26.20 CRA

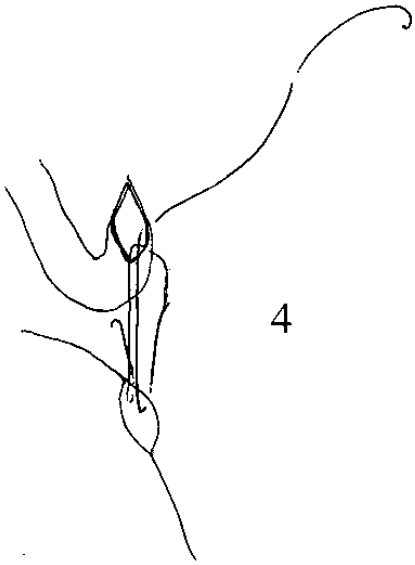
Techniques:
(From Gongora E. and Sundt T., Myocardial revascularization with cardiopulmonary bypass. *Cardiac Surgery in the Adult, Third Edition*, Ed., Lawrence H. Cohn.) TSDA Boot Camp - Anastomosis Page 10.)

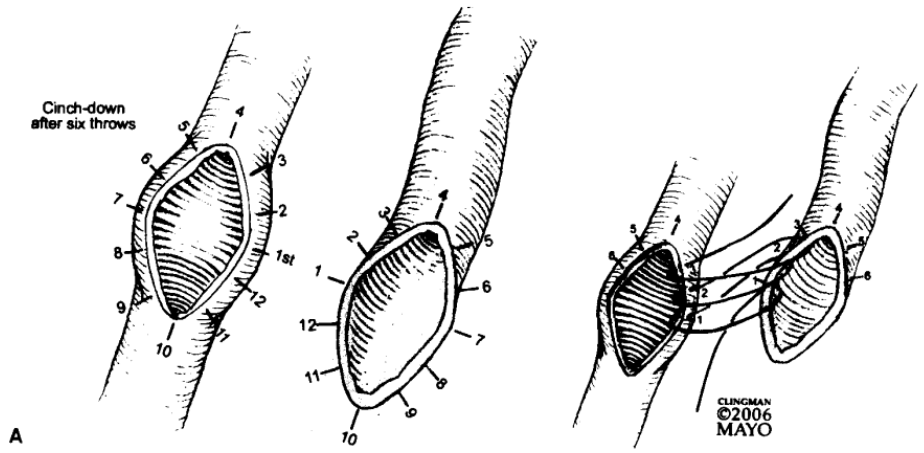











Cinch-down
after six throws
A
CLINGMAN
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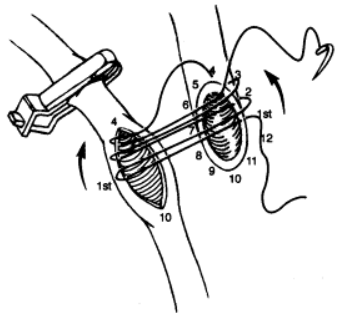

