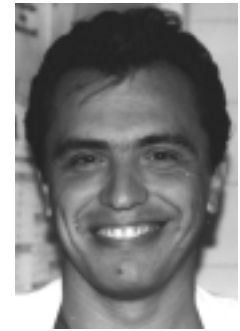


# Robotically Enhanced Totally Endoscopic Right Internal Thoracic Coronary Artery Bypass to the Right Coronary Artery



Dr. Aybek



(#2000-33418 ... August 23, 2000)

Tayfun Aybek, MD<sup>1</sup>, Selami Dogan, MD<sup>1</sup>, Eva Andreßen,<sup>1</sup>  
Stefan Mierdl, MD<sup>2</sup>, Klaus Westphal, MD<sup>2</sup>, Anton Moritz, MD<sup>1</sup>,  
Gerhard Wimmer-Greinecker, MD<sup>1</sup>

<sup>1</sup>Department of Cardiovascular and Thoracic Surgery

<sup>2</sup>Department of Anesthesia, Intensive Care and Pain Therapy

Johann Wolfgang Goethe University, Frankfurt am Main, Germany

## ABSTRACT

Computer-enhanced telemanipulation systems allow totally endoscopic coronary artery bypass grafting. This report demonstrates the feasibility of a coronary artery anastomosis between the right internal thoracic artery and the right coronary artery using the daVinci surgical system (Intuitive Surgical, Inc, Mountain View, CA).

## INTRODUCTION

Two different minimally invasive operative techniques and philosophies have been followed to achieve increased patient benefit. The off-pump coronary artery bypass (OPCAB) grafting technique was developed to revascularize coronary arteries on the beating heart, thus avoiding cardiopulmonary bypass and inflammatory whole body response [Ribakove 1998, Talwalkar 1998, Diegeler 1999]. The second philosophy follows the concept of reduced surgical trauma with less postoperative pain, thus providing more rapid recovery. With the introduction of robotics into cardiac surgery, the surgical access was further reduced enabling totally endoscopic coronary artery bypass grafting (CABG). Closed chest grafting of the left internal thoracic artery to the left anterior descending coronary artery has

been demonstrated by several surgeons [Autschbach 1999, Loulmet 1999, Damiano 2000, Falk 2000]. We want to report a case with right internal thoracic artery (RITA) grafting to the right coronary artery (RCA).

### *Patient history*

A 77-year-old female patient complaining of typical angina on exertion was admitted for coronary angiography. The ECG showed sinus rhythm with signs of ischemia in the posterior wall. The coronary angiogram on admission showed multiple severe lesions of the proximal RCA and a severe stenosis of the mid-RCA. A transluminal angioplasty was not considered due to the significant ostial stenosis. The preoperative medication was Aspirin, and Bisoprolol. Cardiac risk factors were 25 years history of hypertension. The patient was referred for minimally invasive revascularisation of the RCA.

After informed consent was obtained, the patient underwent totally endoscopic revascularization of the right coronary artery at our institution on November 30, 1999.

### *Anesthetic preparation*

The patient was anesthetized using Sufentanyl, Etomidate, Succinyl and Enflurane. A double lumen tube (Mallinckrodt, Athlone, Irland) was used to deflate the left lung. Invasive blood pressure monitoring was performed cannulating both radial arteries. Additionally, a 9 Fr pulmonary artery vent catheter was introduced percutaneously via right jugular vein for left heart decompression.

### *Operative technique*

The patient was placed on the operating room table in a supine position with the right chest elevated about 30 to 40 degrees. Three ports were placed to introduce a three-

Submitted August 21, 2000; accepted August 23, 2000.

Address correspondence and reprint requests to: Tayfun Aybek, MD, Klinik für Thorax-, Herz- und thorakale Gefäßchirurgie, Johann Wolfgang Goethe-Universität Frankfurt, Theodor Stern Kai 7, 60590 Frankfurt, Phone: +49 69 6301 6141, Fax : +49 69 96741522, Email: T.Aybek@em.uni-frankfurt.de

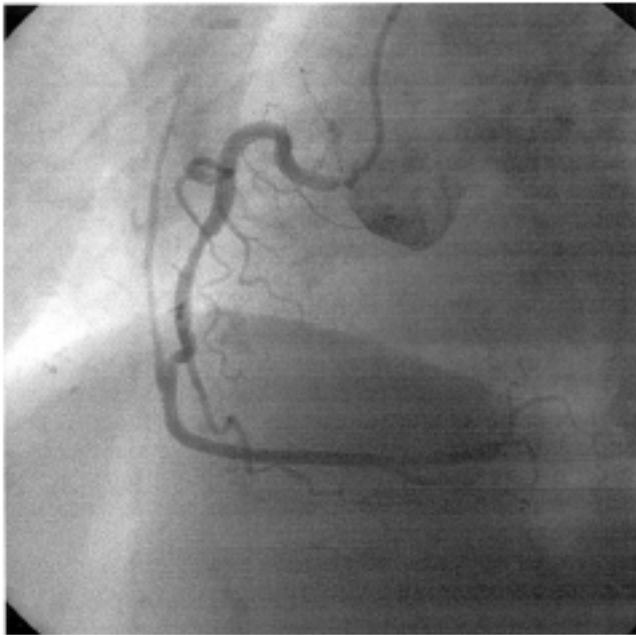


Figure 1. Postoperative control angiography of the right ITA bypass to the RCA.

