

Off-Pump CABG is “the platinum standard” in Japan

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**JACAS &
JAOPCAB**

**AHA Scientific
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Thank you, chairpersons. Ladies and gentlemen, it is a great honor to have this opportunity to report and discuss the current status of off-pump CABG in Japan. And again. I would like to thank Dr Puskas and Dr Woo very much on behalf of the following two associations.

Presenter Disclosure Information

- *Shinichi Osaka*
- *Off-Pump CABG is the platinum standard in Japan*

FINANCIAL DISCLOSURE: None

UNLABELED/UNAPPROVED USES DISCLOSURE:
None

“We have two nationwide associations specific for CABG”

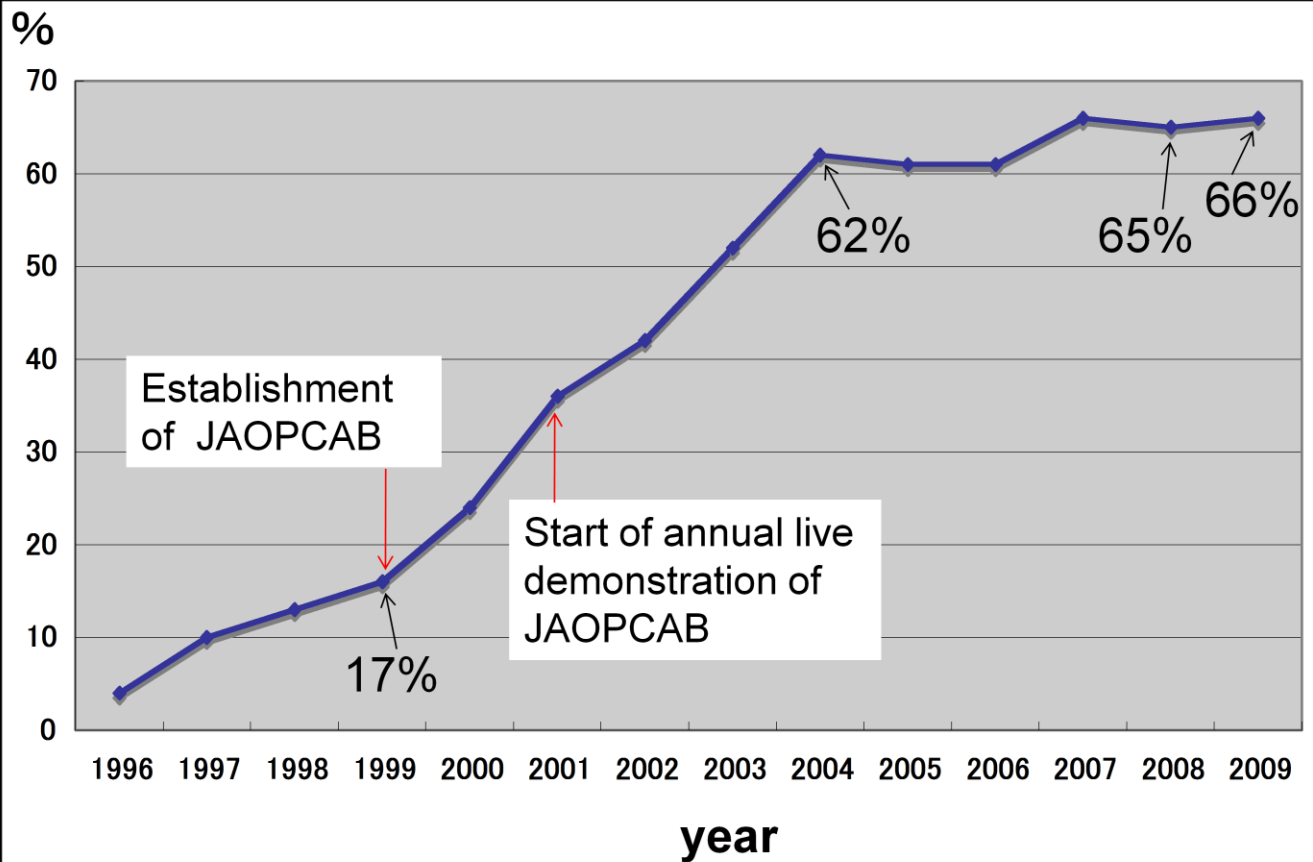
**JACAS: Japanese Association
for Coronary Artery Surgery**

**JAOPCAB: Japanese Association
for Off-Pump CABG (OPCAB)**

I will introduce two associations specific for CABG in Japan. JACAS was established in 1996 and collects the data on CABG and reports it every year. JAOPCAB was established in 1999 for prevalence of off-pump CABG.

Proportion of off-pump technique in JAPAN for elective primary CABG

JACAS
DATA



This graph shows the proportion of off-pump technique for primary elective CABG. In 1999, the off-pump rate was only 17%, when Japanese association for OPCAB was established, but It has increased gradually and since 2001 when the association first began live demonstration of off-pump CABG, the proportion has increased rapidly.

In 2004 the off-pump CABG rate exceeded 60% and it has been so for six consecutive years.

Coronary artery bypass grafting in JAPAN 2009

JACAS
DATA 2009

Total number : 14,262

Isolated : 10,659 (75%)

Combined : 3,603 (25%)

Isolated CABG

Elective primary: 8,974

Off-pump : 5,939

On-pump : 3,035

(Off-pump rate: 66%↑)

Redo/Emergency: 1,685

Off-pump : 843

On-pump : 842

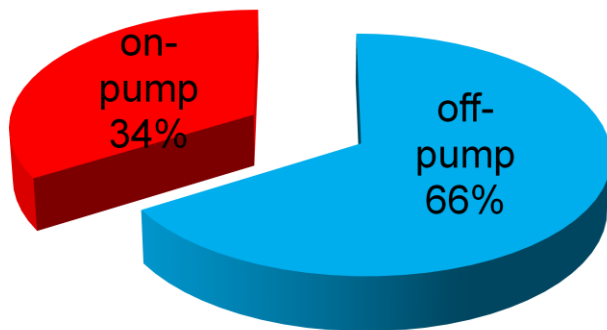
(Off-pump rate : 50%↓)

This is the latest report from the JACAS . The total number of CABG was 14,262, including isolated CABG 10,659 and 3,603 were CABG combined with other cardiac surgery.

Of the isolated CABG, 8,974 cases were the number of primary elective CABG and 1,685 cases were redo and /or emergency.

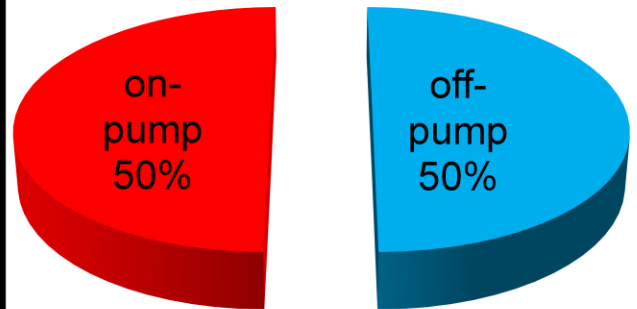
Proportion of off-pump CABG in JAPAN 2009

