THE RF APPROACH TO TREATING MITRAL REGURGITATION: THE QUANTUMCOR SYSTEM

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Presenter Disclosure Information

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Within the past 12 months, the presenter or their spouse/partner have had a financial interest/arrangement or affiliation with the organization listed below.

<table>
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<tr>
<th>Company Name</th>
<th>Relationship</th>
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<tr>
<td>QuantumCor</td>
<td>Major Stock Holder/Medical Director</td>
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<td>Kensey Nash</td>
<td>Honorarium</td>
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**Patents** -- RF, Snares, Wires, Balloon Catheters, Covered Stents, Devices for Arterial Venous Connection, Devices for LV and RV Closure
THE HEART IN SYSTOLE: VIEWED FROM BASE WITH ATRIA REMOVED
Background

• Ischemic Mitral Regurgitation (MR) is a common problem occurring in 45-74% of all myocardial infarctions and results in harmful ventricular remodeling and increased morbidity and mortality.
Percutaneous Treatments for Mitral Regurgitation

Percutaneous Treatment for Ischemic Mitral Regurgitation is not new...
Coronary Angioplasty for Acute Mitral Regurgitation Due to Myocardial Infarction

A Nonsurgical Treatment Preserving Mitral Valve Integrity

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Percutaneous Mitral E2E Repair

Caution: Investigational Device. Limited by Federal (US) Law to Investigational Use
Event Free Clinical Success Kaplan-Meier
Patients with Acute Procedural Success
n = 68
Evalve Results

• 100 Patients on Front end...18% out at end...eligible for enrollment
• 159 enrolled...135 receive clip
• Success rate 83%
• Discharged home 98%
Usually Addressed with Mitral Annuloplasty Rings

Reduce posterior annular circumference
Push posterior leaflet forward for better coaptation
Fig. 1. CS venography taken in the left anterior oblique 30° view demonstrates the close relationship between the CS and the mitral annulus. The CS encircles the mitral annulus. The GCV empties into the CS and then into the RA. AIV, anterior interventricular vein; CS, coronary sinus; GCV, great cardiac vein; MAR, mitral annuloplasty ring; RA, right atrium; LPV, left posterior vein; and 7F C = 7 French catheter.
Coronary Sinus Anatomy For the Venture Capitalist

Coronary sinus allows percutaneous mitral repair

Standard Sheath  Coronary Sinus  PTMA Device
Coronary Sinus Anatomy For The Clinician

Coronary Artery Between IV Vein or CS and Mitral Annulus In 16.4% and 63.9%

\{ Mean Distance 9.7 +/- 3.2 mm

Maselli, et.al., Circulation, August, 2006
Problems with coronary sinus approach

• Anatomic variability is great
• Muscle stretch may occur over time losing the desire effect over time
• Potential for compromise of the circumflex coronary artery as it passes beneath the coronary sinus
• Long term effect of a device in the coronary sinus not known (probably not a problem)
Distal Anchor

Proximal Anchor

AJGC. 2006;15:291-301.
AJGC. 2006;15:291-301.
Why Pursue Percutaneous Devices in FMR

- Devices Do Work To Some Degree In Some Patients
- Only A Miniscule Percentage Of The 400,000 Patients With HF And FMR Are Currently Referred For Surgery
- These Are Still First Generation Devices
- There Is A Whole Lot Of Money And A Lot Of Smart People Working On This
Background

Mitral Annulus Slices

(Trichrome Stain)

Left, Posterior Leaflet Segment

Middle, Posterior Leaflet Segment

Right, Posterior Leaflet Segment
The QuantumCor™ Device Uses Radiofrequency (RF) Energy At Sub-ablative Temperatures To Produce Contraction Of The Mitral Valve Annulus And Theoretically Reduces Mitral Regurgitation.
Method
Method

- 7 Electrodes/14 Thermocouples
- 3mm Length
- 2mm Spacing
- 40mm Loop Diameter

Boa-Surg
Acute Animal Procedure

- **Intra-cardiac Ultrasound (ICE) Pre-procedure.**
- **Left Thoracotomy-on Pump.**
- **Access Through The Atrial Appendage.**
- **Sutures In 4 Regions Of The Annulus As Markers (1-2cm).**
Mitral Annulus Treatment Sites

Method

Anterior Leaflet

Site 1

Site 2

Posterior Leaflet

Site 3

Site 4
Mitral Annulus Treatment Sites

Method

Anterior Leaflet

Posterior Leaflet

Site 1

Site 2

Site 3

Site 4

PA or Septal Lateral
RESULTS
Mitral Annulus Treatment Sites

Anterior Leaflet

Posterior Leaflet

Site 1

Site 2

Site 3

Site 4

PA or Septal Lateral

Reduced by 5.0 ± 2.1 mm (p < .001)
RESULTS

June 27, 2006
Mitral Valve Pre-treatment
S-L Diameter 28.7 mm

Sheep #10
Mitral Valve Post-treatment
S-L Diameter 20.3 mm
RESULTS

Acute Histopathology Results

"Acute Radiofrequency Treatment Of The Mitral Annulus With The QuantumCor Probe Produced Well-demarcated And Discrete Areas Of Subendocardial Myofibrin Necrosis With No Or Little Appreciable Acute Structural Effect Microscopically To The Collageous Framework."

