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From dotted lines to fetal cardiology: the pioneering contribution of Xin-Fang Wang (1934–2021)

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The earliest published article on fetal echocardiography in German was by Kratochwil and Eisenhut in 1967 [1], and that in English by Fred Winsberg in 1972 [2]. There is a lesser-known study of this type, published in Chinese, by Xin-Fang Wang (Figure 1) and Ji-Peng Xiao.

In early 1960s, they first observed "flashing dots" above the pelvic area of pregnant women using an A-mode ultrasound device, made by a Shanghai shipyard. They later used device, manufactured locally in Wuhan, to display the dots against time, producing the earliest M-mode waveforms of fetal cardiac activity. This was distinctive from maternal pulsatile waveforms in rate, confirmed on simultaneous maternal ECG. The study was first presented in Chinese Medical Association (Wuhan Chapter) Annual Meeting in 1963, with a full paper published in 1964 (Figures 1, 2, S1)[3].

Wang, who died in November 2021, was a graduate of Tongji Medical College (Deutsche Medizinschule, funded by German Dr Erich Paulun in 1907 in Shanghai, and relocated to Wuhan in 1951). He then worked as a doctor in its teaching hospital**,** the Wuhan Union Hospital. The hospital was funded by a UK missionary, Griffith John, in 1866 and mainly run by two English surgeons, Tom and Keith Gillison (father and son), until 1950 when the Korean War broke out. China then virtually closed to the West, in particular during 1960s and 1970s. It is therefore no wonder that this work was virtually unnoticed by researchers elsewhere until several years after China's gradual "reopening" from 1978 [4].

Wang received a medical ultrasound pioneer award from WFUMB & AIUM in 1988 for his work in fetal echocardiography and other areas of medical ultrasound, such as explaining normal and stenotic mitral waveforms on M-mode in 1963, before B-mode became a useful tool. He also authored and edited the first five editions of the Chinese textbook of echocardiography.

Wang's early study echoed 140 women (147 fetuses), and developed a new technique for the diagnosis of early pregnancy of about 3 months by observation of fetal heart activity and

estimation of cardiac size. No correlation between M-mode waveforms and specific cardiac structures was made due to the lack of a fast cross-sectional scanning machine at that time. However, it is not very difficult to make such correlations using the figures published in their paper (more relevant materials can be found in References [5,6]). Kratochwil's independent work in 1967 significantly brought forward the detection of fetal cardiac activity to as early as 32 days after fertilization [1].

These M-mode studies by Wang and Kratochwil established the most accurate methods for diagnosing fetal life. They still formed the basis for the differential diagnosis between normal pregnancy, early pregnancy loss, hydatidiform mole etc. Winsberg's M-mode study, guided by early real-time B mode, allowed known anatomical dimensions to be measured [2]. And the rest is well-documented and cited history: real-time cross-sectional ultrasound with ever improving spatial and temporal resolution applied to the fetal heart allowing detailed postmortem anatomical correlations to be made. Prenatal detection of cardiac structural and then functional abnormalities became possible, rather than just confirmation of fetal viability.

Real-time cross-sectional ultrasound with color and spectral Doppler still forms the stem of echocardiography today [7], branching into 4D imaging [8,9] , speckle tracking [10,11] and other fields, allowing earlier diagnosis #[12,13] and even in-utero intervention [14,15]. We honour those pioneers who sowed the seed of fetal echo, and those who have nurtured it into the tall oak we have today.

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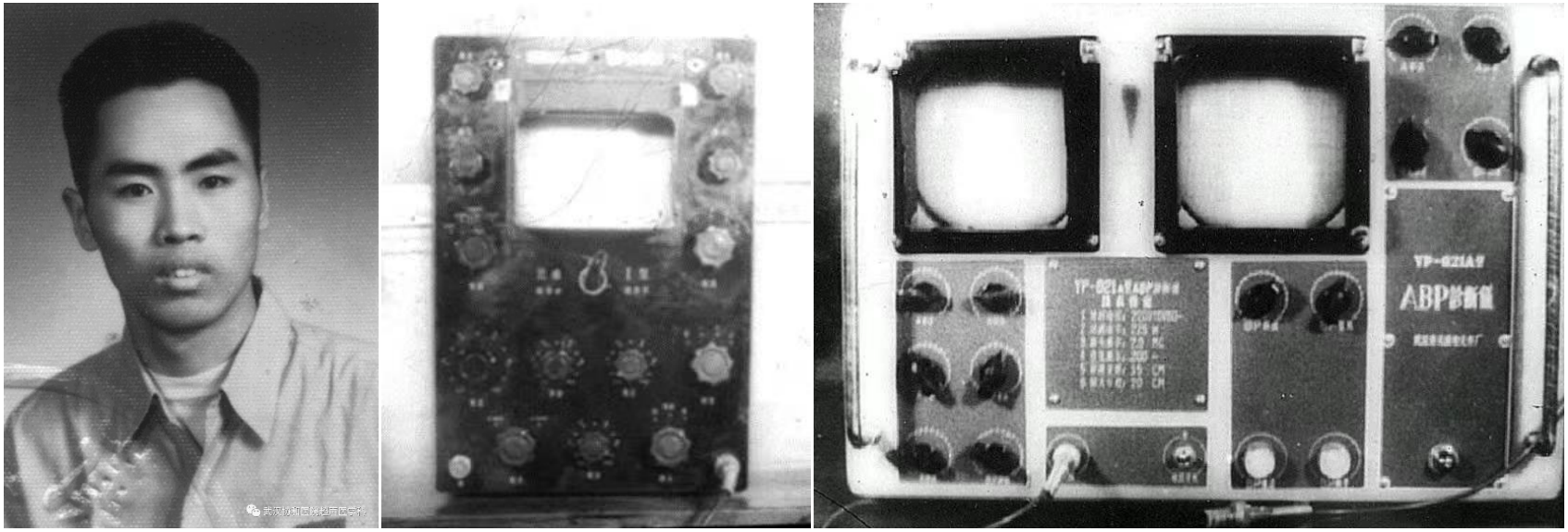
Figures