Primary, elective



N=8,974

Redo/Emergency

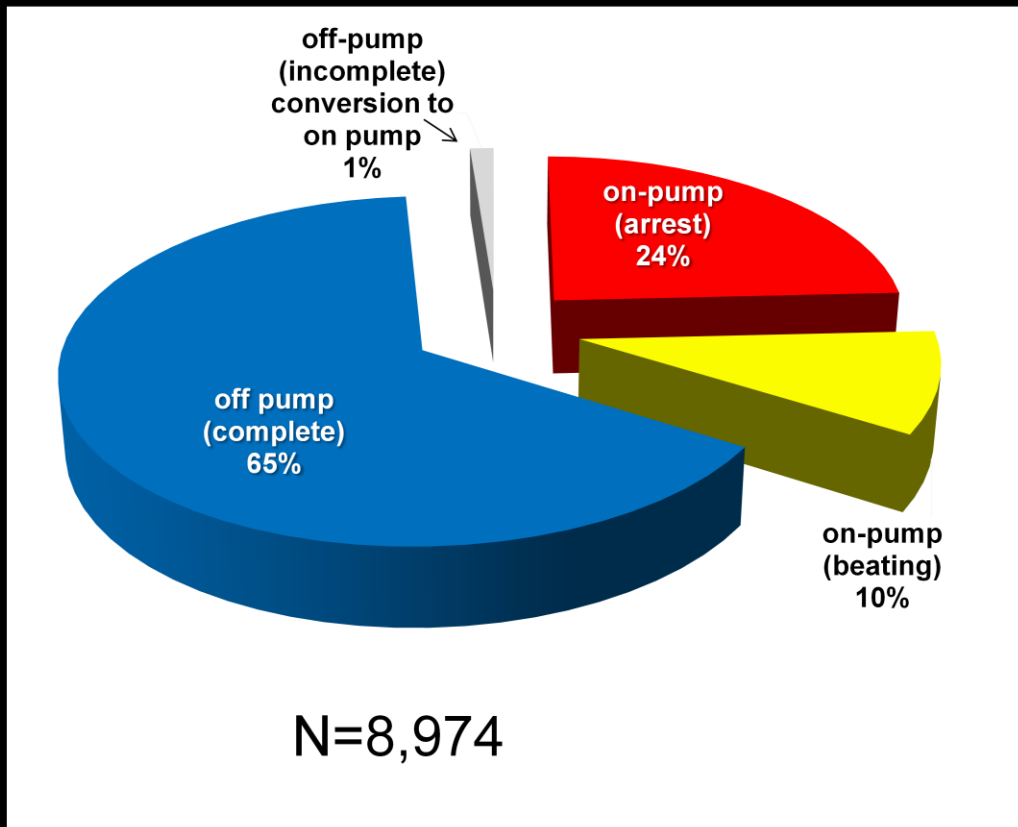


N=1,685

While 66% of primary elective CABG was performed by off-pump technique, 50% of redo and/or emergency CABG was performed by off-pump technique. In this slide, off-pump CABG includes the cases in which, for whatever reason, the off-pump technique was converted to the on-pump technique.

Primary elective CABG

Technical Differences in JAPAN 2009



This slide shows the detail of proportion of techniques. As I mentioned, 66% underwent off-pump CABG

but 1% had conversion to on-pump for some reason.

So among the off-pump group, 98.2% had the completion of procedure, but 1.8% had pump conversion.

On the other hand, 24% had on-pump CABG with cardiologic arrest and about 10% had on-pump beating CABG.

Techniques of elective primary CABG of 8,974 in Japan in 2009

JACAS
DATA 2009

On-pump (cardioplegia) :2,175(24.2%)

On-pump (beating) : 860 (9.6%)

Off-pump (initial) :5,939(66.2%)

Off-pump (complete) :5,830

On-pump (pump conversion):109

Completion : 98.2%

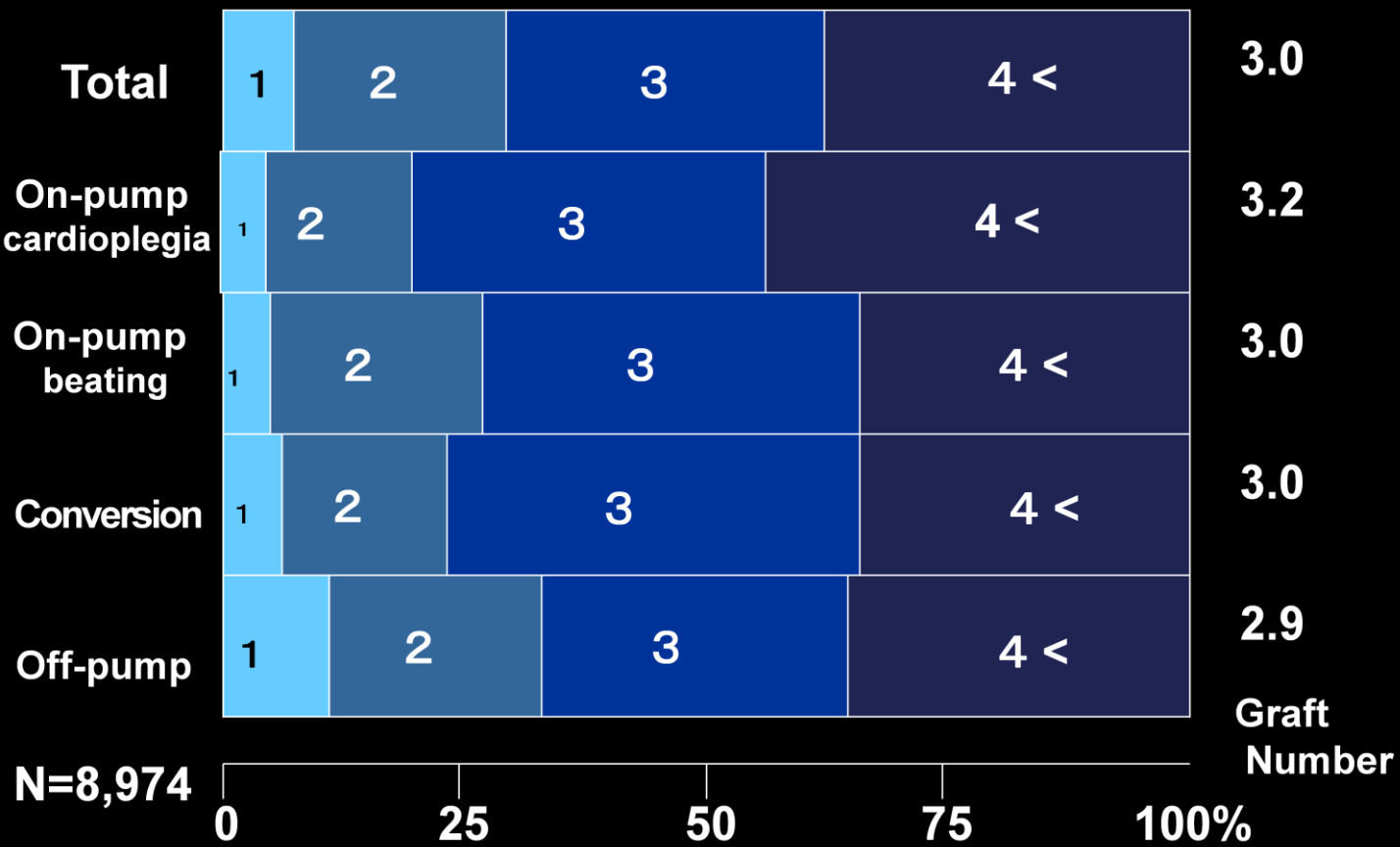
Pump conversion : 1.8%

This is the detail of the previous slide.

The hospital mortality of the primary, elective case is shown in this slide. The total hospital mortality was 1.2%. Hospital mortality of the on-pump CABG with cardioplegic cardiac arrest was 0.6% and on-pump beating CABG was 1.98%. As to off-pump CABG, the total hospital mortality was 1.3% and hospital mortality of conversion case was 6.4%.

Average number of graft in primary elective CABG

JACAS
DATA 2009



How many grafts were used in different techniques? The average of number of grafts in all primary elective CABG was 3.0/patient. In on-pump CABG with cardioplegic arrest it was 3.2/patient and 2.9/patient in off-pump technique. There was no considerable difference.

