

CARDIAC PACING

Editor

YOSHIO WATANABE

Cardiac pacing

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Editor

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Sunao Tawara (1873-1952)

Tawara, the son of Sadao Nakajima, was born in Ooita Prefecture, Kyushu, Japan, in 1873. When he was three years old, he was adopted by his uncle, Shunto Tawara, who was a distinguished physician. In 1901 Sunao Tawara graduated from the Faculty of Medicine of the University of Tokyo, and in 1903 he went to Marburg, Germany, to work under the direction of Ludwig Aschoff, one of the leading young pathologists in Europe.

In 1906 he published his monograph *Das Reizleitungssystem des Säugetier-herzens: Eine anatomische-histologische Studie über das Atrioventrikular-bündel und die Purkinjeschen Fäden*, which presented the results that the bundle originated with a complicated network of small muscle fiber that he called 'Knoten des Verbindungsbündels', and he moreover demonstrated how the bundle divided into twigs, covered by connective tissue sheath, that finally connected directly with a network of Purkinje fiber. Before his demonstration, it had been thought that the connecting bundle fused with myocardial fiber of the septum and that the Purkinje fiber had no special role in the conduction system. Tawara called the whole network of the bundle 'Reizleitungssystem'.

In 1906 he returned to Japan, in 1908 he was appointed professor of pathology at the Kyushu University where he continued until his retirement in 1933. In 1914 the Royal Award was conferred on him by the Japanese Imperial Academy for his study of the conduction system of the heart. He died in January 1952 in his seventy-eighth year at Fukuoka, Kyushu.

Preface

As a result of close collaboration between people from different disciplines, including basic scientists, clinicians and medical engineers, cardiac pacing has rapidly evolved into an important field of medicine. In order to summarize various new developments observed in the 3-year period after the Fourth Symposium held in Groningen, The Netherlands, and to exchange the latest information needed for continued progress, the Fifth International Symposium on Cardiac Pacing convened in Tokyo from March 14 to 18, 1976, under the joint sponsorship of the Japanese Circulation Society, Japan Society of Medical Electronics and Biological Engineering and Japan Heart Foundation.

The ever-increasing interest in the art and science of cardiac pacing was clearly reflected in the number of submitted abstracts (261), and in a record total of 1,387 participants representing 42 countries. The scientific sessions were subdivided into the following major topics: (1) Cardiac Electrophysiology, (2) Natural History of AV Block, (3) Adams-Stokes Attacks and Sudden Cardiac Death, (4) Hemodynamics of Pacing, (5) Pacing as a Diagnostic Tool, (6) Treatment of Arrhythmias with Temporary Pacing, (7) Treatment of Arrhythmias with Permanent Pacing, (8) Long Term Follow-up of Implanted Pacemakers, (9) Pacemaker Malfunctioning and Side Effects of Pacing, (10) Pacemaker Engineering and Testing of Pacemaker Function, (11) Energy Sources, and (12) Electrodes. Each of these twelve sessions was opened with a keynote address to introduce the subject, and a total of 103 free papers was presented.

The Symposium was highlighted by 3 Round Table Discussions, entitled: (1) World Survey on Long Term Follow-up of Cardiac Pacing, (2) Is Pacing Really Prolonging Life in Patients with High-grade AV Block?, and (3) An Ideal Pacemaker: Physiologic, Clinical and Engineering Considerations. In addition, the Tawara Memorial Lecture given by Dr. E. Kimura, President of the Symposium, honored the late Professor S. Tawara, who was the first to describe the AV node (the node of Tawara) and to define accurately the role of the intraventricular conducting system. This Proceedings volume contains all the above lectures, papers and discussions, except for the 8 Fireside Conferences where interesting electrophysiologic and clinical problems related to cardiac pacing were freely discussed by invited speakers and small groups of enthusiastic participants. Thus, this book is the most updated and comprehensive review of both the scientific basis and the clinical applications of cardiac pacing as of 1976.

