St. Vincent's Hospital Sydney Limited

UNDER THE CARE OF THE SISTERS OF CHARITY

Sydney Australia

New Concept of “Patient Robot” based on Cardiovascular Analysis

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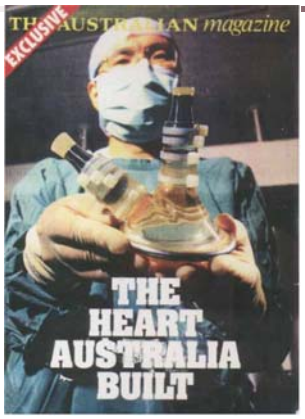
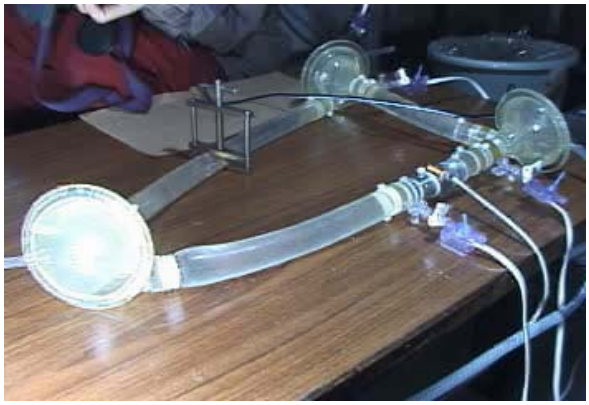
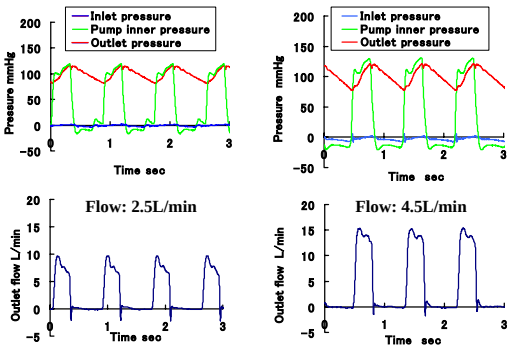
<Contents>

1. Self introduction: Bloody Engineer
2. Brief summary on “Mock circulatory system” (Cardiovascular simulator)
3. Background of “Patient Robot”
4. Basic trials for the development of “Patient Robot”

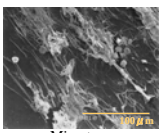


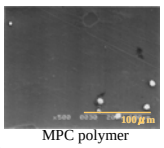


Typical Hydrodynamic Waveforms in the Circuit



In vitro Biocompatibility test using Natural Blood


Miractran

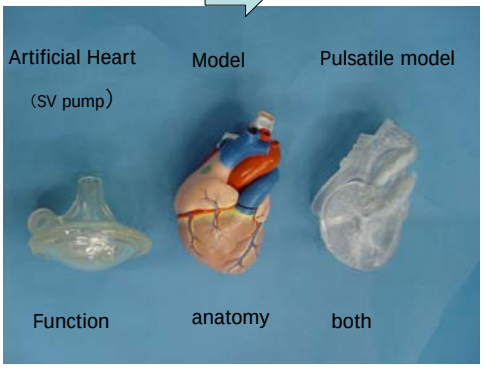

MPC polymer

1) Complete closed circuit
2) Elimination of flow stagnation
3) All disposable circuit

Heart Model

(Patient robot project)

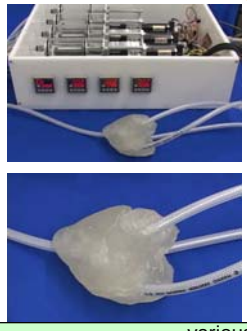
Based on Simulation Technology → Anatomically, functionally identical

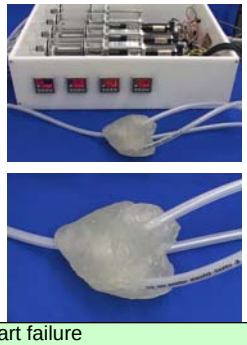


Contractable artificial heart

(One of the patient robots)

Pattern 1 | Pattern 2





⇨ various heart failure
more realistic test condition

☆ Background
How to practice surgical procedure

Requirement of expert surgeon

At least 20 cases experience per year as the chief surgeon

※Japanese guideline

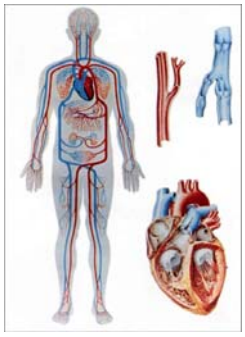
Small number ！

Heart surgeons(2005,4) → **1,642**

CABG (2001) → **20,095** cases

⇨ Cases for each surgeon $\frac{20,095}{1,642} = 12.23$ 症例/人年

Specification of
"Patient Robot with Vascular Disease"