Hospital Mortality

JACAS
DATA 2009

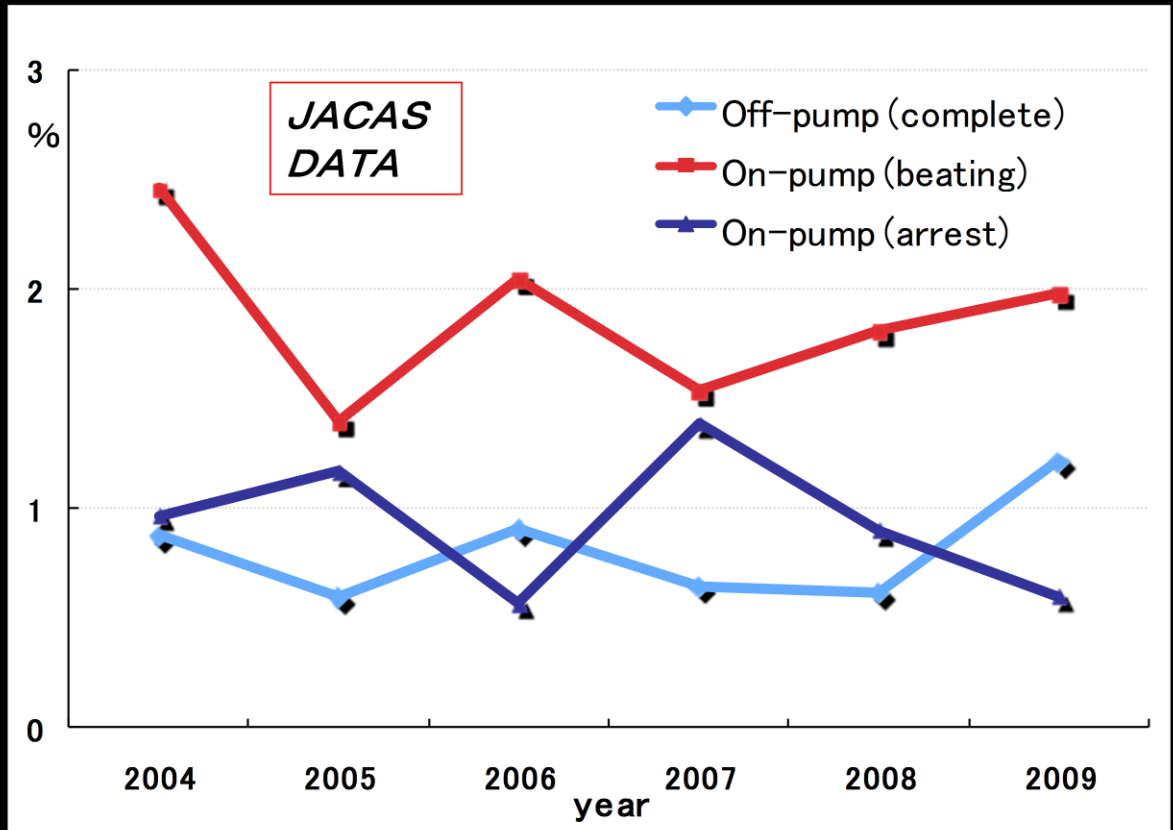
Isolated CABG: 2.1% **N=10,659**

Elective primary: 1.2% **N=8,974**

On-pump (Arrest) : 0.6%
On-pump (beating) : 2.0%
Off-pump : 1.3%
Off-pump completion : 1.2%
Pump conversion : 6.4%

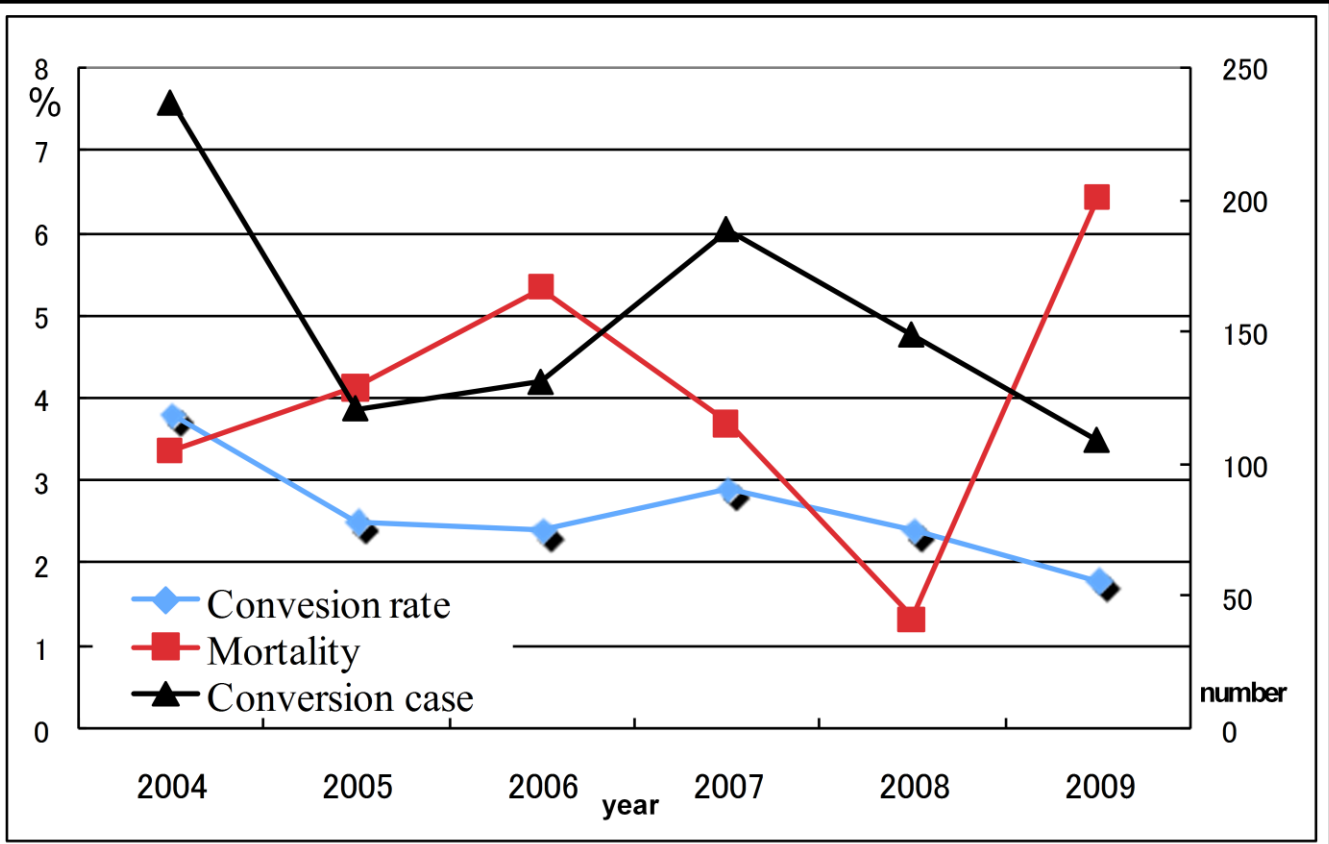
The hospital mortality of isolated CABG , including primary elective and redo and/or emergency was 2.1%. The hospital mortality of primary elective CABG, on-pump CABG with cardioplegic arrest , and on-pump beating CABG were 1.2%, 0.6% and 2.0% respectively. As for off-pump CABG, 1.2% for the completion group and 6.4% for conversion group.

Mortality of different techniques in primary elective CABG



We can see the hospital mortality of three different technique over the past 6 year period when off-pump rate for the primary, elective CABG constantly exceeded 60%. The dark blue line shows the mortality of on-pump with cardiac arrest and the light blue line shows that of off-pump CABG. The mortalities of on-pump and off-pump have been stable around 1% and the mortality of on-pump beating which is shown by red line has been at the level of near 2%.

The number, rate and mortality of conversion to on-pump CABG from 2004 to 2009 *JACAS DATA*



This slide shows the conversion rate and its hospital mortality over the past 6 years.