This book undoubtedly owes its superb scientific content to all the speakers and discussants who actively participated in the Symposium. I would also like to express my gratitude to Dr. Kimura, Dr. Hori, the Secretary General, and the members of the Organizing Committee, for their dedicated efforts to make this Symposium a great success. My special thanks are also due to Dr. N. Conway, Department of Cardiology, Western Hospital, Southampton, United Kingdom, for his excellent supervision of papers submitted from non-English speaking countries.

Yoshio Watanabe

Contents

| | |
|------------------------------------|---|
| Preface. Y. Watanabe | X |
| Tawara memorial lecture. E. Kimura | 1 |

Part I. Cardiac electrophysiology

| | |
|---|----|
| Pathology of the sick sinus syndrome. R. Okada, K. Gotoh, Y. Nakata and K. Kitamura | 8 |
| Sinus node activity in man and animal studies recorded intraatrially by an on-line pre-memorized averaging technique. M.J. Stopczyk, M. Pieniak, W.J. Wajszczuk and M. Rubenfire | 13 |
| Clinical studies on noninvasive investigation of the His bundle electrogram. M. Honda, S. Tanaka, N. Kohno, M. Suzuki and K. Kobayashi | 19 |
| Intrahisian blocks. P. Puech, R. Grolleau and C. Guimond | 22 |
| Conduction changes in and around the Purkinje-myocardial junction in ventricular overloading. T. Sawanobori and T. Sano | 28 |
| Effect of multiple simultaneous activation sites (biventricular pacing) on ventricular depolarization and ventricular arrhythmias. L.S. Dreifus, S. Ogawa, Y. Watanabe, H.N. Dreifus and B.V. Berkovits | 33 |
| The determination of the degree of pharmacological influence on the myocardial threshold. F. Unger, M. Deutsch, G. Eder, G. Joskovicz, A. Keiler and K. Steinbach | 40 |
| Effects of antiarrhythmic drugs and hyperkalemia on the ventricular electrogram in dogs with acute myocardial infarction. N. Haberern, J. Ingram, J. Oravec, R. Spevak, R. Rockland, M. McCredy and S.S. Barold | 44 |
| Demand pacing in coronary heart disease. R. Sutton | 48 |
| Resistance and facilitation gradients in cardiac pacing: experimental demonstration in dogs. A. Varenne, J.P. Camous and J.B. Guiran | 52 |
| Volume effect for excitation of ventricular muscle. F. Tamura and M. Hori | 58 |
| Application of a new threshold tracking pacemaker concept. D.P. Zipes, T.L. Jirak, P.R. Foster and V. Elharrar | 66 |
| Electrocardiographic diagnosis of myocardial infarction in patients with transvenous ventricular pacemakers. S.S. Barold, L.S. Ong and R.A. Heinle | 72 |
| Diagnosis of acute myocardial infarction in the presence of endocardial pacing. V. Niremborg, S. Amikam, N. Roguin, B. Pelled and E. Riss | 76 |

Part II. Natural history of atrioventricular block

| | |
|---|----|
| Natural history of atrioventricular block. B.W. Johansson | 80 |
| Natural history of atrioventricular conduction disturbances in 115 patients. S. Feldman, J.H. Yahini, A. Palant, A. Shem-Tov and H.N. Neufeld | 89 |
| Unrecognized intermittent bradycardias in patients treated for senile dementia. N.-J. Abdon | 93 |

Part III. Adams-Stokes attacks and sudden cardiac death

- Long term ECG in ambulatory clinical practice. B.W. Johansson 98
- Miniaturized implantable automatic defibrillator for prevention of sudden death from ventricular fibrillation. M. Mirowski, M.M. Mower, A. Langer and M.S. Heilman 103

