

# CORONARY ARTERY DISEASE TODAY

Diagnosis, Surgery and Prognosis

Editors:  
A. V. G. BRUSCHKE, G. VAN HERPEN  
and F. E. E. VERMEULEN

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# Coronary artery disease today

## Diagnosis, surgery and prognosis

Proceedings of an International Symposium, held in  
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## Foreword

The doctor who was fortunate enough to belong to the generation after the Second World War, and to find his occupation in the field of heart disease was indeed to be envied: at each year's end he might stand marvelling at the new developments that the past year had brought to his chosen profession, and wonder about the amazing advances the next year would certainly bring. In no other clinical specialty was progress as spectacular, was the impossible proven to be feasible in so little time, and was science fiction so quickly turned into daily routine. Cardiac catheterization gave insight into hemodynamic mechanisms, angiography visualized the cavities of the beating heart. Surgery of congenital defects evolved from the simple technique of closure of an open duct to the most sophisticated reconstructions. From a laboratory instrument, cardiac defibrillation was shaped into a tool for daily clinical routine and cardiac pacing was built into an entire novel technology.

Still, it was relatively late that the recesses of the coronary arteries were explored. In the early sixties the technique of selective coronary arteriography emerged from the Cleveland Clinic. The insight into the mechanism of coronary artery disease gained by this method was enormous. One of the first effects was that cardiologists had, somewhat reluctantly at first, to face the fact that the accuracy of some of their highly esteemed non-invasive diagnostic methods was not as great as they had supposed. However, soon the availability of a gold standard for the status of the coronary artery system and the left ventricle was appreciated and a rewarding feedback process set in which generated a spectacular development of non-invasive diagnostic methods. Currently we have reached the point where non-invasive methods not only help to select patients for coronary arteriography but often provide important accessory information. The continuing rapid evolution has made it difficult to use the diagnostic armamentarium judiciously, that is, to avoid redundancy and unnecessary costs and yet warrant adequate evaluation of the individual patient. At the same time the reliability and safety of coronary arteriography has greatly improved. We look at the coronary arteries from more and different angles than we used to. We pay more attention to phenomena like spasm and myocardial bridging, and one may even wonder if these factors are not being overemphasized. New techniques using computerized processing of radiographic images are on the horizon and it is conceivable that in due course these will enable us to depict the coronary circulation and the left ventricular walls with less effort and with less discomfort to the patient.

The truly admirable feat of the development of the method of selective coronary arteriography was not the invention itself but the fact that it was pursued and perfected with great determination at a time when it did not seem to serve much therapeutical purpose: it would take some ten years before the momentous advance of modern coronary surgery started. But indeed, it would have taken many years more if it were not for the staunch dedication of the pioneers of coronary arteriography: Dr. F. Mason Sones and Dr. Melvin P. Judkins. For some time the protagonists of coronary surgery were engaged in a running battle with those maintaining that operative treatment only provided symptomatic relief which could equally well be given by medical treatment. Today little doubt is left that coronary bypass



surgery is efficacious in prolonging life in judiciously selected patients. Long-term results that are now becoming available bear out that in some groups of operated patients life expectancy even approaches that of the population in general. Surgical techniques have developed to the point where up to ten anastomoses are being fixed in one single patient and myocardial revascularization can be safely performed even in cases with markedly impaired myocardial function. It is still uncertain, however, how extensive myocardial revascularization should be and to what extent the left ventricle may be damaged and yet the patient may be expected to benefit from surgery. The results of surgery in patients with acute myocardial infarction are promising, as are those of operation on the complications of infarction. Surgical treatment of drug-resistant life-threatening arrhythmias after myocardial infarction is a fascinating possibility but still requires a great deal of study. The largest problem in the area of coronary bypass surgery at present is the progression of the coronary disease process, defying measures aimed at secondary prevention, and the closure of grafts, requiring reoperation. Therefore, the results of reoperations should be known to determine the optimal time for any surgical intervention. It is equally important to include in the decision making process what is known about mortality, morbidity and progression of the disease in non-operated patients.