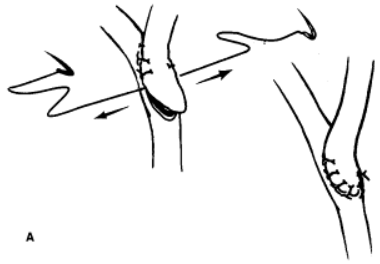
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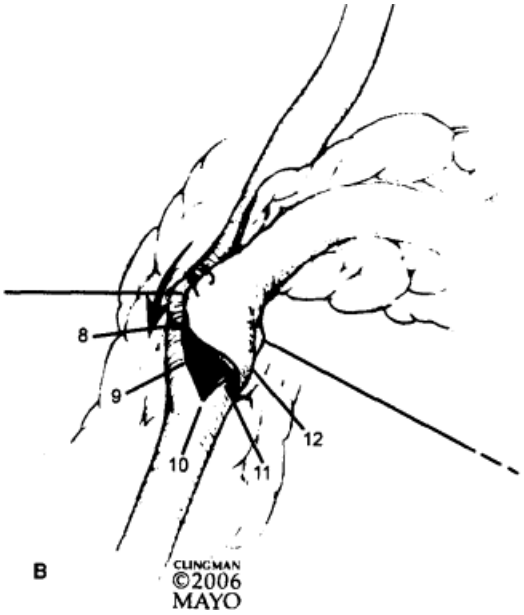
B
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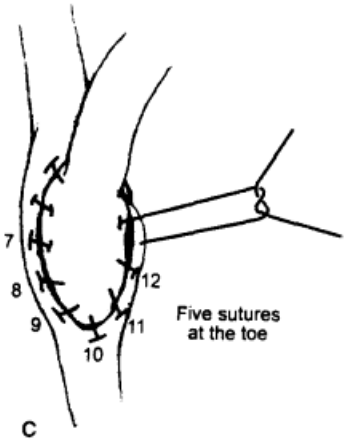
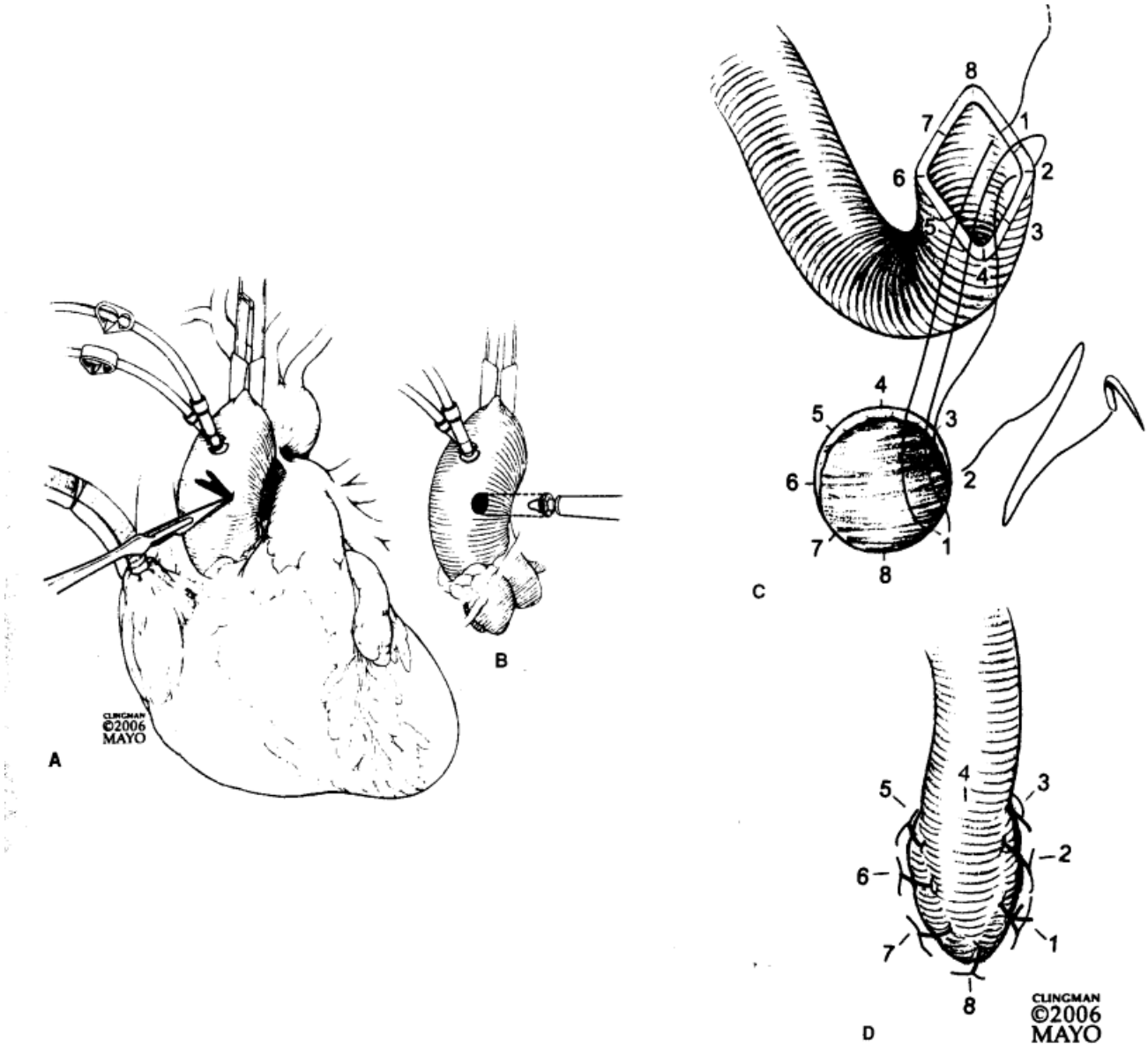