Part IV. Hemodynamics of pacing

- The influence of pacemakers on hemodynamics as a function of time. H. Esser and D. Kikis 107
- Left ventricular function and myocardial metabolism prior to and after coronary bypass surgery, evaluated by means of rapid atrial pacing. W.W. Klein, D. Brandt and J. Kraft-Kinz 112
- Cardiac pacing in the study of ischemic heart disease (with special reference to its surgical treatment). S. Eguchi, M. Terazima, H. Matsuzawa, Y. Yamazaki, K. Asano, S. Bannai, H. Sato, N. Higuma and K. Tamura 115

Part V. Pacing as a diagnostic tool

- Pacing as a diagnostic tool. G. Sloman, A. Tonkin, J. Vohra and D. Hunt 120
- Analysis of sinus node response to premature atrial stimulation in the isolated rabbit heart. G. Steinbeck, F. Jacob and B. Lüderitz 124
- Contribution of the electrophysiological study of sinus node function to the indications for long term cardiac pacing. C. Barnay, J.L. Medvedowsky and J.C. Vincey 129
- Sinus node dysfunction and AV conduction disturbances following repair of atrial septal defect. T. Mitsui, K. Fuse, A. Mizuno and M. Saigusa 135
- Sinus node dysfunction in Chagas' disease. A.H. Roura, J.E. Riera, O. Ríos and A.G. de Roura 140
- His bundle electrogram in atrioventricular block produced by ligation of septal arteries in the dog. M. Fukutani, S. Mochinaga, W.H. Wang, M. Hayano, F. Kiya and K. Hashiba 143
- Clinical and experimental study of the usefulness of the ventricular overdrive test in complete AV block. T. Sugimoto, T. Inasaka, K. Kaseno, T. Uraoka, H. Watanabe, T. Ishikawa and K. Kontani 148

Part VI. Treatment of arrhythmias with temporary pacing

- Temporary pacing in the treatment of arrhythmias. D.J.W. Escher, S. Furman, J.D. Fisher and R. Giusti 153
- The use of overdrive pacing for termination of tachycardia episodes in the Wolff-Parkinson-White (WPW) syndrome. W.J. Mandel, I. Yamaguchi, M. Laks and B.V. Berkovits 162
- Significant reduction of recurrent tachycardias by programmed rate-related premature stimulation. B. Lüderitz, G. Steinbeck and F. Zacouto 166
- Cardiac pacing in the coronary care unit in Jakarta. K.F. Lie, N. Abdurrahman, Kisyanto, Hanafi, and D. Jusi 172

Part VII. Treatment of arrhythmias with permanent pacing

| | | |
|--|--|-----|
| Treatment of arrhythmias with permanent pacing. | H.J. Sykosch | 174 |
| Pacemaker therapy combined with beta-receptor blocking agents for the treatment of intractable tachyarrhythmias. | E. Czako, R. Rényi-Vámos, F. Solti, E. Bodor and Z. Szabó. | 185 |
| The management of paroxysmal supraventricular tachycardia using a scanning pace-maker system. | R.A.J. Spurrell and E. Sowton | 187 |
| Treatment of tachycardias by pacing. | P. Coumel and J. Mugica | 191 |
| Termination of ventricular tachycardia by bursts of rapid ventricular pacing. | J.D. Fisher, S. Furman and R. Mehra | 194 |
| Cardiac pacing in the sick sinus syndrome. | H. Paepre, I. Thormann and M. Nasser | 200 |
| Specific problems of cardiac pacing in the sick sinus syndrome. | T. Iwa, T. Misaki, T. Ueyama, J. Sakurai and T. Bando | 204 |
| Reappraisal of 150 patients with Chagas' cardiomyopathy treated with implantable cardiac pacemakers. | A. Bello, H. Velarde, J. Izquierdo, R. Balza, J. Bianco, J. Octavio, J. Gallardo and R. Jaén | 208 |
| Two cases of successful permanent pacing in systemic lupus erythematosus. | C. Kawai, H. Hamajima, H. Okazaki, T. Konishi, A. Wakabayashi, M. Yokota and A. Mori | 212 |
| Transvenous atrial synchronized pacing. | J. Witte, L. Dressler, G. Schröder and G.H. von Knorre | 217 |
| Permanent pervenous atrial sensing and pacing. | N.P.D. Smyth and P. Citron | 221 |
| Comparative studies in transmediastinal retrocardiac and transvenous endocardial placement of atrial electrodes. | M. Kleinert, P. Beer and A. Taylessani | 228 |