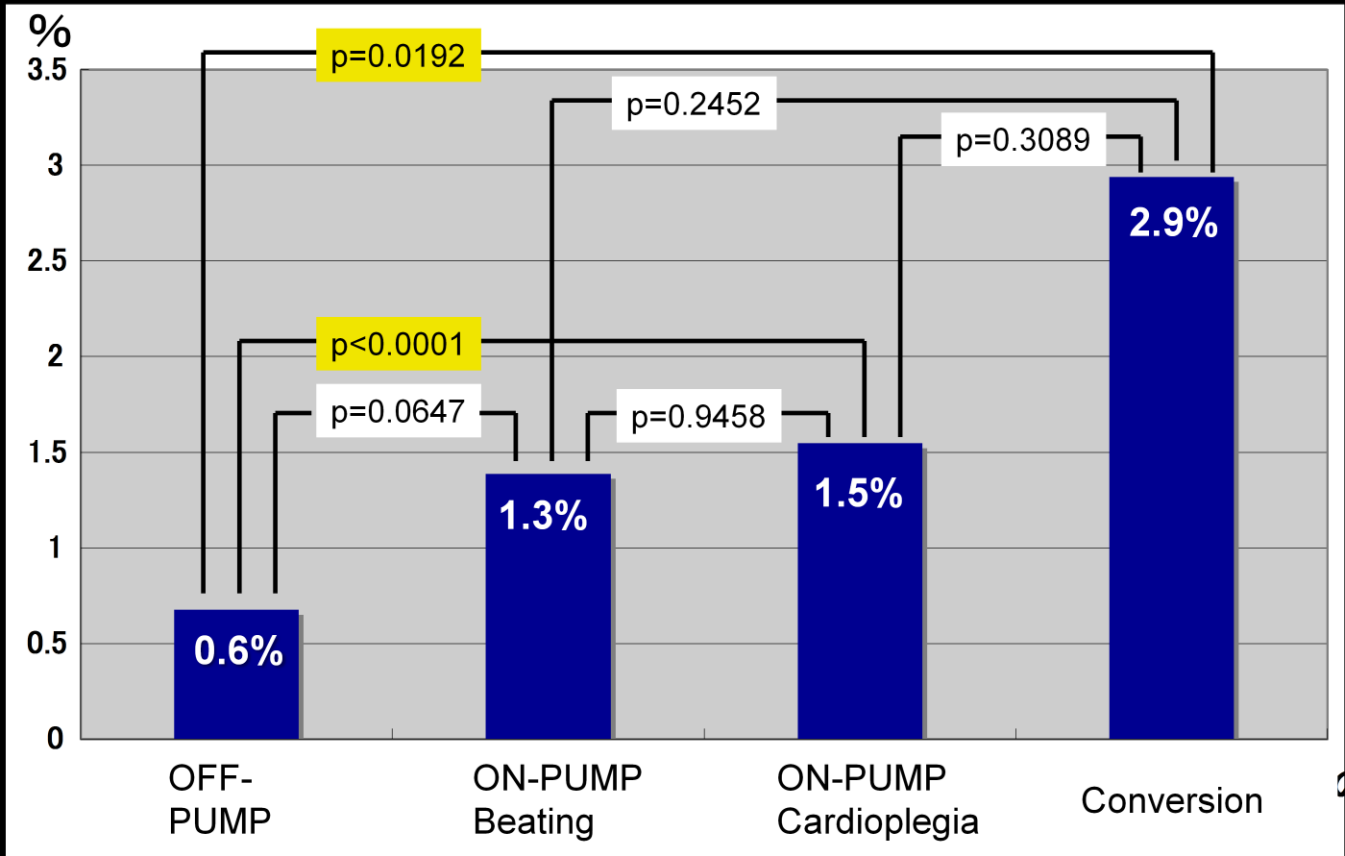
Both the conversion rate and the mortality have tended to decrease but the mortality increased from 1.2%

to 6.4% from 2008 to 9. So it is certain that pump conversion is still an important problem in off-pump CABG.

Incidence of Stroke in isolated primary elective CABG

total : 1.0% N=8,974

JACAS DATA 2009

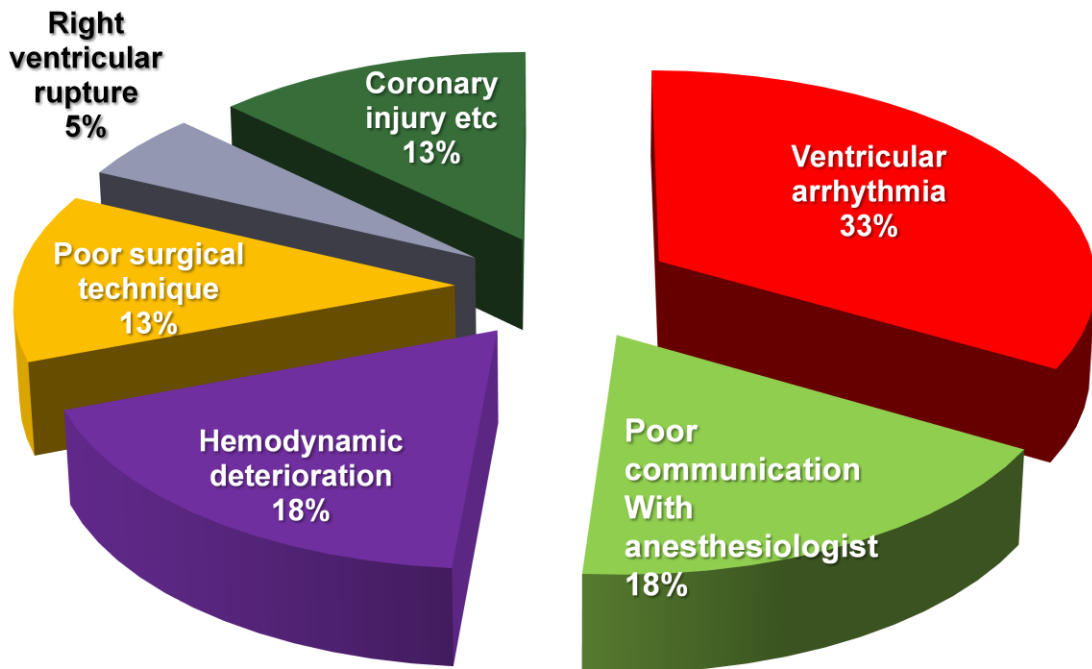


This slide shows the incidence of perioperative stroke in primary elective CABG. The off -pump CABG had the lowest incidence of 0.7%. This was statistically lower than that of on-pump CABG with cardioplegic arrest which was 1.5%.

But the incidence of the conversion group was 2.9% which was the highest.

Causes of conversion from off-pump to on-pump CABG during operation

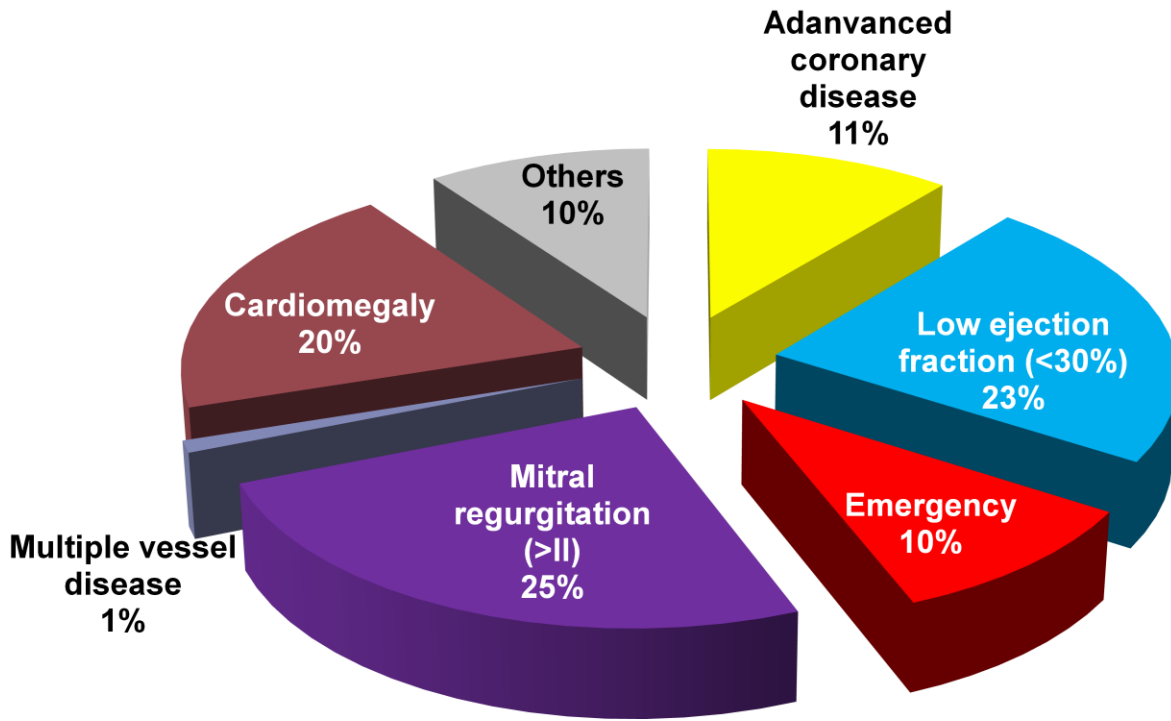
Answers from 39 Japanese OPCAB surgeons



So I will take up the pump conversion issue here. I asked several questions to 39 cardiac surgeons, most of whom have each performed more than 100 cases of off-pump CABG in a year. The first question was “What were the common causes of pump conversion in off-pump CABG?”. The results are shown here. For the first question it should be noted that poor communication with anesthesiologists accounted for 18%