Five sutures
at the toe
C


A
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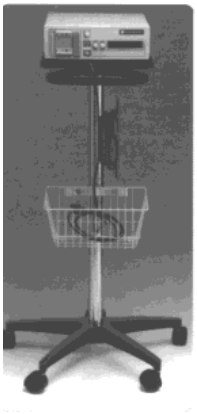
Intraoperative graft patency assessment:

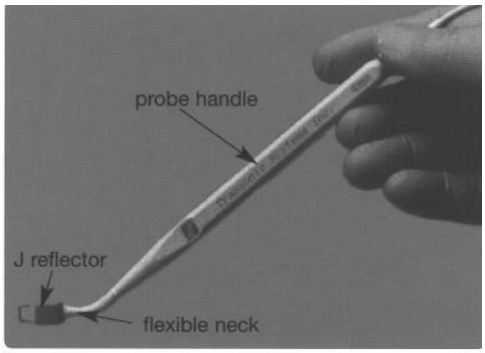
Palpation: Not reliable; subjective.

Doppler probe: Not reliable; subjective.

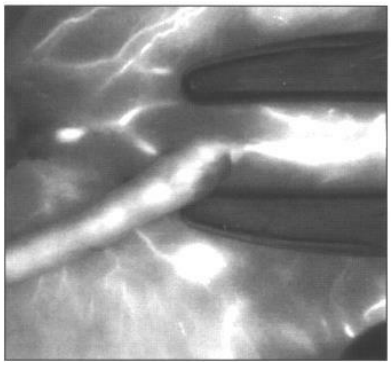
Epicardial ultrasound with Doppler: Demonstrates flow velocity but not volume of flow; limitations include probe positioning, motion artifacts, flow velocity profile, and vessel diameter.

Transit time flow measurement ("flow probe"): Data include flow curve, mean flow, pulsatility index, and percentage of backward flow. Different size probes are available (e.g., 2 mm, 3mm, 4mm). Limitation: this method may prompt unnecessary graft revision.





SPY system (Novadaq Technologies): Imaging is based on fluorescence of indocyanine green (ICG), a nontoxic dye; it provides real-time images. When illuminated with 806-nm light, ICG fluoresces and emits light at 830 nm. The fluorescent light is captured by a charged couple device video camera at 30 fps and displayed on monitor. Limitations: it cannot quantify the amount of flow and is influenced by surrounding soft tissue.



Intraoperative angiography: Large instrumentation, contrast injection, long operating time, and high cost.

Example of transit time flow measurement:

CABG

Coronary Graft Patency Assessment Protocol

I. Measuring Graft Flow

Accurate measurements are technique dependent.

- Select a flowprobe sized so that the graft will fill at least 75% of the lumen of the probe. Probe should not compress the graft.
- Fill probe window with ultrasound gel.
- Position probe on graft (not over metal clips or fascia).
- Measure graft flow with occlusion of the native coronary artery to establish maximal flow conditions for the graft.
- When flow reading is stable (10-15 seconds), press PRINT. Leave probe on graft until printer stops.

II. Does Mean Flow Confirm Graft Patency?

✔ **Normal Mean Flow** per table below **= Patent Graft**

✔ **Medium Range Flows**

Does flow exhibit the expected pattern?(**IV.** on right)
Evaluate other factors that may lower flow. (**V.** below)

✔ **Mean Flow <5 ml/min = Graft in Trouble**

Mean Flow Readings, Off-Pump[1,2]

Graft Location	Normal Flow Range (85% of cases)	Questionable Flow (requires further tests & diagnosis)	Obstructed Flow (graft with technical problem)
LIMA → LAD	> 27 mL/min	27 → 5 mL/min	Any flow under 5 mL/min
RIMA → RCA	> 26 mL/min	26 → 5 mL/min	
SVG → RCA	> 29 mL/min	29 → 5 mL/min	
SVG → DIAG	> 21 mL/min	21 → 5 mL/min	
SVG → OM1, OM2	> 29 mL/min	29 → 5 mL/min	
SVG → PDA	> 24 mL/min	24 → 5 mL/min	
SVG → CX	> 48 mL/min	48 → 5 mL/min	

[1]On-pump readings are typically 25% below off-pump readings.
[2]The normal range is average minus one standard deviation of the reported readings. This captures approximately 85% of the observations.

