



TMR

Clinical Application and Surgical Technique

Physician Training



Clinical Application

- Surgical procedure
- Performed as in-patient
- General anesthetic



Image courtesy of Keith Allen, MD, St. Vincent Hospital, Indianapolis, Indiana

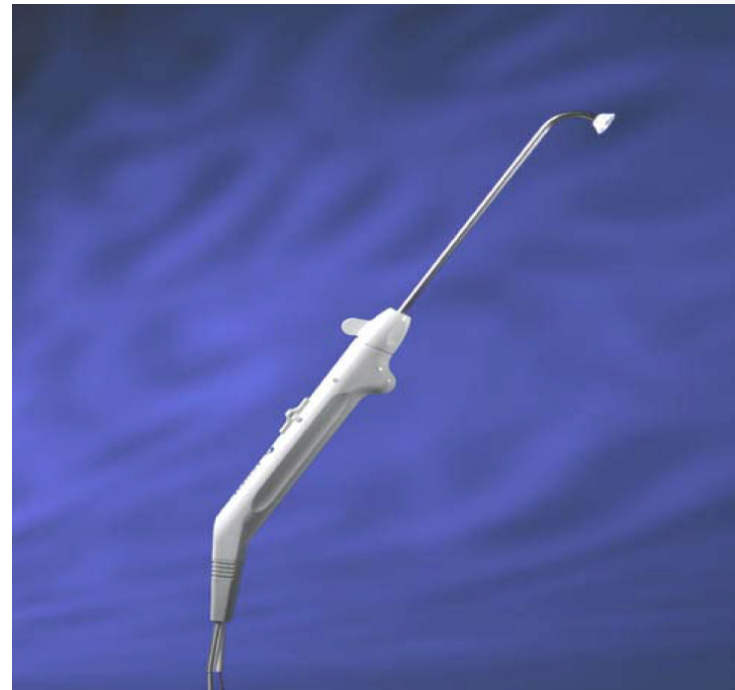


TMR: The System

Optimizing Tissue Interaction for Therapeutic Angiogenesis



Solargen 2100s
Holmium:YAG Laser

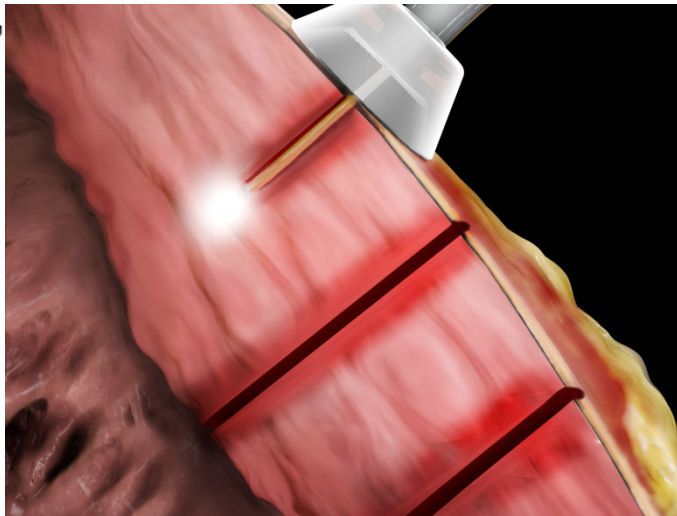
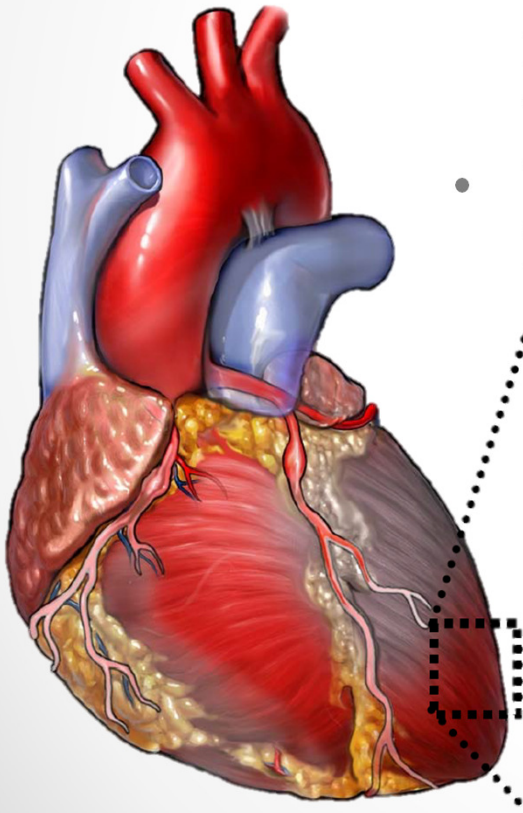