Reasons for intentional avoidance of OPCAB

Answers from 39 Japanese OPCAB surgeons



The second question was “ Why did you avoid off-pump CABG intentionally?”

The most common reason was coexistence of mitral regurgitation of 25%. It followed by low ejection fraction. of 23%.

And cardiomegaly account for 20%. These results were quite reasonable.

How to avoid conversion from off-pump to on-pump CABG

Good patient selection

Good anesthesiologists

Good communication with them

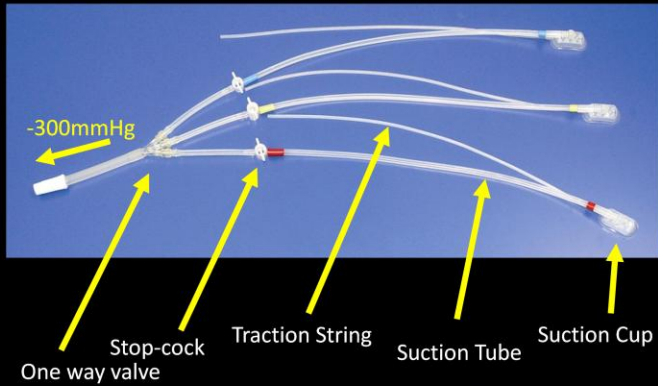
Good exposure and immobilization

Good surgical techniques

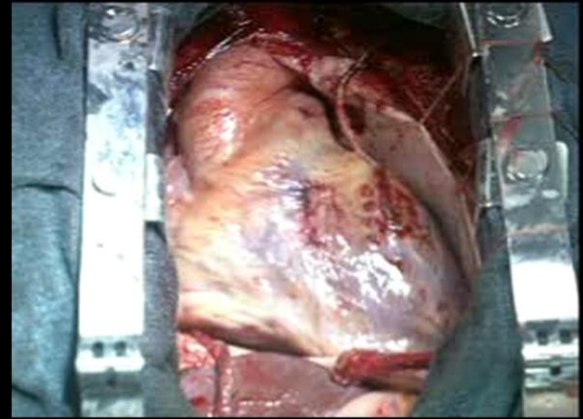
Good validation of anastomosed grafts

I summarized the key points for how to avoid pump conversion. All these points have been considered many times and at many places. However I here would like to emphasize the last three points.

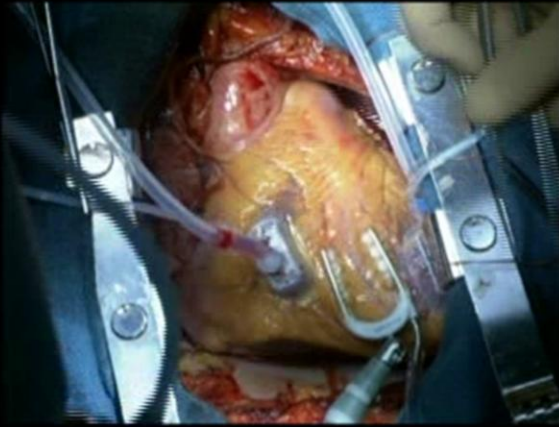
Good exposure & stable hemodynamics



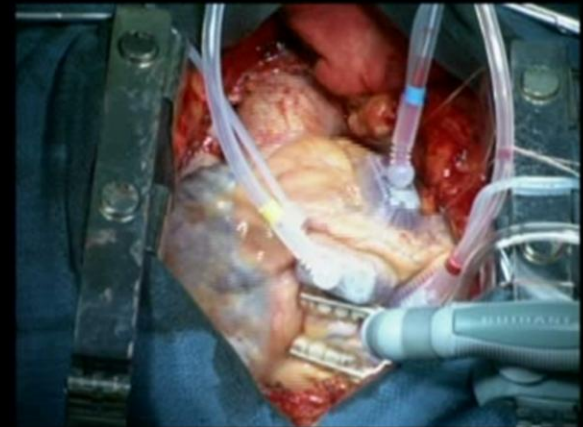
Cx



LAD



#4PD



TENTACLES™

For a good exposure I will show you the advanced Japanese heart positioning device, the Tentacles, which comprises three traction silicon strings with a suction cup on the one end. This device was invented by Professor Arai. As you see, using three silicon strings in a step by step fashion any aspects of the heart can be exposed without blood pressure drop while avoiding the distortion or compression of the heart.

Intra-operative Graft Validation Technique is so important to keep high level OPCAB

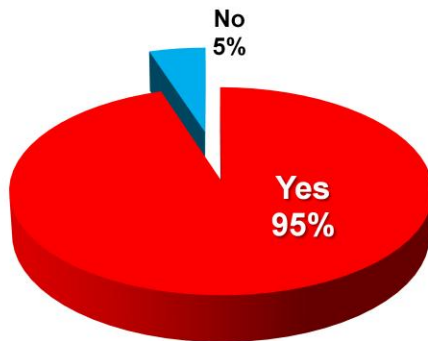
- 1. Transit time flow measurement (TTFM)**
- 2. ICG fluorescence imaging system (SPY)**
- 3. B-mode & Doppler color flow mapping (VeriQc)**

Moreover, intra-operative graft validation is so important not only for avoidance of pump conversion but also for the high quality of off-pump bypass grafting. There are three useful modalities for this purpose.

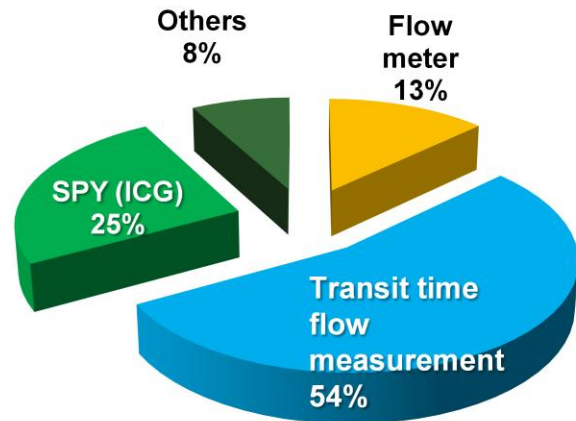
How to validate the patency of bypass in OPCAB

Answers from 39 Japanese OPCAB surgeons

Intraoperative graft validation



Intraoperative graft validation technique



VALIDATION technique

Again I asked 39 surgeons the way to validate grafts intra-operatively. 95% of the surgeon routinely perform graft validation, 54% use transit time flow measurement system and 25% use ICG IPY system and 13% use flow-meter.

