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Review

History of the Ultrasound Machine in Obstetrics and Gynecology

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This paper goes through the evolution of the ultrasound machine. It examines the various inventions and improvements to the machine over time, starting with the first 2D scanning machine in 1958 to present-day portable point-of-care machines. This paper will further explore the various uses of the ultrasound machine in obstetrics and gynecology over time, including the more recent developments in artificial intelligence. There have been many different modifications and improvements to ultrasound machines over the years making technology increasingly more valuable. Although the machine is used widely in various fields of medicine, it has significantly impacted obstetrics and gynecology.

INTRODUCTION

The ultrasound machine stands as a ubiquitous fixture in the medical realm, particularly for its indispensable role in prenatal care. It uses sound waves to generate images of the inside of a patient's body, serving various medical purposes. However, the modern machine has undergone a protracted evolutionary trajectory, becoming an essential tool used by many physicians daily.[1]

REVIEW

While there were references to the scientific technology needed to build the ultrasound machine before, the device's official debut was in 1958 in the United Kingdom. Ian Donald and Tom Brown, working with a local engineering company, developed the first 2D ultrasound scanning machine, the diasonograph. While this machine was revolutionary for its time, it was coined the "dinosaurograph" by Americans because it was mammoth in size, towering at eight feet tall, and taking up nearly a third of the scanning room.[2] In comparison to the sleek, real-time grayscale images we see with ultrasound machines today, this device was archaic. Static images were slowly generated and lacked any real grayscale. However, the diasonograph was still widely used around Europe throughout the next few years because it had the best image resolution compared to its competitors. That same year, Donald, Brown, and John McVicar published a paper in the Lancet titled "Investigation of Abdominal Masses by Pulsed Ultrasound." The nine-page paper detailed the men's experience with one hundred patients and contained twelve images from their machine.[3] At the time, it was considered by many to be the most important paper on the use of sonography within obstetrics and gynecology ever written, with conditions such as ovarian cysts, fibroid ascites, and various other normal and abnormal conditions highlighted.

After the invention of the diasonograph, the race for a better ultrasound machine was kicked into full gear. Throughout the 1960s, similar static-imaging machines were built throughout Europe in Copenhagen and Vienna by the company Kretztechnic, and even across the world in Japan by the company Aloka. The next major development of the ultrasound machine came in 1962. Richard Soldner, an engineer for the German company Siemens, built the first real-time scanning machine, which produced images at fifteen frames per second. This machine was sold all over Europe in the 1960s. The diasonograph was still used over this machine for static imaging because the image quality was much better, but this machine's real-time imaging proved to be very useful for more invasive procedures.[4]

Many other static scanning machines were built over the course of the decade. In the mid-1960s, Kretztechnic and Aloka began developing transvaginal scanners. While these devices are used commonly today in prenatal care, their potential was not utilized when they were first released because real-time imaging was not yet a common practice. These machines were revolutionizing, but they were impractical; they had a harsh black-and-white image, with no grayscale.[5]

Grayscale was introduced in the 1960s when George Kossoff built the Octason Static Scanner, and later, the scan converter. The Octason scanner involved the patient lying face down on a plastic tank containing degassed water. This machine got rid of reverberations beneath the skin, but it wasn't until the scan converter came along that this machine became truly useful; the scan converter introduced grayscale into sonography, which allowed for a more detailed appearance of tissues within images. Unfortunately, the Octason wasn't successful for very long, but the scan converter went on to be used with numerous other static scanning machines.[1]

One of the first major applications for the use of the ultrasound machine came in 1966, when Ken Gottesfeld and the Denver group published a paper on ultrasound placen-

tography. During this time, placenta previa, a condition where the placenta partially or entirely covers the cervix, was a leading cause of death in mothers because of bleeding late into pregnancy. While there were image methods at the time, they had previously failed to accurately find the placental edge. This paper set the precedent for placenta previa to be observed on ultrasound. A few years later, Ian Donald – the creator of the Diasonograph – and Usama Abdulla used better equipment to observe the placenta in all locations. In 1970, Stuart Campbell made the first prenatal fetal diagnosis. He and his team reported a case of anencephaly, which involves the fetus missing parts of the skull and cerebral hemispheres of the brain.[1] A year later in 1971, Horace Thompson and Ed Makowsky measured the thoracic circumference, which measures the fetus's lungs.

Over the next few decades, many companies would continue to develop different kinds of ultrasound machines, competing with each other and continually improving. In 1983, Sam Maslak made the Acuson 128, which introduced a new beam-forming software called "computed sonography." Japan started studying three-dimensional ultrasound imaging in 1984, and Aloka developed Doppler imaging in 11985. Doppler imaging is still used to this day; it shows the movement of blood and where various are within the body. This set a new standard that was followed by manufacturers worldwide.[4]

Three-dimensional ultrasonography resurfaced again in 1990. The production of the 530D Voluson was what showed that three-dimensional and four-dimensional gynecological imaging had an important place in the field of obstetrics and gynecological care. By the year 2000, real-time scanners with a 3D/4D option had become inexpensive and widely accessible.[2]

After these machines became widely accessible, Point of Care Ultrasound, or POCUS, became more widely used. It provides real-time images, and can help determine why a patient has certain symptoms, and any negative changes can be detected much faster. This is especially important in obstetrics; any issues with fetal or maternal health which is especially important in high-risk pregnancy cases. It can give swift answers for potentially life-threatening situations and has proven its usefulness over the last few years.[6]

The most recent development with the ultrasound machine has to do with artificial intelligence (AI). While it seems daunting to many, AI has become a large part of life with recent technological advancements. Most people are already somewhat familiar with AI because of things such as virtual assistants through smartphones, but it has also been revolutionizing many fields of healthcare.[6]

In recent years, AI has been used frequently in radiology due to its ability to recognize patterns and diagnose certain diseases. While it is doing something that has been done by humans for hundreds of years, it significantly reduces the time spent analyzing an image, saving time and money. For obstetrics and gynecology, AI is used to analyze ultrasound images in a variety of ways. It has been used to attain measurements that would have otherwise been very difficult to see in cases involving maternal obesity, or acoustic shadowing (which is where there is a signal loss at the boundaries between two different tissues, which results in a dark appearance, making it difficult to see and accurately obtain data). In addition to measurements, AI can analyze ultrasound images. A recent program has been trained to recognize different parts of fetal anatomy, such as distinguishing arms and legs, automatically gathering measurement data from these structures. This program has already been put to use, and many other similar programs are set to be released soon. Teaching AI to recognize and measure different fetal structures, can be very useful in catching early deformities and abnormalities. In addition, an AI-powered guidance system is a useful way of assisting in training people to use ultrasound machines. By guiding students to the general areas to find certain organs, it can be a very useful teaching tool. Other programs have been used in the fields of obstetrics, such as one that estimates the gestational age of the baby and another that measures brain growth. Although it has not been perfected yet, the next step for AI in obstetrics involves making a diagnosis after obtaining the measuring data and recommending steps for further treatment.[7]

CONCLUSION

The ultrasound machine has undergone many changes throughout the years, gradually increasing its availability, quality, and affordability. While the real-time three- and four-dimensional scanners we have today are a far cry from the earliest versions of the machines, every prototype and instrument was vital in achieving the level of prenatal care we have today.

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