RESULTS

Acute Histopathology Results

• No damage to the valve leaflets.
• No damage to the coronary sinus.
• No damage to the coronary arteries.
BOA-SURG Probe
RESULTS

Animal Study Summary

16 Total Sheep Treated

7 Chronic

2 Developed (4,6) Systemic Infection

5 Currently Survived

9 Acute
RESULTS

Acute Success in All Animals

Acute and Chronic Pre-Post OP
N=16
Mean Reduction=23.82%   A-P Reduction=5.75+/-0.86 mm
RESULTS

Chronic Histopathology Results

• The healing process was shown to be mature and complete at the 90 observation period. There were no apparent adverse changes caused by the thermal treatment at 90 or 180 days.
RESULTS

Chronic Histopathology Results

- When extramural coronary arteries were present in the tissue, they were not involved in the lesion and were microscopically normal.
- Most sites at 180 days showed no appreciable microscopic changes.
RESULTS

Chronic Histopathology Results

• No damage to the valve leaflets.
• No damage to the coronary sinus.
• No damage to the coronary arteries.
Chronic Animal Series S-L Shrinkage Durability

More Than a Leap of Faith
Human Heart Project
Histological Comparison of MV Annulus
Human vs. Ovine

- Tissues Stained with Hematoxylin & Eosin (H & E) and Masson’s Trichrome.
- Annulus of mitral valve of both species consisted of a sheet of closely packed connective tissue fibers.
- Connective tissue of Ovine have the appearance of small closely packed bundles.
- Connective tissue of human have the appearance of tissue arranged as a sheet or of very large bundles.

Conclusion:
- Overall structure of the mitral valve annulus of human and Ovine sections are comparable.
- Both the annular segment and histology studies validate that the human results should be similar to what was seen in the Chronic Ovine series.
Histological Comparison of Mitral Valve Annulus: Human VS Ovine

Human Mitral Annulus X-section

Sheep Mitral Annulus X-section
Annulus Linear Shrinkage
Porcine (In situ), Human (In situ) and Ovine (In vivo)
BOA-SURG Probe
BOA-SURG Probe
The RF Approach to Treating Mitral Regurgitation: The QuantumCor System

A Repeatable Less Invasive Option May Be Desirable.
The Best Possible Application to the Less Invasive Approach for Mitral Regurgitation...
FUNCTIONAL MR
ISCHEMIC MR
EXTREMELY REDUCED LV FUNCTION
MODERATE MR
Background
Percutaneous Mitral Valve Repair

- **Obvious Strategy for PMVR is to combine direct valvular procedure with a percutaneous annuloplasty technique**

- **Mimics what is done surgically**
Percutaneous Treatment for Mitral Regurgitation

• With RF Energy Applied To The Mitral Annulus It May Be Possible To Treat A Larger Population Of Patients With Mitral Regurgitation.

• If You Don’t Succeed You Can Repeat The Procedure.

• Treat Without Affecting The Coronary Sinus.

• Use In Conjunction With Leaflet Procedures.
CONCLUSIONS

The QuantumCor Device May Offer An Option For Some Patients With Mitral Regurgitation:

1st In The Operating Room.

Eventually As A Percutaneous Treatment For Mitral Regurgitation That Could Be Performed With Standard EP RF Consol In The Catheterization Laboratory.
Surgical isolated edge-to-edge mitral valve repair without annuloplasty: clinical proof of the principle for an endovascular approach

Francesco Maisano*, MD; Giorgio Viganò, MD; Andrea Blasio, MD; Antonio Colombo, MD; Chiara Calabrese, Ottavio Alfieri, MD

San Raffaele University Hospital, Milano, Italy
Surgical Isolated Edge-to-edge Mitral Repair Without Annuloplasty

Clinical Proof Of Principle For An Endovascular Approach

Freedom from re-operation and 2+ MR

Maisano F, Vigano G, Blasio A, Columbo A, Calabrese C, Alfieri O,
Eurointervention 2:181-186, 2006
Evalve Results

- Freedom from MACE 30 days 95%
- Partial clip detachment 8.7%
- 73% surgery free at follow-up
- ~ 50 patients randomized most have 1+ or less of MR
Human Heart Project

• Bench-top treatment comparison between normal:
  - Human mitral valve annulus, in situ
  - Porcine mitral valve annulus, in situ
  - Ovine mitral valve annulus, in vivo
  - Ovine mitral valve annulus, in situ (not complete)

**Objective:** Evaluate in situ thermal shrinkage in human annular tissue as compared to Porcine

• Histological comparison of annular collagen in:
  - Human normal
  - Human with MR
  - Ovine normal

**Objective:** Evaluate human annular collagen as compared to Ovine collagen
Results

• All tissue segments treated the same: RF generated heat, 65 °C, 50 W for 60 Seconds.

• Several human segments intermittently calcified probably affecting the shrinkage response.

• In-situ porcine and human segments response similar, 8.9 and 8.5 %, respectfully.

• Ovine response greater, 11.8 % expected-live viable tissue.

• On-going study-Ovine in situ and MR human hearts in situ to be evaluated next.