SPY™

Intraoperative imaging
system using ICG
fluorescence property



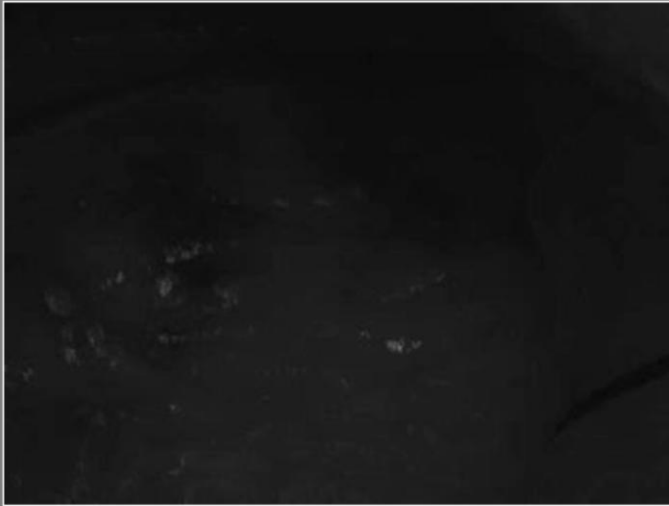
VALIDATION technique

SPY is the graft validation modality to visualize the bypassed graft intra-operatively.

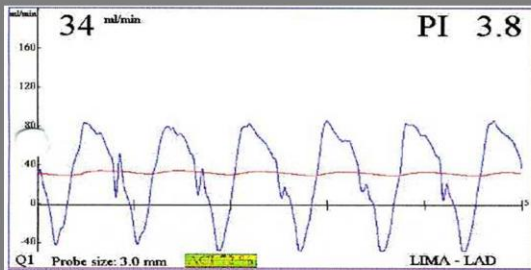
I show you some cases in which SPY revealed the technical error of grafting.

December 12, 2002 was the first day when SPY was used in Japan by Dr Takahashi.

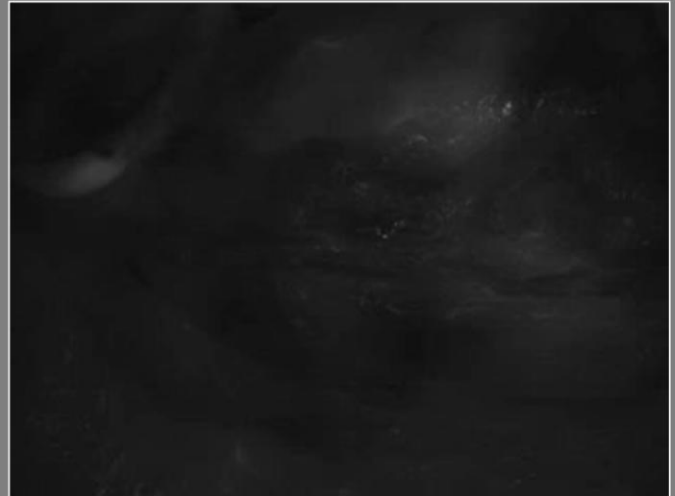
LITA – small LAD grafting



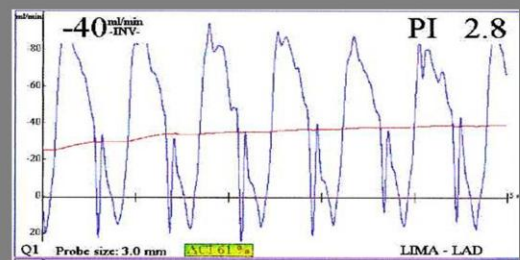
SPY could reveal that the toe side of the LAD anastomosis was occluded.



After revision



After revising the LAD anastomosis, the graft flow was visualized clearly.



In this case, the left anterior descending artery (LAD) was bypassed with the in situ left internal thoracic artery (ITA), but the graft and the LAD could not be well visualized even after ICG injection via the central vein. But after revising the anastomosis, the graft and the LAD could be visualized with improvement of graft flow.

Distal revision case

66 y.o.male, Emergency OPCAB

SVG-4PD-4AV



SPY detected an occlusion of 4AV anastomotic site.

After revision



After revising the 4AV anastomosis, a clear image could be seen by SPY.

This is another case of revising the anastomosis. The sequential vein graft to the posterior descending artery and the distal branch by the SPY system. Both bypassed arteries could be visualized via the graft after the revision of the distal graft anastomosis.

The VeriQ^c System

- The most complete system for intra-operative quality and guidance
- Based on proven VeriQ2/3 platform
- High performance ultrasound
 - Simultaneous 2D, CFM, PW and TTFM
 - Up to 20MHz ultrasound bandwidth
 - Supports all common geometries and modalities

VALIDATION technique



Now we can use an effective graft validation modality, VereiQc system, which has the functions, B-mode, and color flow mapping.

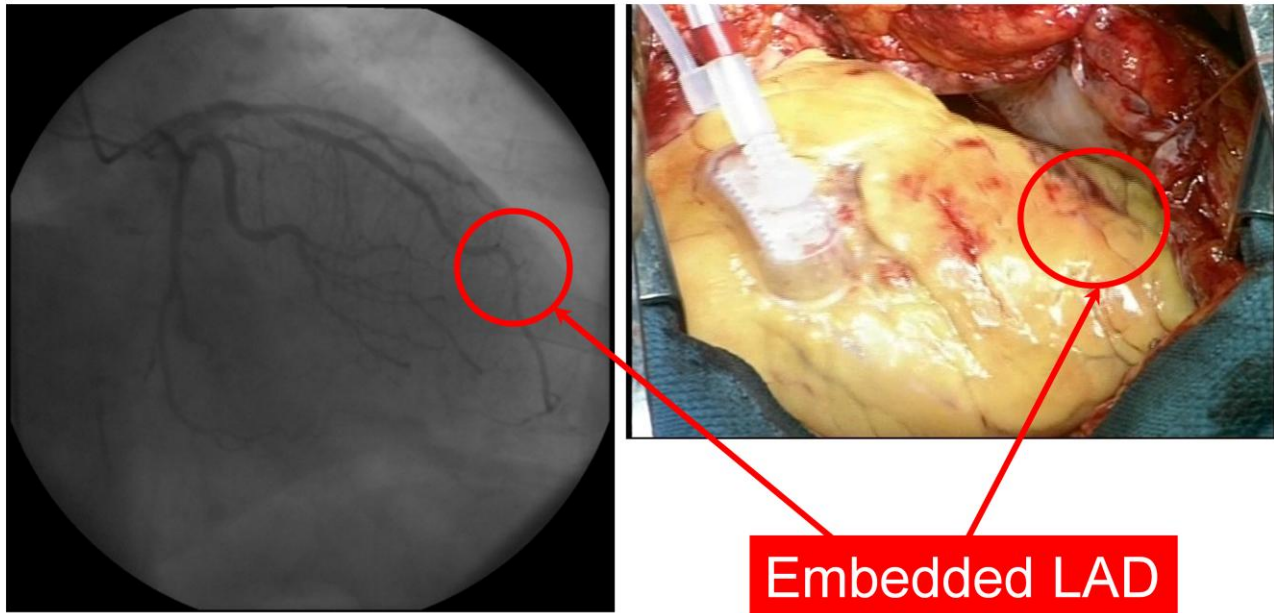
The VeriQ^c probe

- Imaging @ 15MHz gives superior resolution in the near field 0-40mm
- Low profile probe design for easy access
- Plasma sterilizable 50 times
- Approved for direct cardiac contact



The flow probe of VeriQc is very small and can be put on the surface of the heart and the bypassed graft itself.

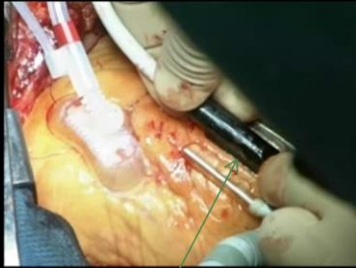
Intra-operative epicardial assessment of the target coronary artery by VeriQc



VeriQc can detect an embedded coronary artery.