We have tried to summarize various aspects in the title of the Symposium: 'Coronary Artery Disease Today: Diagnosis, Surgery and Prognosis'. The Symposium was primarily meant to present the state of the art and to indicate guidelines for the near future. Therefore, we have chosen to treat the various topics in a more or less general manner rather than focus on highly specialized details. We could only achieve our objective if we could secure the cooperation of unquestionable authorities in various fields. We appreciate it that so many distinguished speakers accepted our invitation with great enthusiasm. We are also greatly indebted to the Netherlands Heart Foundation and the American Heart Association, who agreed to sponsor and co-sponsor this Symposium.

The Symposium was held in a small country: The Netherlands, which is not so surprising as it may seem, because in The Netherlands the surgical treatment of coronary artery disease has for a long time been a subject of great interest to both the professional and the lay side. Among the European countries, in The Netherlands the highest number of heart operations per capita is performed. But still there is a general discontent with our surgical capacity, which is falling short of the demand, so that many patients are sent to other countries to undergo coronary surgery. One of the persons who have contributed most to the development of the diagnostic and surgical facilities in cardiology in The Netherlands is the former head of the Department of Cardiology of the St. Antonius Hospital in Utrecht: Prof. Dr. C.L.C. van Nieuwenhuizen. We have taken the opportunity to honour him during the Symposium.

Finally, we are confident that the Symposium has contributed to an even better understanding and continuing cooperation on an international level in our field of work.

**A.V.G. Bruschke**  
**G. van Herpen**  
**F.E.E. Vermeulen**

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## OPENING OF THE SYMPOSIUM

E. Dekker  
Netherlands Heart Foundation

Ladies and Gentlemen,

These are fascinating times to live in. Just a few weeks ago under the powerful thrust of a blazing furnace with a temperature of  $6000^{\circ}\text{C}$ , burning its liquid hydrogen and oxygen, producing 23 times the Hooverdam power, the Columbia took off from its pad amid roar and towering clouds of steam to open up a new era of technical and commercial exploitation of space in a joint effort that will have a profound influence on daily life, especially in the field of communications. And yet, all the technology that is reshaping our world needs to be complemented by an equal effort in the field of person to person contact on a global basis if we are to avoid a second Babylon. If this is true for society as a whole, it is more in particular the case for those scientific communities that work in rapidly developing fields like those of cardiology and cardiac surgery. It is therefore my special privilege to welcome all of you on behalf of the organizing committee and of the Netherlands Heart Foundation. Not only the prominent speakers - the list of whom reads like Who is Who in Coronary Heart Disease - but all of you who came from several parts of this small world to participate in this meeting. I hope that you will not only enjoy what is being offered in visual form and in the spoken word but that you may also make good use of this opportunity to broaden your insight and to maintain and create friendships in interpersonal contacts.

For this opportunity we are all deeply indebted to the Organizing Committee, Dr. A.V.G. Bruschke, Dr. G. van Herpen, Dr. J.W. Ludwig, Dr. H.W.M. Plokker and Dr. F.E.E. Vermeulen, who took the initiative and produced such a well-balanced program. However, if I look at this program and if I look around this hall with the celebrities in the first rows and their eager audience beyond, one important category in this interpersonal exchange is lacking; a very vital group, because we all pay lip-service to the dogma that the patient is the centre of our universe.

And yet our patients might raise a few useful points

in the discussions that lie before us. My work for the Heart Foundation perhaps entitles me to offer a few of these points for your consideration. I would like to touch on three of them: underproduction, overproduction and quality control.

Cardiac patients nowadays have become as much part of the jet-set as this learned audience. The Netherlands, for one thing, belong to the patient-exporting countries. We, in this country, have traditionally opposed the provision of medical care in the form of a commercial enterprise. We have a system of social security that provides for the cost of operation for everyone who needs it and yet we take twelve million dollars each year of social premium money in this era of unemployment to buy the services of commercial enterprises that provide surgical services at competing quality and price; in the United States, in Switzerland and in Great Britain, whereas in the latter two countries the pro capita rate of operations is lower than in this country. To any critical patient this situation is at least confusing. In some hospitals in this country patients are on the waiting list for cardiac surgery during periods up to one year, in the recent past even longer. For one year each morning they sit near that telephone, electrified each time it rings because this time it may be their call for the hospital. They are the victims, of underproduction of surgical services.