The Ergonomic
Sologrip III® Handpiece



Surgical Technique

- Via an epicardial approach, an optical laser fiber is advanced completely through the myocardium to create a ≈ 1.0 mm diameter channel through the myocardium in the distal $2/3$ of the left ventricular wall.
- Transmural channel is normally created in 1–2 seconds.





Surgical Protocol

- Expose the left ventricle.
- Determine/Identify areas of viable myocardium which are suitable for TMR therapy.
- Press the tip of the fiber against the epicardial surface of the heart before lasing.
- Laser energy should be delivered only when advancing the fiber, stopping as soon as fiber penetrates ventricle.
 - Goal is \approx 10 pulses to create each channel
 - A change in auditory tone will take place when fiber penetrates into the ventricle – “tap” to “pop”
 - A change in tactile feel or pressure will take place when the fiber penetrates into the ventricle
- Laser is deactivated when myocardial channel is completed by releasing foot switch.
- Fully retract fiber before removing cup from epicardial surface.
- Place the channels \approx 1.0 sq. cm apart, through the entire thickness of the left ventricular wall.
- Typical patient will receive 20–45 channels, 50 maximum.
- If performed on a beating heart, it is very important to pause $\frac{1}{2}$ –2 minutes every 2–5 channels to allow vital signs to stabilize, achieve hemostasis, and avoid dysrhythmias.
- Manipulate the heart minimally.
- Bleeding from epicardial surface usually stops spontaneously, digital pressure may be required if bleeding continues.

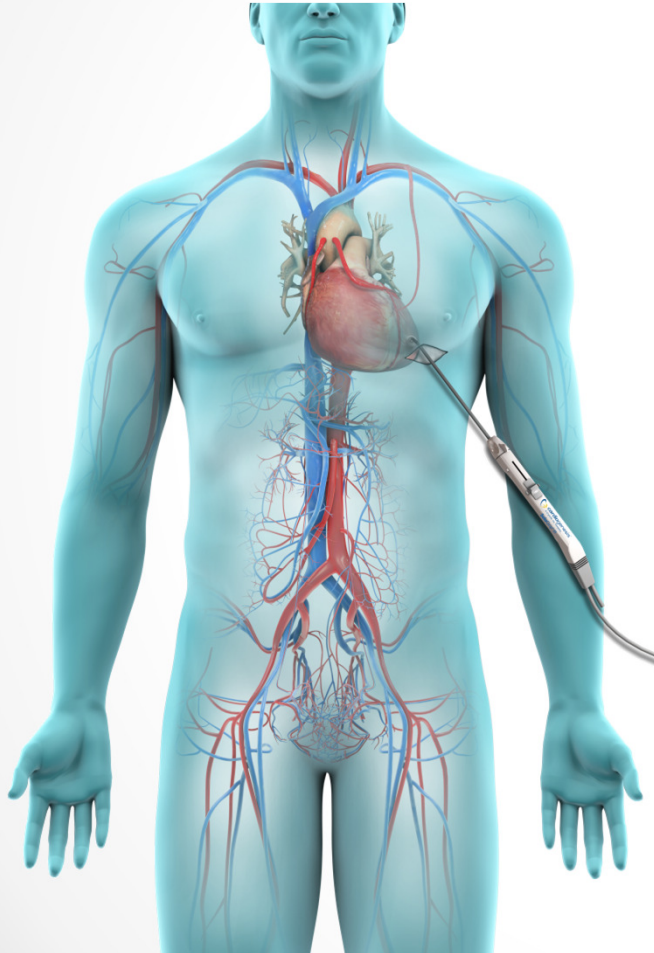


When/How can I do it?

