Frank R1. Guy Fontaine MD PhD HDR. Eur Heart J. 2018 Jun 21;39(24):2226-2227. doi: 10.1093/eurheartj/ehy276

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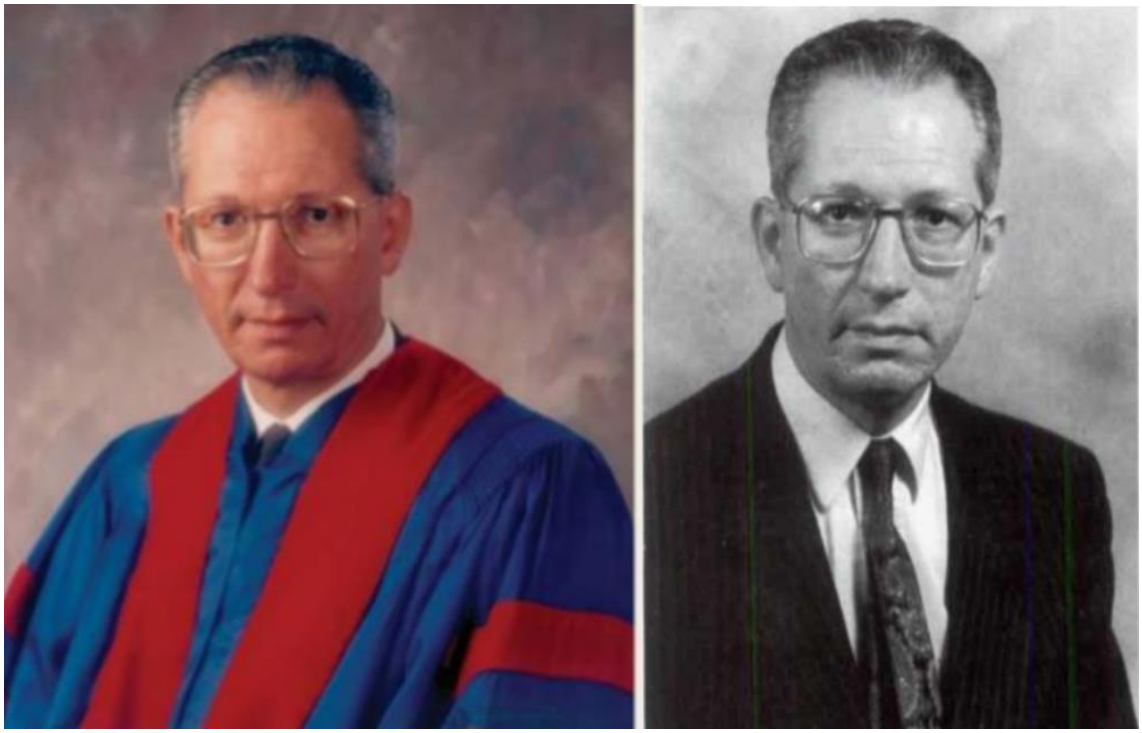
Guy Fontaine with Robert Frank 2017

A pioneer in modern electrophysiology, outstanding researcher and teacher, departed from cardiology on 7 March 2018