If an informed international group of patients would be present at this congress which is dedicated to their care, they might well ask the question "What are the optimal levels of operation in standardized rates per 100.000 population? Are they too high in the United States? Are they too low in Great Britain? How come that Holland can airlift its patients to be operated there?" It is difficult to blame anyone for these inequalities and disregulations that are the causes of so much unhappiness and suffering. They are a consequence of the sky-rocketing development to which this congress will bear witness. But it is my strong conviction that the health authorities carry a heavy responsibility and that the medical community should look into this question and make its specific knowledge, its time and energy available to reach a well-balanced judgement and work together with the health officials and responsible patient organizations to come to a solution of the underproduction problem.

More insidious, but perhaps even more threatening, is the problem of overproduction. In this small country alone, with its fourteen million inhabitants, there are no less than forty-three catheterization laboratories where a total of 14.000 coronary angiograms are being performed yearly. That is one angio lab in every five general hospitals. The proposal is to raise that to one in three and yet there is no guarantee of a well-

balanced regional distribution so as to ensure the permissible minimum number of patients examined.

I cite these figures not because they are important to the world at large but because I want to avoid making unfavourable comments on friendly nations. Contrary to public opinion, this aspect of overproduction has little to do with financial greed. It is much more dangerous because it is intimately connected with a tendency that made this profession great: the quest of personal excellence. I realize, therefore, that the passionate plea of our informed patient for more co-operative effort in this field might meet with only moderate acceptance. And yet it is my firm conviction, that progress in medical care may sometimes call for a reduction in the number of hospitals that provide a certain service. In the far future empty operating rooms might become an even greater potential threat to health than empty catheterization labs. Under their suction force the elasticity of the indication might easily be overstretched to provide the number of patients that is required to maintain excellence.

The development in cardiac diagnosis and cardiovascular surgery have nicely kept pace with other rapid developments in this space age. The patient nowadays is surrounded by ever more sophisticated, biochemical, biophysical and data-processing gear. We are, of course, all aware of the need to complement high level technology with real human partnership on a personal level between the doctor and his patient. But do we always live by what we preach? Or do we sometimes tend to get so fascinated by the insight our methods provide us with that we tend to forget that our insight is not necessarily of benefit to our patient. That is only so in as far as a better diagnosis leads to at least a different and hopefully better management. I am not talking about research but about routine care when I say that the financial cost and health risks for each patient must not be weighed against our desire to gain insight but against a reasonable estimate of the potential health gain for the patient in question.

This kind of decision making is not commonplace, or at least not a formal procedure in present-day health care. The well-informed patient, on whose behalf I try to speak today, might well urge you that more of you make a real contribution to decision analysis and its application in patient care, taking into account all the costs and estimates of the benefits in terms of quality adjusted years of life to be gained from all the technological marvels.

If one arrives at a node in the decision tree that is vital to the patient such as the decision to catheterize or not to catheterize, to operate or not to operate, let us weigh the patient's risks, not in terms of the best results published in the literature, but



in terms of the local performance. In order to measure local performance we need quality measurement; comparison of local quality with quality elsewhere and measures of quality control. Such comparisons must be done by competent people and they must be done right. Otherwise they can create misconceptions that do great harm and injustice. Nevertheless, our informed patient might very well realize, that much of the decisions for patient referral are based on the 'old-boys' network instead of on carefully weighed quantitative estimates for his well-being and survival. Let us at least keep an open eye for the possibility that we may not be all equal, that some of us are more competent in the performance of certain tasks than others.