- Sole Therapy (TMR Only)
 - Left Thoracotomy
 - Thoracoscopically
 - Procedure time – 60 to 90 minutes
- Adjunct to CABG
 - Sternotomy
 - TMR completed before or after CABG – 5 to 10 minutes



Sole Therapy TMR: Surgical Technique

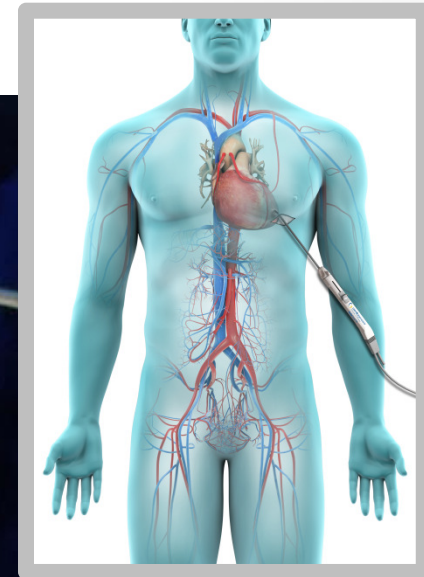
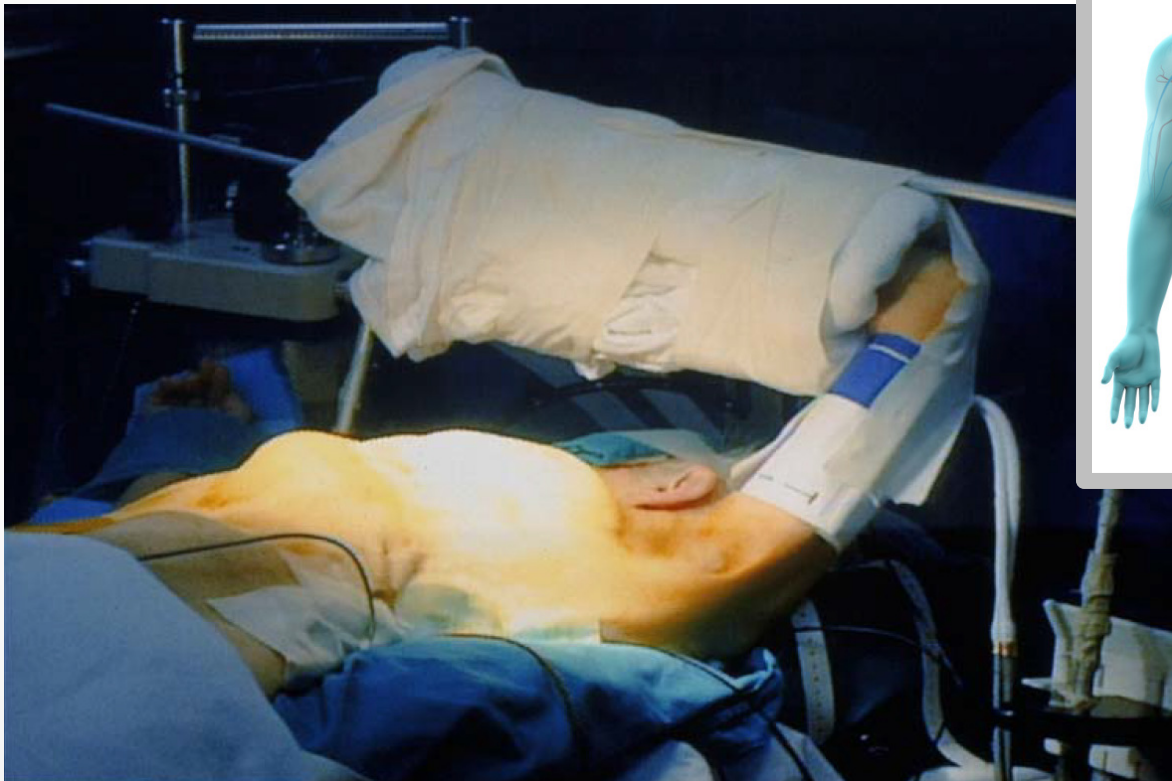