Figure 1 Xin-Fang Wang in 1958 as a graduate of Tongji Medical College (Deutsche Medizinschule, funded by a German doctor in 1907) in China. Wang had since worked as a doctor in its teaching hospital –Wuhan Union Hospital. He and Xiao first observed fetal heart beats in early 1960s using an A-mode ultrasound device made by Shanghai Jiangnan Shipyard [centre]. They later used a M-mode ultrasound devised by Wuhan Radio Equipment Company [right] to display the earliest M-mode fetal echocardiograms (Figure 2)

Figure 2. On the Left: Figures from Wang's original article (1964). *Upper left panel*: when fetal heart beats appeared swinging left and right on A-mode, M-mode tracing would show dotted lines (arrows); *Lower left panel*: when the beats appeared up and down on A-mode, M-mode would produce wavy tracings. This is similar to atrioventricular valve (AVV) movement seen in recordings by Kratochwil (1967), and also by Winsberg (1972) (Right). The device used by Kratochwil could detect fetal heart beats as early as 30 days. A Siemens Videoson real-time B mode scanner allowed Winsberg to align the M-mode cursor cross a line of interest so the anatomical dimensions could be measured on M-mode.

Figure S1 This picture is not an early "Wave" painting of the floating world from Japan, but an sci-art work by an ISUOG member on M-mode fetal echocardiograms, known as the earliest publication (in 1964) of its kind, by late Prof Xin-Fang Wang.



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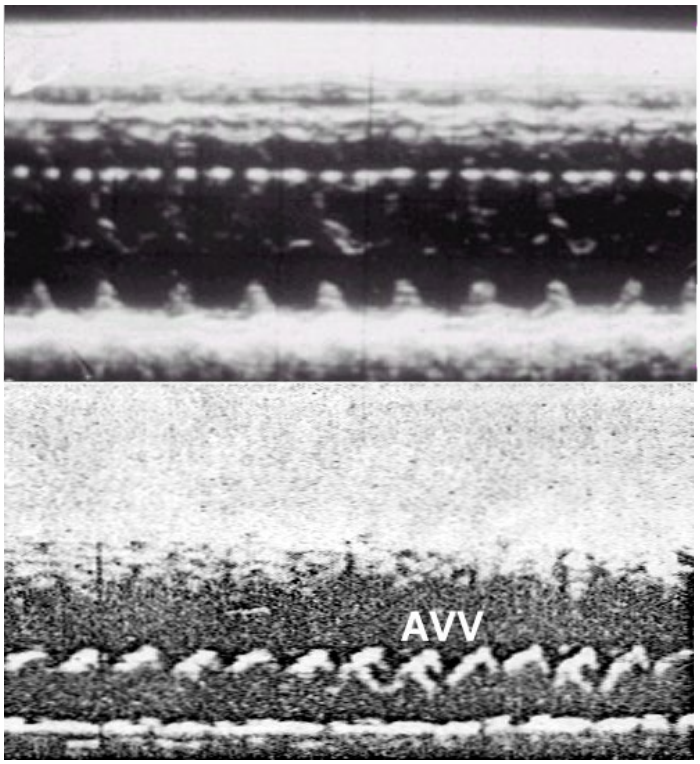

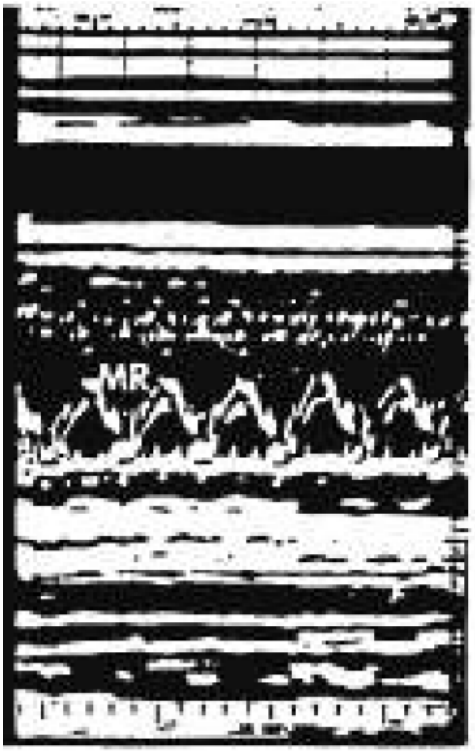

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