The dazzling rate of our capability in data handling, to which the roar of the launching of the Columbia bears witness, could very well be applied to the collection of data that allow for documentation and processing of data that bear on the cost efficiency of methods of investigation and treatment. This might lead to less travel of people who can be adequately treated near their home town and should perhaps be conducive to more travel for patients with rare diseases to certain highly specialized centres of great competence in a certain field.

We all strive for professional excellence. That is the best guarantee for our ability to serve our patients well, but it is perhaps good to realize that each prescription has its side effects and that some of the side effects of our quest for excellence may have negative consequences for our patients in terms of cost, discomfort and health risks.

Mister Chairman, I realize that I have walked a ground that angels feared to tread and I dared do so only in the disguise of the well-informed patient. Let me therefore now put on the professional garb again, saying, dear colleagues, I welcome you again to this congress where I hope you will take interest in the wider community issues and gain in wisdom.

Hoping you will all feel at home and that this congress may be a contribution to your quest for excellence, I declare it opened.

## INTRODUCTION TO THE SYMPOSIUM

F. Mason Sones, Jr., M. D.

Senior Physician, Department of Cardiology, Cleveland Clinic  
Foundation, Cleveland, Ohio, U.S.A.

Doctor Dekker, members of the Organizing Committee of the Symposium, ladies and gentlemen. I am greatly honored by the privilege of introducing this International Symposium on coronary atherosclerosis to you. It holds great promise for providing useful insights in evaluating our past efforts, current trends, and in the definition of future objectives and possible means for their accomplishment.

The past 25 years have certainly provided a host of exciting times and opportunities for those of us whose main objective has been to deal more effectively with the scourge of coronary atherosclerosis. In some facets of this struggle our progress has been reasonable; in others, disappointingly unproductive.

In 1943, at the end of my medical school training, our peers in cardiology had amassed remarkably good insight into the recognition of acquired valve lesions and relatively simple congenital malformations of the heart. Rheumatic carditis was the major scourge of children in the Western World as it remains in the Third World today. The valve lesions and permanent myocardial damage which resulted were definable by the relatively simple measures of careful history taking and physical examination. On the other hand, coronary atherosclerosis was recognized only when its major complications, angina pectoris, myocardial infarction, and death, evolved in the very late stages of the disease. In that era our ignorance was immortalized on one hand by large numbers of death certificates describing sudden death as due to "acute gastritis." On the other hand, there were unusually large numbers of patients who were "successfully treated" who survived for longer than ten years after the onset of symptoms on various forms of medical management. Large numbers of these patients were subsequently proven to be free of significant obstructive lesions in their coronary arteries. The iatrogenic disability caused by these diagnostic errors was enormous.

From the early 40's until 1955 two distinctly separate and essentially noncooperating groups of our peers labored to develop what were essentially laboratory techniques that might be useful in the more precise characterization of congenital malformations and acquired valve lesions. Coronary artery disease remained beyond the scope of these efforts. On one hand the cardiac physiologist was exploring the central circulation and great vessels with catheters, learning to measure pressures, blood flows, and to localize the presence and direction of intra and extra-cardiac shunts. From evaluation of these parameters it was possible with varying degrees

of success to deduce the presence of anatomic lesions responsible for their genesis. A second group was made up of our radiological colleagues who were engaged in injecting contrast agents, usually into peripheral veins, and recording its progress through the heart and great vessels on large x-ray film. With progressively sophisticated film changers, x-ray generators, and mechanical injectors, these often permitted remarkably good demonstration of relatively simple lesions, but were often frustrated by intracardiac shunts which led to simultaneous opacification of overlapping chambers which frustrated demonstration of critically important intracardiac structures.

In my own experience at least, the introduction of the fluoroscopic image amplifier in 1955 provided a potential means for overcoming many of these problems by combining the essential techniques of cardiac catheterization with selective opacification of individual intracardiac structures with small doses of contrast media. The majority of patients were infants and small children under two years of age. In most of these a communication at the atrial level was present which provided easy access to the left atrium and ventricle. When one approached the heart through the inferior vena cava, selective opacification of the left ventricle, left atrium, and right ventricular outflow tract in appropriate projections was easily accomplished. The passage of contrast media through these structures was recorded on 35 mm motion picture film at rates of 60 frames per second. This resulted in significant improvement of our ability to demonstrate the physical characteristics of more complex combinations of intracardiac defects. In other patients without interatrial communications, we learned to approach the ascending aorta and left ventricle from the femoral artery, combining these techniques with right heart catheterization, and selective opacification of the right heart structures. The application of these methods made it possible for us to more effectively meet the needs of our patients when our surgical colleagues began to invade the heart during the early use of pump oxygenators.