- Performed in OR
- General anesthesia
- Limited left anterior thoracotomy
 - This is essentially a more lateral mid-cab incision in the Y-Rib space in the 5th intercostal space.
 - Important to be in the 5th intercostal space because it will be more difficult to access the apex of the heart if not.
- Extubation in OR



Sole Therapy TMR: Surgical Technique

Patient Positioning



Right arm
at side of
patient

Image courtesy of Keith Allen, MD, St. Vincent Hospital, Indianapolis, Indiana



Intra-Operative Management

Arrhythmias

- To prevent:
 - When using the laser, remember to pause between groups of channels
 - The CardioGenesis laser system is a pulsed laser that fires five pulses per second.
 - Each pulse essentially causes an electrical stimulation of the heart. If you were to look on an EKG, you would see something like VT, but what you are actually doing is pacing the heart.
 - If you drill the channels too quickly, or if you don't allow the heart to recover in between a group of channels, you may place the patient into VT.
- To treat, can use:
 - Lidocaine bolus (100 mg)
 - MgSO₄



Intra-Operative Management

Tee

- Not required when using the Holmium:YAG (Ho:YAG) TMR system
 - When using the Ho:YAG system, you can rely on an auditory pitch change. You will hear the laser make a hollow or popping sound when you have traversed the tissue and are into the ventricle.
- Is required when using the CO₂ TMR System:
 - The CO₂ system fires a single shot timed with the EKG to fire on the R-Wave at the end of diastole when the ventricle is full because it relies on blood inside the ventricle to stop the laser from traversing through the heart and out into the body.

Intra-Aortic Balloon Pump (IABP)

- Want to be cautious when/if using because complications may occur



Post-Operative Management

Until your center gets up to speed, this is up to YOU because they are not familiar with these types of patients!



Post-Operative Management

Fluid Management

- This is extremely important because of the diastolic dysfunction you may see acutely with any type of laser you do on the heart. This may last up to 48 hours.
 - After Ho:YAG TMR:
 - Want to run patients dry.
 - Should not administer more than 1 liter of fluid.
 - Don't overload them and start diuresis on the afternoon of surgery.

Medication management

- Positive Inotrops
 - Resume Nitrates/ACE Inhibitors immediately if patients BP will tolerate
- Negative Inotrops
 - Resume Beta/Calcium Channel Blockers approximately 36–48 hours after surgery
 - Typically should start them with a lower dose than what they were on preoperatively



TMR: Adjunctive with CABG

Adjunctive TMR can be utilized in a variety of CABG scenarios:

- On-pump
- Off-pump
- Alternative incisions

TMR is an extremely versatile procedure!!!



TMR: Adjunctive with CABG

- Hybrid Revascularization with CABG+TMR:
 - Patients for whom the usual standard of care is CABG
 - Patients who have one or more major vessels or branches that are not by-passable for anatomical reasons
- Sternotomy:
 - Usual exposure for adjunctive TMR
 - Indicated for:
 - De Novo cases
 - Re-operations
 - Alternative to sole therapy approach



Adjunctive TMR: Surgical Technique

- Adjunctive therapy can be applied to:
 - Beating heart or arrested heart (on or off pump)
 - TMR prior to or after the placement of grafts on an arrested heart
 - Post-operative care unchanged from routine CABG
 - Fully heparinized patients
- TMR before/after the placement of grafts on a beating heart