dimensional endoscope and the working arms. After deflation of the right lung, the camera port was inserted into the fifth intercostal space (ICS) in the mid axillary line. CO<sub>2</sub> inflation into the right chest was achieved via a separate line of the camera trocar. The port for the left robot arm was inserted under endoscopic control in the third ICS in the anterior axillary line; the right port was placed in the seventh ICS, also in the anterior axillary line. Using a 30-degree endoscope looking up the RITA was mobilized with the da Vinci' telemanipulation system (Intuitive Surgical, Inc, Mountain View, CA) from the subclavian artery down to the epigastric branch. Side branches of the internal thoracic artery (ITA) were cauterized using low energy cautery. The end of the ITA was prepared for grafting.

The right femoral artery and vein were dissected using a 3 cm oblique incision in the groin. After heparinization, a 25 Fr Port Access canula (Heartport, Redwood City, CA) was inserted into the femoral vein and advanced into the right atrium under transesophageal echocardiographic control. The femoral artery was cannulated with a 22 Fr Y-shaped Port Access cannula. Starting cardiopulmonary bypass (CPB), the heart was decompressed and endoscopic pericardiotomy was performed. An 8mm parasternal stab wound in the fourth intercostal space was cut for additional transthoracic assistance. First the distal RCA (1.5 mm vessel) was identified and marked with a clip. The ITA was clipped and taken down showing good antegrade flow. Transient ITA occlusion was performed using a bulldog clamp. Then cardioplegic arrest was achieved by antegrade crystalloid cardioplegia delivered to the aortic root via the Port Access aortic endoclamp, which was advanced under echocardiographic control.

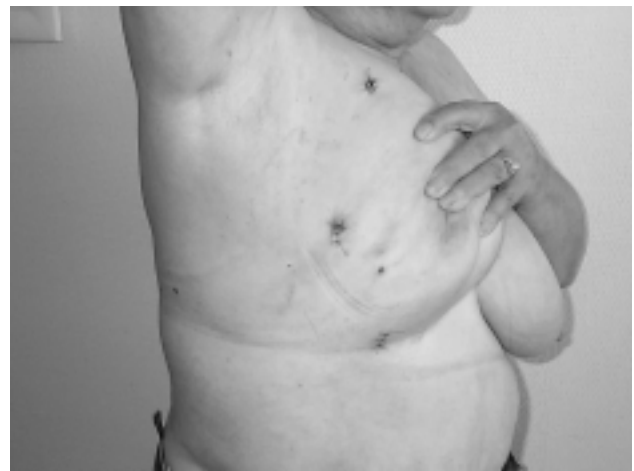


Figure 2. The Cosmetic result after robotically enhanced totally endoscopic coronary revascularization

After a 6mm arteriotomy on the RCA, the ITA was anastomosed end to side with a running 7.0 prolene suture. Testing of the anastomoses showed no leakage. After deflation of the aortic endoclamp the heart resumed in sinus rhythm. The patient was weaned from CPB, and heparin was antagonized with protamin. Venous and arterial canulae were extracted. The femoral artery incision was closed using a 5.0 running prolene suture. After removal of the robot, two chest tubes were inserted through the camera and left arm incision. The two other stab wounds were closed with single prolene sutures and the groin wound used a 5.0 running intracutaneous suture.

## RESULTS

The total skin to skin time was 5.5 hours. The CPB time was 149 minutes and the X-clamp time was 65 minutes. The patient was weaned from mechanical ventilation and extubated 6.5 hours postoperatively. Total chest tube drainage within the first 24 hours was 600 ml. Normal values for routine laboratory parameters, including cardiac enzymes were found. The patient was transferred to the normal ward on the first postoperative day. The postoperative course was uneventful. The control angiography on the eighth postoperative day showed a patent ITA anastomosis (Figure 1, ⊙). The wounds healed normally. The cosmetic result was excellent (Figure 2, ⊙).