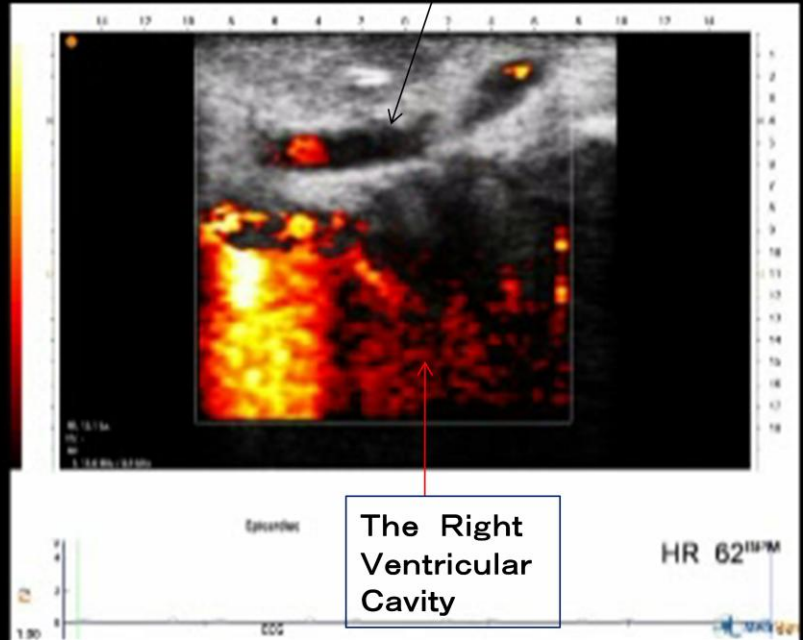
In this case VeriQc detected the embedded LAD most of which ran in the inside of the inter-ventricular septum.

Exploration of the embedded LAD



VeriQc
Probe

The Left anterior
descending artery
(LAD)

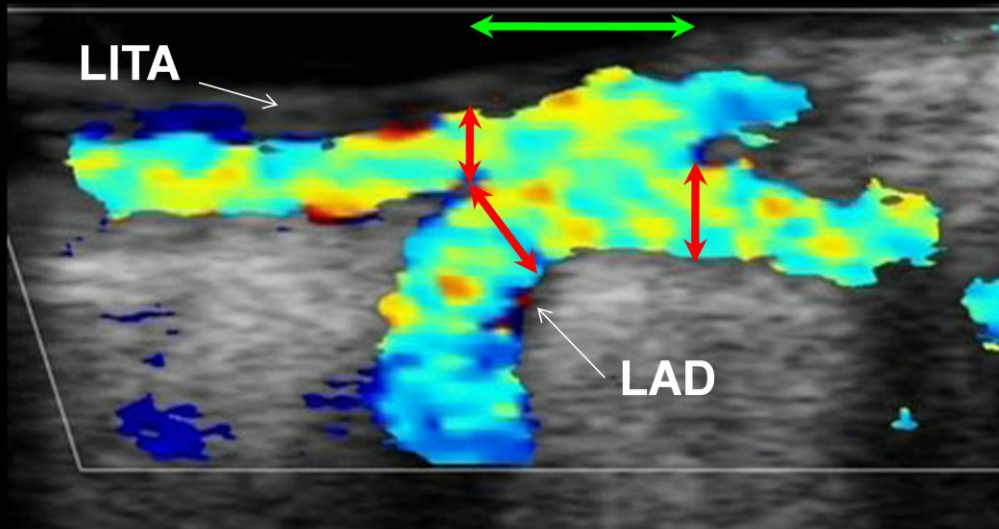
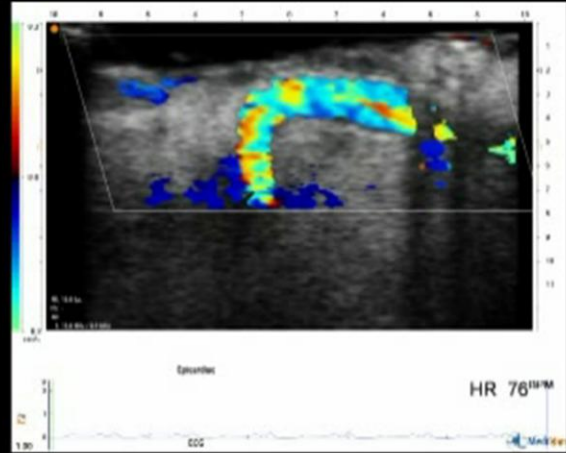


According to the findings by VeriQc, the anastomosis site of LITA to LAD was chosen at a more distal site where the LAD ran superficially. You can see the LAD ran deeply, very close to the cavity of the ventricle.

Intra-operative graft assessment

↔ Length

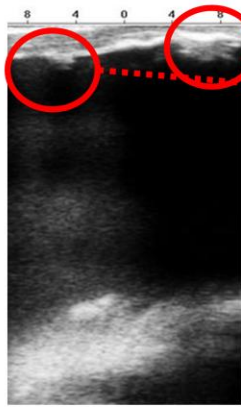
↕ Diameter



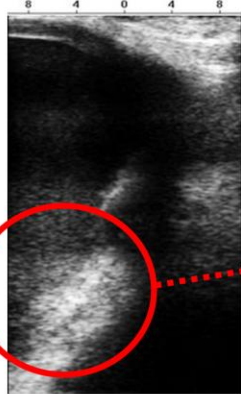
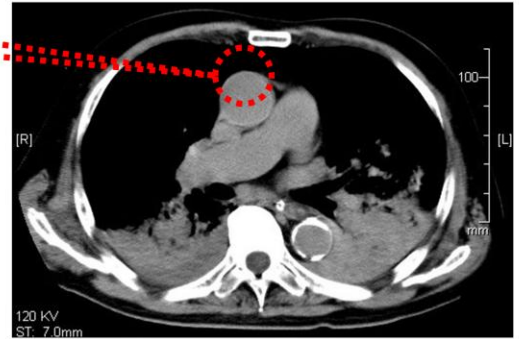
After the anastomosis was performed, we could see the structure of the graft anastomosis clearly and the flow direction by VeriQc

Assessment of Aortic wall by VeriQc

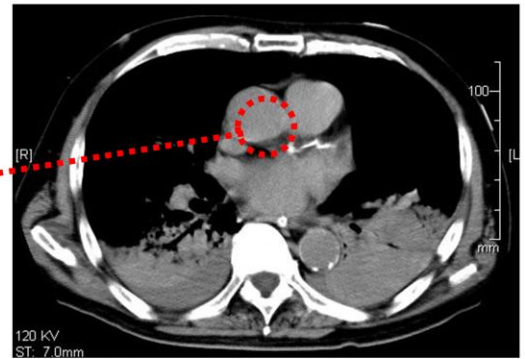
Case: 81 y/o male undergoing OPCAB



Atheroma



Localized
Calcification



VeriQc

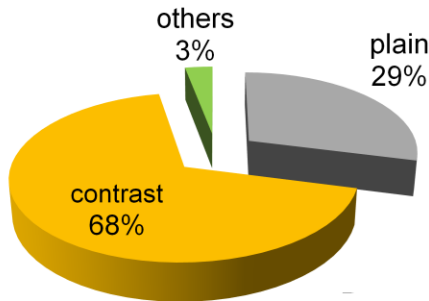
Preoperative plain CT

VeriQc can be used to examine the ascending aorta to detect small atheroma plaque and calcification inside of the ascending aorta which can not be diagnosed by CT scanning.

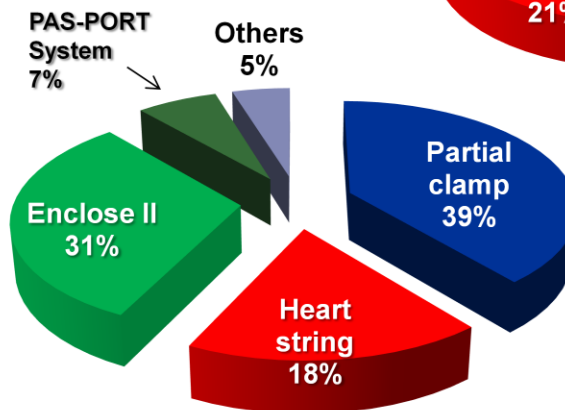
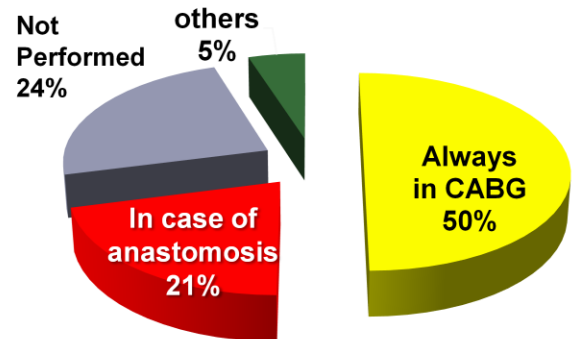
How to reduce intra-operative Stroke in OPCAB

Answers from 39 Japanese OPCAB surgeons

Preoperative Chest CT



Intraoperative periaortic echography



Technique in proximal (aortic) anastomosis

Let's see what the Japanese cardiac surgeons perform to reduce the incidence of CVA

95% perform pre-operative chest CT scanning and 68% use contrast material.