Is Pulsatility Index (PI) between 1 & 5?

(Check flow printout.) A PI over 5 is generally associated with low mean flow and systolic-dominant flow pattern indicating that the graft should be reexamined.

III. Examine Graft

- With probe on the graft, engage FlowSound. Listen for an increase in the pitch as adjustments are made to the graft (1 octave pitch ↑ = 4 x ↑ in flow).
- Look for kinks, twists in the graft, low MAP, vasospasm. Redo anastomosis if indications point to technical error.

V. Analysis of Other Factors

- Vasospasm of Arterial Grafts
- Small target vessel or small patient?
- Small graft capacity
- Poor runoff

IIIa. Flow Waveform Analysis

For graft flows in the "questionable range," the quality of the graft is evaluated from the systolic/diastolic waveform properties, using FlowSound or a printout. The systolic and diastolic phases are identified in the printed waveform by the following rule of thumb: the systolic lasts one-third of a heart beat and diastolic lasts two-thirds.

Diastolic-Dominant Pattern

For left ventricle grafts, the lesser peak is usually systolic, and the higher, broader peak is diastolic (Fig. 1). The exception occurs in the presence of severe tachycardia when the duration of diastole is shortened. An acceptable left ventricular graft waveform is **"diastolic dominant"** with the delivered diastolic blood volume (i.e., area under diastolic curve) exceeding the delivered systolic blood volume.

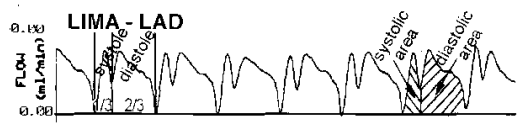


Fig. 1: **Mean** = 24 ml/min; **Diastolic dominant; PI** =1.3

Balanced Systolic/Diastolic Pattern

In grafts to the right ventricle, flow is more equally distributed between the systolic and diastolic phases. This produces a flow waveform where the systolic peak may dominate but is followed by a proportionally strong diastolic flow producing a **systolic/diastolic balanced** waveform (Fig. 2).

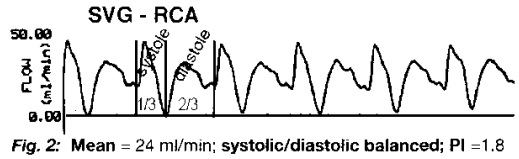


Fig. 2: **Mean** = 24 ml/min; **systolic/diastolic balanced; PI** =1.8

Stenotic Pattern

In stenotic grafts, the systolic peak dominates the off-pump flow profile and is associated with low or zero-mean flow. Often, systolic charge flow flows backwards as a negative flow during diastole (Fig. 3).

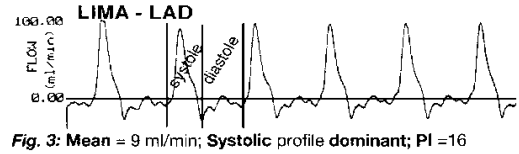


Fig. 3: **Mean** = 9 ml/min; **Systolic** profile **dominant; PI** =16

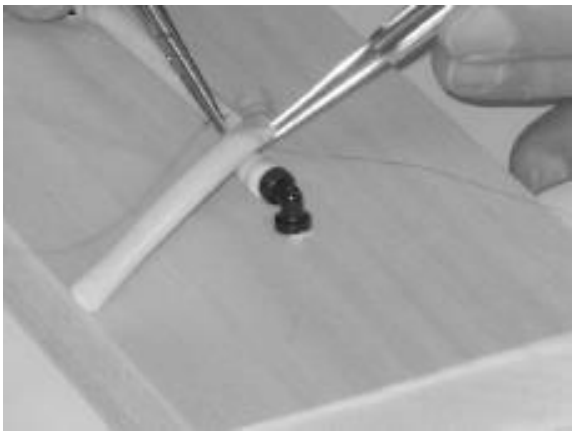
Transonic Systems Inc.
Tel: 800-353-3569(USA); Fax 607- 257-7256; www.transonic.com
Europe: Tel: 31 43 407 7200; e-mail: info@transonic.nl; Fax: 3143 407 7201

Reference: Flow-Based Intraoperative Coronary Graft Patency Assessment.