Adjunctive TMR: Surgical Technique

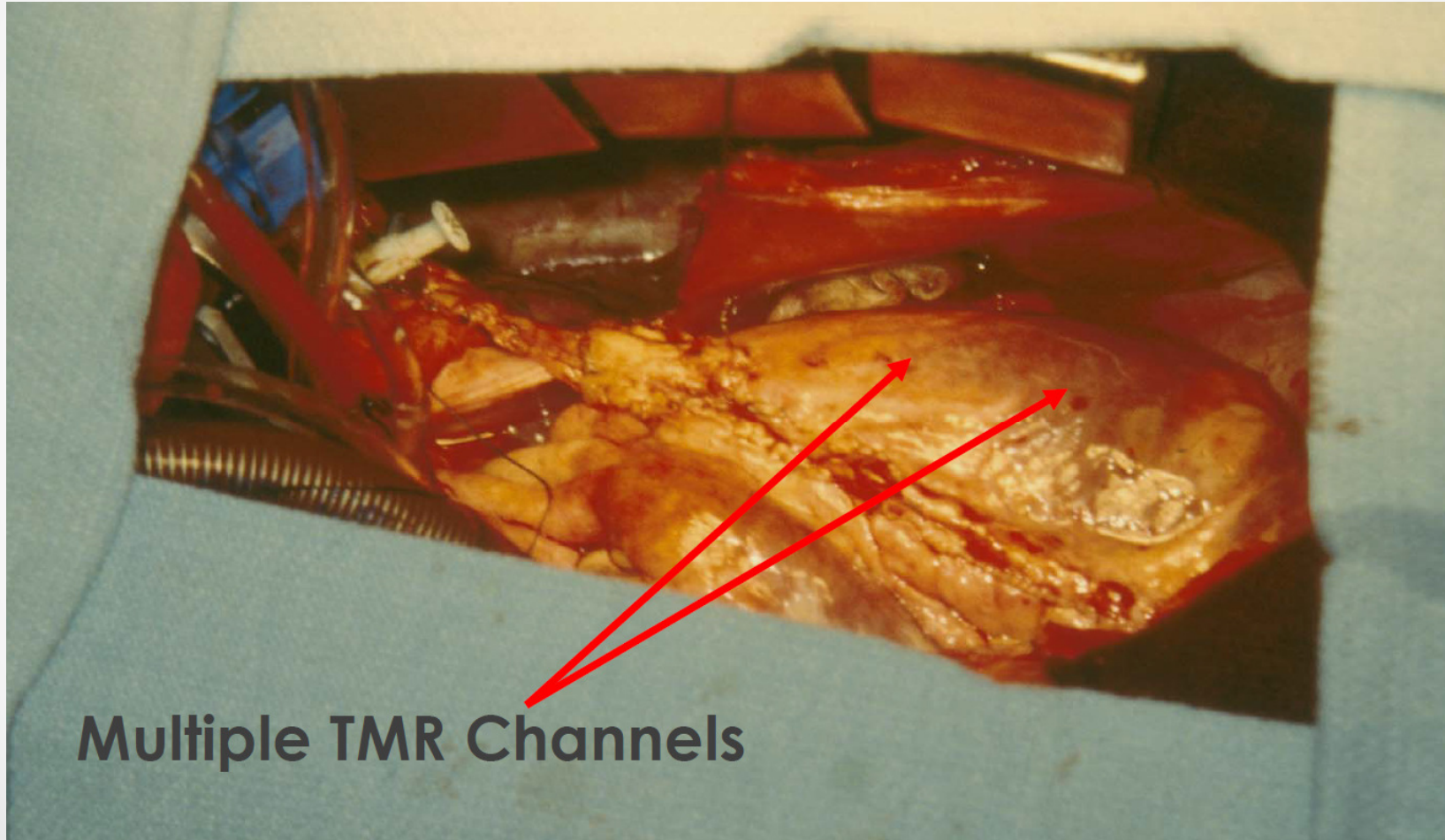


Image courtesy of Keith Allen, MD, St. Vincent Hospital, Indianapolis, Indiana



Proven Clinical Benefit

Clinical Trials Have Shown a Clinical Benefit
with the Use of TMR

- Primary Outcomes:
 - Relief of Angina by Two or More Classes
 - Increased Exercise Tolerance
- Secondary Outcomes:
 - Reduction in Re-Hospitalizations
 - Reduction in Medication Usage
 - Increased Event Free Survival
 - Increased Perfusion
 - Improved Quality of Life
- Long-Term Efficacy