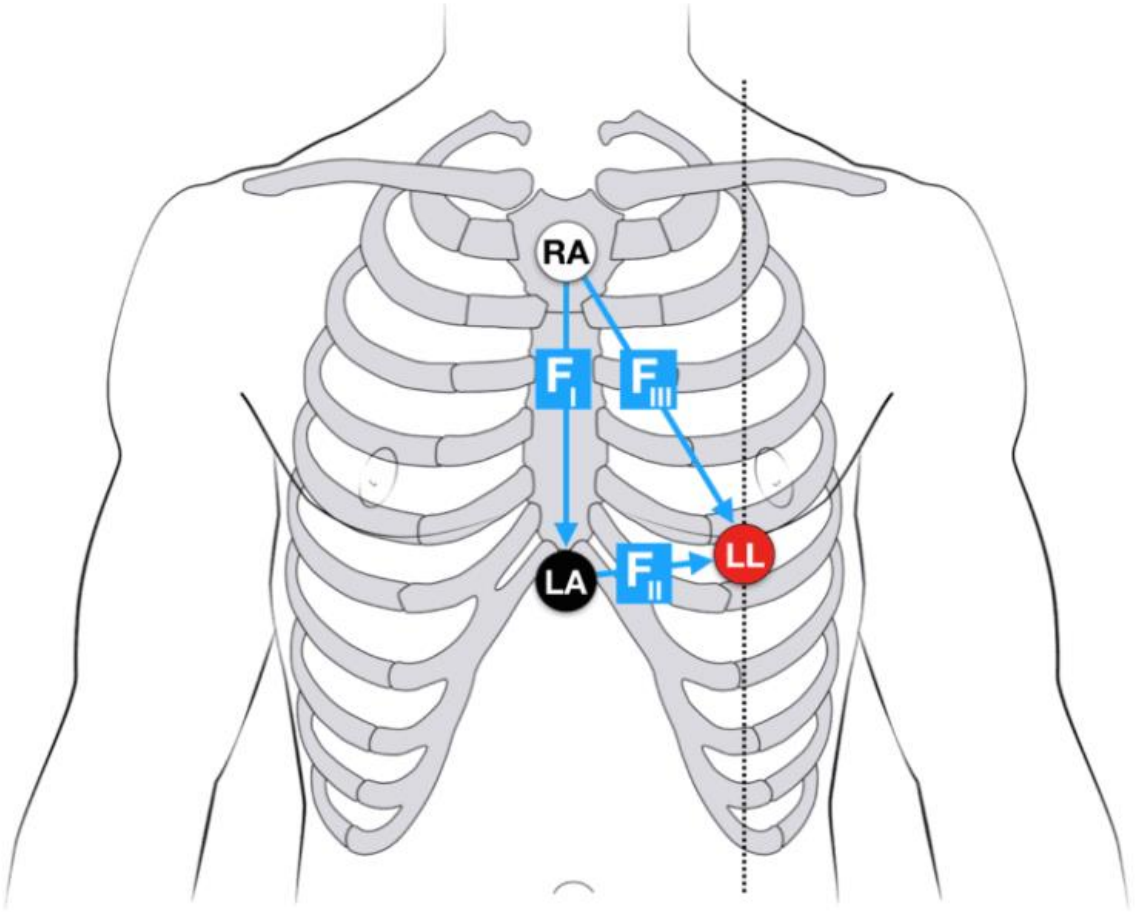
Guy Hughes Fontaine Photo at the height of his life

Was born 24 December 1936 in the city of Corbeil-Essonne, a suburb of Paris. France –Died 7 March 2018 Saint Mandé, France. Primary school was in the city of Bordeaux, in a Loyola institution The secondary school at the Lycte Montesquieu in Bordeaux and then moved to Paris.

Eponymictionary

During this time described and defined arrhythmogenic right ventricular dysplasia; coin the term ‘epsilon wave ‘for the late QRS ‘wiggle’ seen in 30% of patients; and describe bipolar lead placements to best visualize the characteristic waves (Fontaine leads; F-ECG)

- Fontaine bipolar precordial leads ECG(F-ECG) Fontaine bipolar precordial leads (F-ECG) are used to increase the sensitivity of epsilon wave detection. Leads are placed as shown with the Right Arm (RA) over the manubrium; Left Arm (LA) over the xiphoid process and Left Leg (LL) in the standard V4 position (5^{th} ICS MCL). Instead of regular leads I, II, and III there are now three *bipolar* chest leads that are termed FI, FII, and FIII which record the potentials developed in the right ventricle, from the infundibulum to the diaphragm. The vertical bipolar lead FI, (similar to aVF) magnifies the atrial potentials and can be used to record epsilon waves; search for AV dissociation in ventricular tachycardia; and to study abnormal atrial rhythms when the P waves are too small on regular leads.



Fontaine Leads

- Epsilon wave Fontaine coined the term epsilon wave – small positive deflection (‘blip’ or ‘wiggle’) buried in the end of the QRS complex. It is the characteristic finding in arrhythmogenic right ventricular dysplasia (ARVD/C).The term “epsilon” was nice, because it occurs in the Greek alphabet after delta; thus, delta represents the pre-excitation and epsilon the post-excitation phenomenon. In addition, epsilon is also used in mathematics to express a very small phenomenon… Fontaine 1997

- Arrhythmogenic right ventricular dysplasia
- **Medical Eponyms**
- **Fontaine leads**:

Guy Fontaine Photo one year before his death

Guy Fontaine was a pioneer in modern electrophysiology and arrhythmia therapy, an outstanding and visionary investigator and a mentor for many of us from many countries. He is part of the generation that founded modern electrophysiology, as were Philippe Coumel, Hein Wellens, Marc Josephson, and many others from Europe and the United States. I was his friend and associate for 40 years and he made me share most of his innovations.

He had a very unusual career in Paris APHP hospitals, outside the usual academic French system, but was widely supported by his successive department directors, Prs J. J. Welti, J. Facquet, and Y. Grosgogeat. Before his medical studies, he spent 2 years at an engineering school, where he learnt about electricity, electronics, and methodology.

In the early 1960s, he was still a medical student in a cardiology department when he witnessed atrioventricular (AV) blocks and was able to understand through his engineering training the problems of the first pacemakers. He did build an external pacing device to use on patients waiting for their epicardial implants, the only available pacing mode at that time. He implanted the first endocardial models and started his scientific contributions in 1967 by studying the post-implant pacing threshold evolution.