Part VIII. Long term follow-up of implanted pacemakers

| | | |
|---|--|-----|
| Long term follow-up of patients with implanted pacemakers. | O. Edhag | 237 |
| Cardiac pacing for more than ten years. | J. Torresani and J. Jouven | 245 |
| Analysis of 536 cases of permanent pacing. | A.N. Kontaxis, N. Doukas, J. Boutsikaris, G. Koroxenidis, K. Samaras and C. Stathatos | 249 |
| Eleven year follow-up of 1228 patients with 2243 pacemaker implantations. | G. Donadel, V. Gallucci, P.G. Cevese, D. Casarotto and B. Permutti | 254 |
| Long term follow-up of 250 patients treated with atrial-triggered cardiac pacing — a Swedish multicentre study. | S. Larsson, E. Carlens, O. Edhag, I. Karlöf, H. Lagergren, M. Levander-Lindgren, K. Pehrsson, H. Schüller and C.-J. Westerholm | 257 |
| Pacemaker follow-up in a time of change. | H.D. Covey, E.J. Noble, D.C. MacGregor, B.S. Goldman and E.D. Wigle | 264 |
| Electronic indications for pulse generator replacement. | M. Djordjević, S. Nedeljko-viç and L. Kecman | 268 |
| Prognostic determinants of late survival in patients with cardiac pacemakers. | J.W. Harthorne | 271 |
| The reliability of pacemaker rate follow-up for long term cardiac pacing. | S. Yarow | 274 |
| Nuclear fueled pacemaker — 2 to 4 years follow-up. | L. Seipel, I. Buchta, F. Loo-gen, H.D. Schulte and J.C. Reidemeister | 278 |
| Clinical experience with a variable pulse width permanent cardiac pacer. | M.B. Ross, P. Levine, N. Sheiner, O. Rico, A. Sebe and A.D. Rotenberg | 281 |

| | |
|---|-----|
| Clinical experience with an adjustable pulse width demand pacemaker. S.P. Ahuja and M.E. Johnson | 285 |
| A computer-assisted pacemaker follow-up system. G.L. Grunkemeier, J.L. Dobbs and A. Starr | 290 |
| Clinical results and organization of the surveillance of pacemakers by telephone photo-analysis (1000 transmissions). C. Bouvrain, J. Mugica and R. Duconge | 296 |
| Importance of patient and medical education in the prevention of pacemaker malfunction. B. Dodinot, L. Kubler and G. Faivre | 300 |
| Changing aspects of cardiac pacemaking. M. Turina, J. Turina, H.P. Krayenbühl, I. Babotai and A. Senning | 302 |
| Functional capacity of pacemaker implanted patients. H. Ikeda, N. Koga, F. Katayama, K. Ohishi, H. Toshima and N. Kimura | 304 |
| Cardiac pacemakers: morbidity and mortality of the epicardial approach. A. Dussaut Jr, E.J. Fernandez, B.B. Lozada Jr, J.A. Dussaut, M. Vargas and M. del Prado | 307 |
| Right bundle branch block patterns during permanent right ventricular pacing. J.W. Kozłowski | 312 |