## CONCLUSION

Due to the good results of angioplasty, single bypass grafting of the RCA is a rare procedure. Only in cases with complex proximal or ostial lesions an operative revascularization is warranted. This report shows the feasibility of closed chest totally endoscopic CABG of the RCA using the RITA. Standard on pump bypass grafting via complete

median sternotomy represents a significant amount of surgical trauma and a tolerable amount of inflammatory risk from CPB for a single bypass procedure. Quick off-pump revascularization avoids the risks of CPB but still involves complete median sternotomy. Especially in elderly patients with significant comorbidity and increased risks for CPB, the off-pump technique should be preferred. However, in a patient with low operative risk, the use of CPB with an ischemia time of 90 minutes can be tolerated if the surgical trauma can be reduced at the same time.

This case demonstrates the flexible use of a computer enhanced robotically assisted system for CABG. However, the endoscopic technique with robotic telemanipulation as well as the endo-CPB system are complex and require a close cooperation of the surgeon at the console and the patient site surgeon, anesthesiologist, and the perfusionist. The operation time is prolonged compared to other techniques. Further development of telemanipulation as well as endo-CPB system are necessary to facilitate routine endoscopic multi-vessel revascularization.

## REFERENCES

1. Autschbach R, Falk V, Walther T, Diegeler A, et al. Article in German. *Z Kardiol* 4: S42-S46, 1999.
2. Damiano RJ Jr, Ehrman WJ, Ducko CT, et al., Initial United States clinical trial of robotically assisted endoscopic coronary artery bypass grafting. *J Thorac Cardiovasc Surg* 119 (1):77-82, 2000.
3. Diegeler A, Matin M, Falk V, et al. Coronary bypass grafting without cardiopulmonary bypass--technical considerations, clinical results, and follow-up. *Thorac Cardiovasc Surg* 47(1):14-8, 1999.
4. Falk V, Diegeler A, Walther T, et al. Total endoscopic computer enhanced coronary artery bypass grafting. *Eur J Cardiothorac Surg* 17(1):38-45, 2000.
5. Loulmet D, Carpentier A, d'Attellis N, et al., Endoscopic coronary artery bypass grafting with the aid of robotic assisted instruments. *J Thorac Cardiovasc Surg* 118 (1): 4-10, 2000.
6. Ribakove GH, Miller JS, Anderson RV, et al. Minimally invasive port-access coronary artery bypass grafting with early angiographic follow-up: initial clinical experience. *J Thorac Cardiovasc Surg* 115(5):1101-10, 1998.
7. Talwalkar NG, Cooley DA, Minimally Invasive Coronary Artery Bypass Grafting: A review. *Cardiol Rev* 6(6):345-9, 1998.

## REVIEW AND COMMENTARY

### **1. Editorial Board Member LO23 writes:**

The authors should document why this procedure was recommended and accepted by the patients, bearing in mind that it required an extended period of bypass, etc.

### **Authors' Response by Tayfun Aybek, MD:**

The procedure was recommended to the patient as an innovative technique to develop closed chest coronary

artery bypass grafting. The patient gave informed consent after all beneficial aspects and risks were discussed.

I agree that an extension of cross clamp time is a relative risk especially in multi vessel revascularization, complex procedures and elderly patients with significant comorbidity. In a single vessel procedure, however, a prolonged ischemia time below 90 minutes is tolerable for a world's first procedure.

### **2. Editorial Board Member RR54 writes:**

A better image of the right ITA is desirable. A picture of the cosmetic result would be desirable.

### **Authors' Response by Tayfun Aybek, MD:**

We apologize for the poor quality of the angiographic image. Unfortunately, it was impossible to obtain a selective angiography of the right ITA. The second follow up angiogram after six months was refused by the patient. An image of the early postoperative cosmetic result has been added.

### **3. Editorial Board Member SC389 writes:**

The authors should be congratulated on their success. Further explanation is needed for the following:

- a) Is this where the authors would normally have grafted this vessel instead of going to the PDB ?
- b) Would the authors have used the RIMA in an open chest technique to revascularize the RCA? The RCA seems quite large on the angio and I am concerned that the RIMA will not provide adequate flow.

### **Authors' Response by Tayfun Aybek, MD:**

- a) The significant lesion of the RCA is located ostially. The peripheral PDB has no significant disease so that a peripheral anastomosis is not necessary.
- b) In an open chest case, we would have used a saphenous vein graft to revascularize the RCA. In this case, the ITA was used to avoid a proximal anastomosis and a partial aortic crossclamp. Regarding the flow on the RIMA vs. the native RCA, we agree that competitive flow may occur because the anastomosis is patent and the RCA is quite large.

### **4. Editorial Board Member AU34 writes:**

It seems very controversial to put a single CABG using ITA to RCA in such a complex procedure using both robotics and Heart Port System.

### **Authors' Response by Tayfun Aybek, MD:**

I agree that this was a long and complex procedure. It was performed after informed consent and approval from the local ethics committee was obtained. This case shows that totally endoscopic bypass grafting to the RCA with a patent anastomosis and good postoperative result is feasible.

We see such a procedure as an intermediate step to develop closed chest procedures with shorter operating time and less risks in the future.