PARTIAL TASK TRAINER PROCEDURES

Coronary anastomosis

1. Mount the synthetic vessel ("target") on the anastomosis task station.
2. Make "arteriotomy" using small scissors.
3. Anastomose graft to the target vessel using continuous 5-0 or 6-0 polypropylene.
4. Assess the anastomosis.
5. Repeat and perform additional anastomoses using same target vessel.

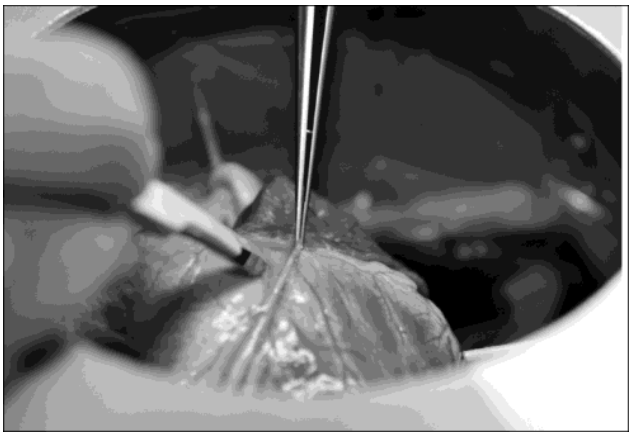


WET-LAB PROCEDURES

Porcine Heart Model

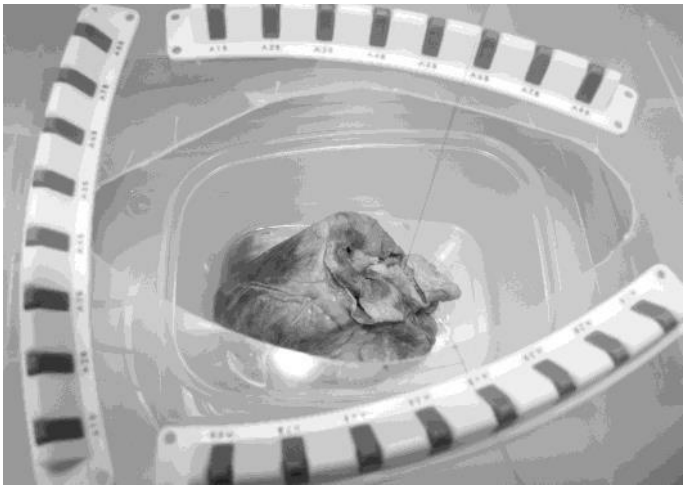
Tasks:

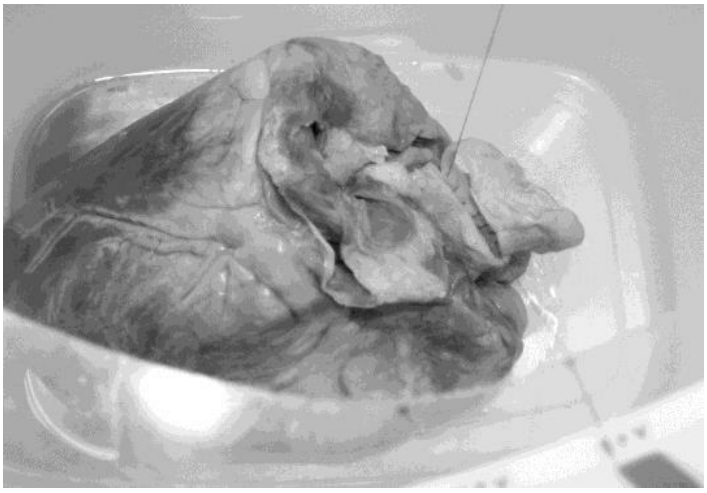
1. Evaluate the coronary anatomy.
2. Create an arteriotomy in the mid LAD using #15 blade or Beaver knife.
3. Perform vein (tissue or synthetic) to coronary artery anastomosis with 6-0 or 7-0 polypropylene suture.
4. Assess anastomosis and repeat.
5. Identify OM and PDA and perform anastomoses if possible.



6. Partially transect the aorta (300 deg) leaving the posterior aspect intact to facilitate orientation and reapproximate with 3-0 or 4-0 polypropylene suture.

7. Partially transect the pulmonary artery and reapproximate with 4-0 polypropylene suture.





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