Part IX. Pacemaker malfunctioning and side effects of pacing

| | |
|---|-----|
| Pacemaker problems – 1975. V. Parsonnet | 318 |
| Safety of competition from fixed-rate pacemakers. P.M. Zoll and M.J. Weintraub | 325 |
| The value of the electrocardiogram before and after chest wall stimulation in diagnosing pacemaker malfunctioning: a reappraisal. I.J. Pinto, J.L. Noronha, L. Shah and P.A. Kale | 328 |
| Clinical experiences and experimental studies of false sensing with demand pacemakers. K. Taniguchi, T. Takaoka, H. Fujiwara, K. Tabuchi and J. Takeuchi | 333 |
| Preventing myopotential inhibition of the unipolar demand pacer. G.G. Wickham | 340 |
| Importance of stimulation threshold in long term unipolar endocardial pacing. F.M. Groegler and H.G. Borst | 344 |
| Long term follow-up of noninvasive measurement of the stimulation threshold. J. Meibom | 349 |
| Intermittent runaway pacemaker. H.C.G. Gaspar and J.R.P. Carmona | 353 |
| Breast cancer at site of implantation of pacemaker generator. P. Zafiracopoulos and A. Rouskas | 356 |
| Phlebographic findings after insertion of permanent pacemaker electrodes via the cephalic vein. O. Haiderer, H. Prager, H. Koller and H. Sterz | 359 |

Part X. Pacemaker engineering and testing of pacemaker function

| | |
|---|-----|
| Achieving reliable pacemakers. W. Greatbatch | 364 |
| The value of patient participation in the control of cardiac pacemaker function. B. Nuber, C. Büchner and W. Dräger | 369 |
| External analyzer for automatic evaluation of implanted cardiac pacemakers. H. Fischler, S. Behar and H.N. Neufeld | 374 |
| Self control of pacemaker function with the Pace-Guard system. A. Wirtzfeld, M. Lampadius and C. Himmler | 382 |
| Self-monitoring pacemaker function with Pace-Pulse Trac. A.M. Bilgutay, I. Bilgutay and J.J. Garamella | 387 |

| | |
|--|-----|
| The endocardial electrogram and pacemaker sensing. S. Furman, P. Hurzeler and V. de Caprio | 391 |
| Proposal of a standard test signal for demand pacemakers. M.S. Lampadius, W.H. Präuer and A. Wirtzfeld | 396 |
| Description and preliminary results of an original unit permitting long term surveillance of a patient with an implanted pacemaker. J. Mugica, J. Buffet, P. Coumel and M. Catte | 398 |
| Biological signals and their characteristics as a cause of pacemaker malfunction. O.-J. Ohm, E. Hammer and L. Mørkrid | 401 |
| The clinical importance of the time constant in pacemaker patients: experiences from a pacemaker clinic of variations of the time constant with normal and malfunctioning endocardial electrodes. M. Levander-Lindgren, A. Lodin, K. Pehrsson and A. Thorén | 405 |
| Pros and cons of increased circuits in cardiac pacemakers. A. Lekholm | 410 |
| A new pacemaker autoregulating the rate of pacing in relation to metabolic needs. L. Cammilli, L. Alcidi and G. Papeschi | 414 |
| Three-year clinical experience with the rechargeable cardiac pacemaker system. K.B. Lewis, R.E. Fischell and J.W. Love | 420 |
| Clinical use of an induction pacemaker with which energy is continuously transmitted during intervals between pacing impulses. K. Suma, K. Nakajima, M. Tsunemoto, Y. Ota, T. Toyoshima and T. Togawa | 425 |
| Influence of electrode positions on pacing threshold and sensed signals. T.A. Preston | 429 |
| Long term follow-up of myocardial pacing threshold measurement with an external radiofrequency transmitter in patients with an implanted pacemaker and an independent radio receiver (Radiocor). P. Rossi, G. Palma, B. Marino, F. de Bellis, A. Solina and F. Vercellotti | 433 |