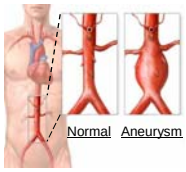


1. Identical pulsatile movement
2. Similar to natural hemodynamics
3. Reproduction of various cardiovascular disease

⇩

Give surgeons a realistic feeling of being at a live performance

Aortic aneurysm



Clinical case

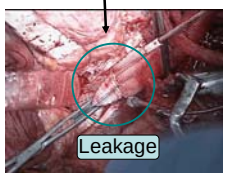
Leakage from anastomosis

⇩

Different outcome

⇩

Quantitative skill evaluation



Purpose

In vitro evaluation of anastomosis portion

Method

Leakage test under pulsatile flow/pressure

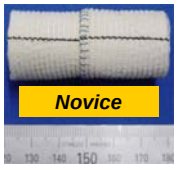
Sutured Model

Vascular graft

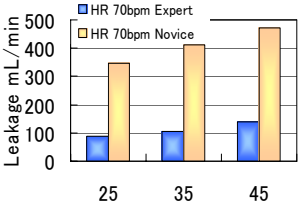
Material Woven Dacron
Diameter ϕ22 mm

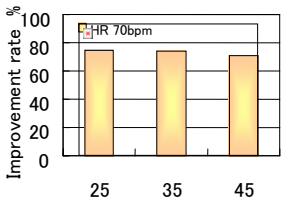
Suture procedure

String 3-0 proline（ϕ0.20 ~ 0.269 mm）
Material Polypropylene（monofilament）
Number of stitch 32 stitches

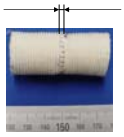


Result





Margin to sew up



Improvement rate $\left(100 - \frac{L_E}{L_N} \times 100\right)$

74.0±1.9%

⇨

Expert 2.05±0.28mm
Novice 2.84±0.32mm

Conclusion

1. Distinct difference of leakage between Expert and Novice.
2. Some relation between leakage and margin to sew up.

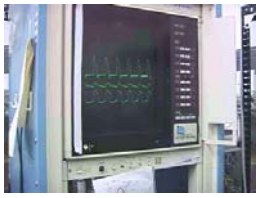
Perspective

1. Fine measurement of sewing tension
2. Identical mechanical properties to be used to produce realistic environment

Present Robot Surgery

→ Quantitative evaluation by Patient Robot is a key for future medical treatment

Current mock circulatory system developed at Umezu Laboratory



1. Similar pressure / flow waveforms
2. Functionally identical design at Left atrium
   - Left ventricle
   - Aortic valve
   - Mitral valve
   - Aortic arch
   - Peripheral resistance

Background

Innovative medical treatment

Present

No quantitative evaluation

Important factor ⇨ Number of cases

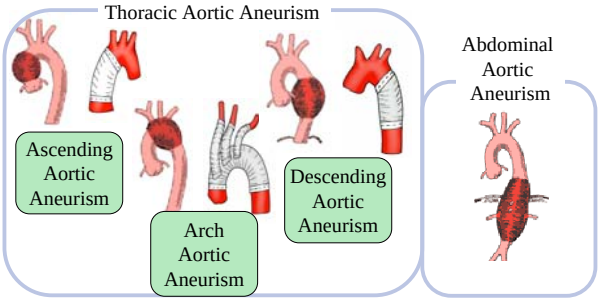
Future

Quantitative evaluation of surgical skill

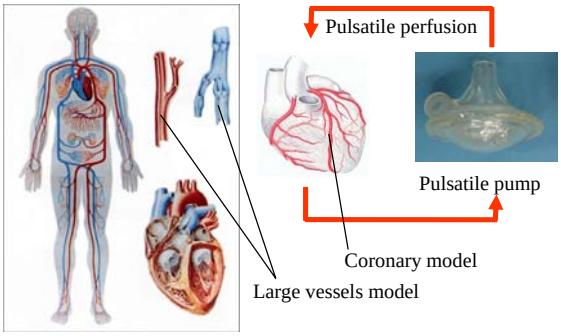
⇩

Engineering Based Medicine(EBM)

Aortic Aneurism

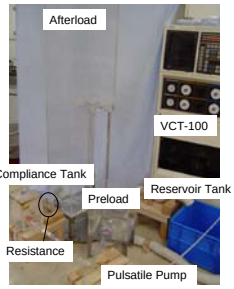


Total number of vascular surgery: 5185 cases (in 2001)



Cardiovascular modeling conducted by Umezu Laboratory

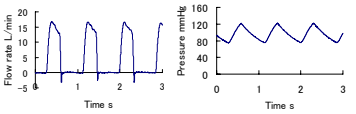
Pulsatile In Vitro Test System



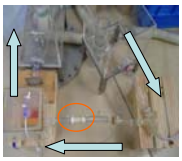
Pulsatile flow circuit

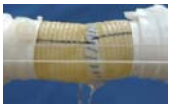
Flow

Pressure



Wave forms





Test section