50% perform it routinely periaortic ultrasound examination to check the ascending aorta and other 21% do in case of planned aorto-graft anastomosis. For the aorto-graft anastomosis, 39% apply a partial clamp for aorto-graft anastomosis but other 56% use less invasive anastomosis devices.

Why has off-pump CABG become “the Platinum Standard” in Japan?

REASONS:

- ✂ Historically tremendous competition between CABG and PCI.
- ✂ Surgeons' strong beliefs that off-pump CABG is the best treatment.
- ✂ Surgeons' strong desire to improve coronary surgery techniques
- ✂ Existence of two novel associations supporting these surgeons' ambitions from scientific and technical aspects.

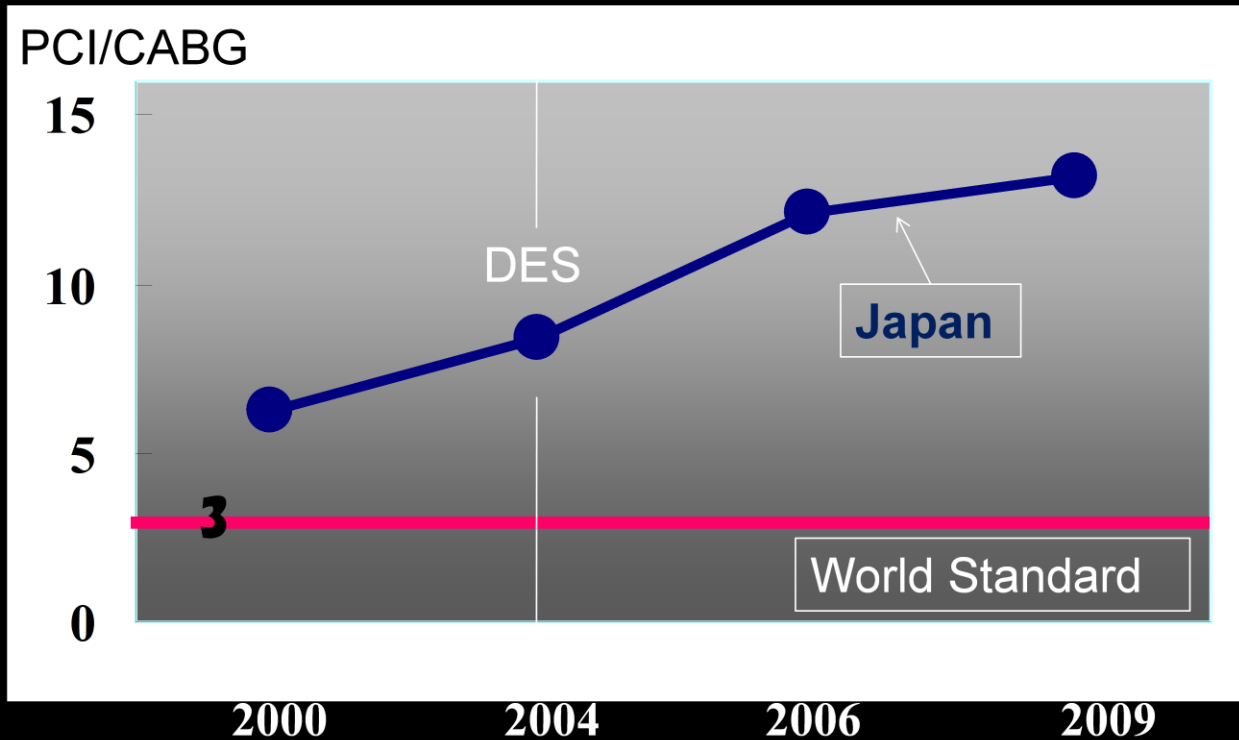
JACAS & JAOPCAB

This slide show the answers to the question” why has off-pump CABG become the platinum standard in Japan?”

Now I will explain the first reason of competition between CABG and PCI..

Whole Procedure Volume in Japan

PCI vs. CABG (including without Surgeon)



In Japan PCI/CABG ratio has been increasing over the last ten years, especially so since 2004 when the use of Drug Eluting Stent was approved. The advent of DES was the important stimulator for keeping the high proportion of off-pump

CABG. The estimated PCI/CABG ratio was 13 in Japan in 2009.

Other novel bottom-up activities for young surgeons

Wet Lab

A competition of CABG techniques

“Challenger’s Live Demonstration”

Dry Lab

Bypass training using a beating heart simulator “**BEAT**”, invented by Dr Y. Park in Dept. of Biomedical Engineering, Waseda University.

Both events are going together with **JACAS & JAOPCAB**.

Other than the two major associations activities, there has been the other novel bottom-up activities to keep high level off-pump CABG in Japan.

One is a Wet Lab contest using pig hearts. The other is a Dry Lab training using beating heart simulator. .

Challengers' Live Demonstration

- Trial of Training Program in Japan since 2003
- For young surgeons (< 33 y.o.)
- 2 Stage-competition
 - Qualifying Round (about 60 surgeons)
 - Wet Lab Practice
 - Qualification based on the scores by expert surgeons
 - Final Round (about 4 surgeons)
 - Live from Wet Lab
 - Evaluated by expert surgeons



Program Director
Prof. Yaku, Kyoto Prefectural
University of Medicine

The wet lab. contest was mainly organized by Professor Yaku. This is a two-stage competition held for under 33 year old young surgeon.



In the contest, young surgeon's surgical skill and manner were checked and scored by top off-pump surgeons.



The important points to keep high quality of off-pump CABG

- ✂ Patient selection
- ✂ Good anesthesiologist and good communication
- ✂ Stabilization of patient's hemodynamics
- ✂ Stabilization of the target coronary
- ✂ Good exposure of the target coronary
- ✂ Highly trained surgeon's skill
- ✂ Precise bypass graft validation
- ✂ Prevention of peri-operative stroke
- ✂ Prevention and Tx. of post-operative atrial fibrillation

The summaries of this presentation are shown here.



Before going to the conclusion, I will show you this year's Live operation performed by Professor Asai at the annual meeting of Japanese Association for OPCAB. The operation was a quadruple off-pump CABG using the bilateral ITAs and the right gastro-epiploic artery as the bypass grafts.

Conclusions

1. Off-pump CABG was originated outside of Japan.
But it has been developed and matured in Japan.
2. Off-pump CABG still has some problems to be resolved: high mortality in conversion to on-pump, high incidence of stroke on conversion etc.
3. To keep quality of off-pump CABG, we, surgeons should pay more attention on intraoperative graft validation by using the various modern modalities.

AHA Scientific Session 2010

These are conclusions.

The contributors



Prof. Arai



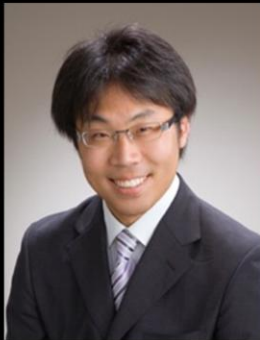
Prof. Asai



A. Prof. Orime



Dr. Yokoyama



Dr. Park



Dr. Kinoshita



Dr. Takahashi



Prof. Yaku

These Doctors are all my friends and the contributors of the presentation.

Thank you, chairpersons and all audiences.