Part XI. Energy sources

| | |
|--|-----|
| Energy sources for pacemakers. E. Sowton | 438 |
| Performance of implanted biogalvanic pacemakers. J.K. Cywinski, A.W. Hahn and J.R. Easley | 447 |
| Current status of the betavoltaic pacemaker system. A.J. Martinis, W.E. Matheson and M. Schaldach | 452 |
| Preliminary experience with a new radioisotopic powered cardiac pacemaker. N.P.D. Smyth, G.J. Magovern, W.J. Cushing and J.M. Keshishian | 458 |
| Test results for long life batteries for cardiac pacemakers. A. Thorén and A. Lodin | 466 |
| Long life pacemakers: 3-year study of Cardiac Pacemakers, Inc., lithium pulse generators. H.D. Friedberg, R.C. Lillehei and M. Mosharrafa | 471 |
| Lithium batteries: are they all the same? R.L. Doty, K. Fester, T. Kuder and W. Tracinski | 474 |
| Lithium generators: experience with 5 different types. H. Mond, R. Harper, M. Luxton, D. Smith, A. Cole and G. Sloman | 481 |
| A lithium-silver chromate powered pacer. G.G. Wickham | 484 |
| Current status of the lithium powered pacemaker and early follow-up on 335 patients. C. Meere, B. Dodinot, D. McGregor, J.L. Cantalapiedra, L. Kubler, J. Teijeira, C. Duran and R. Rivera | 488 |

Part XII. Electrodes

| | |
|--|-----|
| Experience with an electrical conductive rubber electrode for esophageal pacing in infants. H. Meisner, S. Paek, R. Schöber and W. Heimisch | 493 |
| A new concept for a permanent pacing electrode with fewer complications. Z. Naprstek, M. Netušil, M. Krajiček, Č. Švorčík and I. Vaněk | 499 |
| A review of basic studies of electrode physiology — clinical implications. V. Parsonnet, G.H. Myers and P. Chen | 501 |
| Pacemaker electrodes act as high-pass filters on the electrogram. M.B. Raber, T.E. Cuddy and D.A. Israel | 506 |
| Electrochemical aspects of pacing electrodes. F. Hein, R. Blaser, R. Thull, G. Schramm and M. Schaldach | 510 |
| Enhanced electrode stability: the endocardial screw. G.C. Timmis, S. Gordon and J. Helland | 516 |
| Experimental and clinical evaluation of a screw-in electrode. T. Togawa, K. Suma, Y. Fujimori, M. Abe, T. Toyoshima and T. Nemoto | 527 |
| A low threshold endocardial electrode for permanent cardiac pacing. I. Wahlberg, O. Edhag and H. Lagergren | 532 |
| Measurement of the electrical capacitance of a pacemaker lead. H. Ector, A. Peytier, W. Geysen and H. de Geest | 536 |
| Analysis of the longevity of pacing electrodes. A.M. Edwards and J.G. Davies | 539 |
| A new permanent transvenous electrode for fixation in the atrium. H.-J. Bisping and M. Rupp | 543 |
| The use of balloon tipped pacing catheters for permanent cardiac pacing: a new endocardial pacing catheter. R. Harper, G. Sloman, H. Mond, A. Cole, D. Smith and B. Bailey | 548 |
| Round Table: World survey on long-term follow-up of cardiac pacing | 555 |
| Round Table: Is pacing really prolonging life in patients with high grade A-V block? | 579 |
| Round Table: An ideal pacemaker: physiologic, clinical, and engineering considerations | 591 |
| Author index | 599 |

Tawara memorial lecture

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On the occasion of the Fifth International Symposium on Cardiac Pacing held in Japan, we cannot help remembering the fact that this is the country where Sunao Tawara, the discoverer of the atrioventricular (AV) conduction system, was born and lived an active life.

Tawara was born in 1873 in Kyushu, Japan, and graduated from the University of Tokyo in 1901 at the age of 28. He was appointed Professor of Pathology at Kyushu University in Fukuoka in 1908 and retired in 1933. He passed away in 1952 at the age of 78.

Three years ago, in 1973, we celebrated the centennial of his birth in Japan but, regrettably, no appropriate opportunity was found for an international celebration despite the hopes of cardiologists outside of Japan. As it was, however, in 1906 that his book *Das Reizleitungssystem des Säugetierherzens* was published, it is perhaps as fitting that we should commemorate in this year, 1976, the 70th anniversary of the discovery of Tawara's node.