In 1957 we were sufficiently impressed by incidental demonstration of proximal segments of the coronary artery tree during selective opacification of the left ventricle or ascending aorta to initiate a series of attempts to deliberately opacify the coronary circulation. A combined effort in this direction was initiated with our surgical colleagues in laboratory animals. We learned that by selectively opacifying the right or left sinus of Valsalva with smaller doses of contrast agent that were required for aortography or left ventriculography we could achieve more dependable demonstration of individual coronary arteries than could be accomplished by conventional techniques. By 1959 we had achieved demonstration of total or partial ligation of canine coronary arteries, the demonstration of acute inflammatory responses as a result of epicardial abrasion and failure of these to persist in chronic preparations. In one instance, successful anastomosis of the brachio-cephalic artery to the distal segment of a divided anterior descending coronary artery was demonstrated. This occurred more than ten years before the internal mammary artery was successfully used as a bypass graft in the human. In 1959, during performance of an aortogram with grossly

inadequate fluoroscopic equipment, we accidentally injected 40 ml of 90% Hypaque into the right coronary artery of a young patient with severe rheumatic valve disease. He promptly developed asystole, but normal sinus rhythm was restored within approximately 15 seconds. He responded to our urgent request that he cough with a series of explosive coughs which effectively pushed the contrast agent through the microcirculation of his right coronary artery, restoring normal sinus rhythm and a stable hemodynamic balance within approximately 30 seconds. This experience led us to believe that it might be possible to safely opacify individual coronary arteries with much smaller sequential doses in order to demonstrate their morphologic characteristics. A special catheter was designed to facilitate this procedure using a brachial artery approach. Its gradual refinement continues through the present time.

Although our basic objective was to provide a more reliable basic standard for the recognition and evaluation of atheromatous lesions in the living human, the efforts of our surgical colleagues to modify the course of the disease provided a constant stimulus to technical improvements in clinical application. By 1962 we had proven conclusively that the rather widely applied techniques of pericardial poudrage provided no enhancement or improvement in myocardial perfusion. In 1962 we were able to demonstrate that Vineberg's technique of internal mammary artery implantation could provide effective collateral filling to distal segments of severely obstructed anterior descending coronary arteries. Our surgical colleagues rapidly extended this approach to all major segments of the coronary circulation, and we were able to establish for the first time that a significant increment to myocardial perfusion could be achieved by appropriate application of this method.

By 1962 our surgical colleagues initiated a direct attack on localized obstructions in proximal segments of coronary arteries by placing vein or pericardial patches over the obstruction. These met with initial success in overcoming such obstructions, but a high proportion of them failed within two years.

In May 1967, Doctor Rene Favaloro performed what we thought was the first interposed vein graft to replace the mid segment of an obstructed right coronary artery. This effort was rapidly followed by the development of bypass vein graft techniques designed to compensate for severe obstructions in all major segments of the coronary artery tree. Our attempts to document the success and limitations of these efforts continue through the present.

Coincident with the evolution of surgical techniques to improve myocardial perfusion made possible by coronary arteriography, we have had the privilege of participating in the development and testing of a host of technical factors directed toward improving the quality of the images we produce, and in simplifying and improving the safety of their application to patients. These have been far too numerous to review in this summary, but the most important of them, in my opinion, include the following:

1. The development and refinement by Doctor Melvin Judkins of preformed catheters to facilitate a percutaneous approach to the coronary arteries by the femoral approach.
2. The development by Cowenhoven, Jude, and Lown of effective techniques to control ventricular fibrillation.