In those early days, he initiated catheter arrhythmia studies in the department, building his laboratory with industrial oscilloscopes, paper recorders, and multitrack tape recorders for reviewing

information. He also conceived a pacing device for electrophysiology (EP) studies, and in the 1970's promoted computer use in the EP lab, with a completely customized computer system.

His studies on Wolff Parkinson White (WPW) Syndrome led him to initiate cardiac mapping during surgery in 1971 with the surgeon Gerard Guiraudon in the surgical department of Christian Cabrol, and he published the first European case operated on, in 1972. The same years, he studied ventricular tachycardias (VTs) with electrical pacing and applied epicardial mapping during surgical procedures to remove post-infarction myocardial scars.

A patient was operated on in a desperate case of dilated cardiomyopathy to search for a ventricular scar at the site of origin of an intractable VT. However, there was no scar, even in the depth of a transparietal ventriclotomy, but the patient was cured from his tachycardia. Because experimental studies had already demonstrated the re-entrant nature of most VT, the conclusion was simple: a circuit had been interrupted as in WPW Syndrome. Guy Fontaine then became famous with Gerard Guiraudon on the subject, and many patients were thereafter referred for surgery.

Some of these patients operated on had an undetected abnormal right ventricle, which Fontaine chose to name arrhythmogenic right ventricular dysplasia (ARVD), first published in a 1977 book. A larger series was published in 1982 in Circulation with Frank

Marcus who spent a sabbatical in our department. It gave world recognition of the disease and multiple further studies have since been produced around the world. Surgery also demonstrated the existence of late potentials in sinus rhythm and their role in human VT and this phenomenon was named by Fontaine the post-excitation syndrome. He also found that high amplification and a computerized averaging technique could detect them on surface electrocardiogram, a method that, at that time was only suggested for His Bundle potential recording from the surface electrocardiogram.

Catheter ablation was discovered by serendipity. A patient had an induced ill-tolerated VT that could not be interrupted by pacing and needed several electrical shocks. The last shock was effective and the patient reverted to sinus rhythm, but in AV block. The external part of a bipolar electrode placed on the His Bundle happened to be in contact with the patient's skin at that moment, and a spark had simultaneously occurred there, demonstrating that some current had reached the His Bundle. This was published as an unusual accident of an EP study and gave ideas to the arrhythmology community. His Bundle ablation at that time was just an open chest procedure for severe supraventricular tachycardia, and in 1983 after animal studies, the first catheter ablations were proposed in different centres for this indication. It was then extended to pre-excitation and VT, but not without risks.

Guy Fontaine called the procedure fulguration (DC shock ablation) and developed an experimental setup to study its biophysics, which allowed a safer use in our centre. Then when alternative energies were studied, radiofrequency made the method easier to be used everywhere and fulguration disappeared. During this period of VT ablation, it was more challenging to find its site of origin than with the surgical approach, as there was no 3D imaging, and we contributed to the identification of the slow conduction zone, introducing pace mapping during VT and sinus rhythm. His last and recent original study was on brain protection after sudden death by cooling with CO_2 expansion in the nasopharynx cavity.

Guy Fontaine was always interested in the study of what were in his early days so-called intractable arrhythmias, bradycardia with the early pacemakers and tachycardia at a time when few drugs were available, by implanting antitachycardia pacemakers for supraventricular arrhythmias when implantable defibrillators were only experimental by Mirowski. His capacity to go deeper into each subject led him to study pacing thresholds evolution with the first pacing problems. He installed the first computer in 1972 to study the failures of pacemakers and hired a computer engineer to build specific programmes, among others, to draw epicardial cardiac activation maps, make EP studies, perform signal averaging and store patient data.

He also started cardiac surgical mapping to understand abnormal cardiac activation. He trained himself in cardiac histology with the discovery of ARVD and found its relationship to myocarditis. He also developed an experimental setup for a better understanding of the biophysics of fulguration, borrowing a high-speed camera (20 000 frames per second) used by the army to film explosions, and showed the gas bubble implosion at the electrode tip, with temperature, pressure, and electrical measurements. He also loved semantics, and created several words for new concepts, such as right ventricular dysplasia, post-excitation syndrome, concealed entrainment, and the epsilon wave.

Guy Fontaine authored more than 700 manuscripts and book chapters on all these subjects, with ARVD being the most important one. He was well known, a member of several scientific societies, a great lecturer around the world until recently, and he received numerous awards for his contributions. He was also a good story-teller and knew very well how to describe the persons he met and the events he participated in.

Guy was also a pianist, an original painter, and a fine gastronome. He also saved his wife who experienced sudden cardiac death in his home where he happened to have an old external defibrillator and where he used his brain protector device. Guy Fontaine was still active until his last day with several pending publications despite his severe disabling disease. I very much miss our

discussions on his original ideas that he always defended in public debates.