Tawara's achievements in studies on the conduction system

Tawara himself described the details of his experience leading to the discovery of the conduction system in the introduction of his book. According to this introduction and also his talks with his successor, T. Imai, Professor of Pathology at Kyushu University, his first research subject at the University of Marburg was 'Why is a heart having valvular disease so readily paralyzed?' This subject was suggested by Aschoff.

Investigating this problem, Tawara examined more than 100 hearts in detail, but no positive data were obtained. However, he thereby discovered the characteristic histological lesion in rheumatic fever, the 'Aschoff body'. This study was reported by Aschoff alone.

Meanwhile, Aschoff apparently suggested to Tawara the possible significance of the AV conduction tract in the study on heart block. Shortly before this, in 1893, His had described the AV bundle and Kent had described the bundle which now bears his name, in 1892.

However, when Tawara studied the His bundle in man, he failed to confirm the finding of His, that this bundle, after passing through the AV border, connected to the ordinary musculature of the ventricular septum.

Tawara then remembered the study of Purkinje in 1845 on a network of myocardial fibres in sheep. Examining the sheep hearts, Tawara detected that the muscle fibers of the

His bundle ran downwards, divided into right and left branches above the interventricular septum, and finally connected to the Purkinje fibers. He confirmed the existence of such a connection not only in sheep, but also in man, dog, cat and calf.

Before Tawara, the significance of the Purkinje network had not been clear, and several concepts had been proposed by various authors. Some considered that this structure was not different from ordinary myocardium, while others regarded it as a pathological change, but the most widely held opinion at the time was the belief that it was a type of growing myocardial fiber. Such a misconception probably originated from the findings that the nucleus of the Purkinje cell is usually large and frequently lobulated. As Roberts stated recently (1959), such findings led earlier authors to attribute an embryonic role to the Purkinje cell. Tawara discovered, however, that the Purkinje network was already formed in the fetal period, and remained unchanged throughout life, and by his demonstration of the connection between the bundle of His and the Purkinje network convincingly settled the true role of the latter as part of the conducting system.

Tawara's anatomical descriptions were highly detailed. For instance, Figure 1 shows a sketch of the course of the left bundle branch in the human heart illustrated in Tawara's book. Comparing this with our present knowledge, the accuracy of his observation is remarkable.

Despite all this, opinions denying the presence of a specialized conduction system continued to be expressed for some time. Today, of course, studies such as those using microelectrodes have demonstrated that the action potentials of the conduction system are different from those of ordinary atrial and ventricular myocardium.

Another structure discovered by Tawara was the AV node. According to his description, the atrial termination of the AV system expanded into a node in front of the coronary sinus and connected directly with the atrial musculature.

Summarizing his findings Tawara proposed the term 'Reizleitungssystem', or 'excitation conduction system'. It included the AV node, the His bundle, the bundle branches and the Purkinje fibers. It should not be forgotten that the term AV conduction system, which we use today, originated from Tawara.

The establishment of the AV conduction system by Tawara put an end to the prevailing argument between the myogenic and neurogenic theories about control of the heart beat, providing a proof for the correctness of the former.

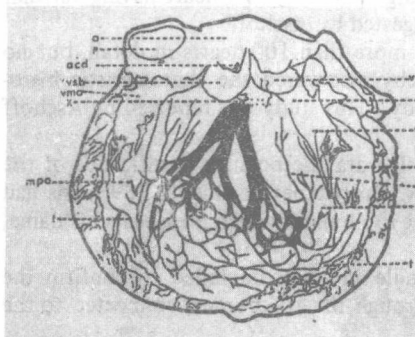


Fig. 1. Left ventricle of human heart, sketched by S. Tawara. Reproduced from *Das Reizleitungssystem des Säugetierherzens*.