# Michael R. Harrison (1943– )

Michael R. Harrison worked as a pediatric surgeon in the US throughout the late-twentieth century and performed many fetal surgeries, including one of the first successful surgeries on a fetus in utero, or while it is still in its gestational carrier's body, also called open fetal surgery. A fetus is an organism developing inside of the uterus that is anywhere from eight weeks old to birth. Harrison hypothesized that open fetal surgery could correct developmental defects that may become fatal to the fetus at birth. After years of research, Harrison and his colleagues at the University of California, San Francisco, in San Francisco, California, performed surgery on the fetus of a woman in her seventh month of pregnancy to correct the fetus's developmental defects. The surgery was successful, as the fetus developed into a healthy child. Harrison's work led to advancements in fetal treatment techniques, such as a method to conduct fetal surgery that will not harm the fetus or pregnant woman, as well as the establishment of one of the first fetal treatment centers in the US.

On 5 May 1943, Harrison was born in Portland, Oregon. Harrison's family then moved to Washington, where he received his early education. While Harrison was growing up in a small, rural town in Washington, his father worked as a country doctor. When asked later on what encouraged Harrison to pursue his career, he explained that he wanted to be just like his father.

In 1961, Harrison began attending Yale University in New Haven, Connecticut. He graduated cum laude with a Bachelor of Arts degree. Harrison then went on to graduate magna cum laude from Harvard Medical School in Boston, Massachusetts, which he attended from 1965 to 1969, with a Doctor of Medicine or medical degree. After graduation, Harrison went to work at Massachusetts General Hospital in Boston to complete his general surgery residency. During his residency, Harrison also worked as a fellow from 1971 to 1973 at the Laboratory of Immunology at the National Institute of Allergy and Infectious Diseases in North Bethesda, Maryland. There, he studied pediatric allergy and immunology, a field that focuses on caring for children with allergies, asthma, and immune system disorders. In 1975, Harrison completed his surgery residency at Massachusetts General Hospital. Around that time, Harrison also met his wife, Gretchen Harrison. After they married, they had four kids together.

Harrison stated in his interview with the Bulletin of the American College of Surgeons that after working at the Laboratory of Immunology, his main interest became working as a pediatric surgeon, though he hoped to use his immunology training to work towards the goal of one day conducting fetal surgery. In 1975, Harrison worked as a pediatric fellow at the Rikshospitalet campus at Oslo University Hospital, in Oslo, Norway. According to the Oslo University Hospital, the hospital is very specialized and is one of the largest hospitals in Scandinavia. In 1976, Harrison returned to California to complete another pediatric surgery fellowship at the Children's Hospital Los Angeles in Los Angeles, California. In 1978, Harrison became a certified surgeon through the American Board of Surgery, an independent organization that recognizes surgeons who are committed to professionalism and quality patient care, according to the organization's website.

Also in 1978, Harrison accepted a faculty position at the University of San Francisco, or UCSF, where he began to explore the possibility of performing fetal surgeries while working as a general surgeon. According to Harrison, he chose to work at UCSF because it had lots of resources that would be needed to work towards accomplishing fetal surgery. For example, at that time, the university's pediatric surgeons, cardiologists, and scientists had been in the process of developing a fetal lamb model, or a maturing lamb fetus in utero that they could later use to test heart surgeries on. Harrison began using the hospital's resources to practice performing fetal repairs in utero. He then

began performing various tests on animal models, trying to perfect the technique of fetal surgery. Harrison would continue performing experiments on non-human primates and other animal models over the next four years while he performed fetal surgeries on humans.

Harrison and his team at UCSF began performing open fetal surgeries in 1981 after receiving approval from an Institutional Review Board, or IRB, a certified group of experts that approves research after ensuring it meets standards of human welfare and protects its subjects. Harrison led one of the first open fetal surgeries in 1981 to unblock a urinary tract obstruction, a condition that blocks the flow of urine from the normal path and can lead to kidney failure. However, the fetus that Harrison operated on died after delivery, as Harrison performed the intervention too late in the fetal development process to prevent fatal kidney failure. The fetus's kidney failure led to a lack of amniotic fluid, or the fluid surrounding a fetus as it develops, which is largely made up of urine after twenty weeks of development. Amniotic fluid plays an essential role in fetal lung development. Without kidneys to filter fluids and produce urine to make up the amniotic fluid, the fetus's lungs could not develop properly, so it died after being delivered.

Also in 1981, Harrison met Rosa Skinner, who was forty-two years old and seven months pregnant with twin fetuses, one male and one female, at the time. Skinner's doctors had noticed through sonograms, or visual images of the internal body produced using sound waves, that her female fetus was developing normally while her male fetus was not. After further testing, the doctors found out that the male fetus had a urinary tract obstruction, the same condition as the fetus Harrison had previously operated on, which could lead to fatal kidney and lung failure. Skinner and her husband met with Harrison and his medical team to discuss their options and the risks of potentially performing open fetal surgery. One of the risks of the surgery was that it posed a potential danger to the male fetus's twin sister, who was healthy and developing normally at the time. However, the Skinners agreed to the surgery in hopes of saving their male fetus.

Harrison performed that surgery on 26 April 1981. During the operation, Harrison made a small incision into Skinner's uterus, where he placed a small shunt, or a small tube, that he created into the male fetus's bladder. The specially designed shunt, which Harrison named the Harrison shunt, allowed the urine to excrete into the amniotic fluid. Many other surgeons have used the Harrison shunt in other fetal surgeries since Harrison first created it. After placing the Harrison shunt in Skinner's fetus, Harrison sutured Skinner's uterus and abdomen, allowing the two fetuses to progress to a full-term pregnancy. The surgery was one of the first ever successful fetal surgeries performed in utero, as Skinner's twins were born two weeks after the surgery and survived. Skinner named her daughter Mary and her son Michael, after Harrison. Skinner's son went on to undergo a few more surgeries, including having the blockage in his urinary tract removed and having the swelling in his stomach that resulted from his urinary tract obstruction repaired. Skinner claimed that her son took a little bit longer than most toddlers to sit up, but that he was up and walking by the time he was eighteen months old.

Following the surgery performed on Skinner in 1981, Harrison helped found the UCSF Fetal Treatment Center, one of the first fetal treatment centers in the US. According to the UCSF Fetal Treatment Center, their institution has more experience with fetal surgery than any other in the world as of 2021. Harrison developed new techniques at the Fetal Treatment Center to improve fetal surgery and correct many detrimental fetal conditions such as malformations of the lungs or diaphragm over the following decades. Also, while working at the Fetal Treatment Center, Harrison published one of the first textbooks on fetal therapy, The Unborn Patient: Prenatal Diagnosis and Treatment, in 1984. The Unborn Patient discusses treatment for several fetal deformities that can be detected in utero and it is now on its third edition as of 2021.

Additionally, in the 1990s, Harrison and his team at the Fetal Treatment Center began performing experiments with the goal of correcting spina bifida, a condition where a fetus's spinal cord does not develop properly, through fetal surgery. Most infants born with spina bifida survive but can be left with many disabilities such as paralysis, difficulty controlling bowels or bladder, excessive fluid in the brain, and developmental delay. Before Harrison's team investigated repairing spina bifida in utero, surgeons often treated spina bifida shortly after an infant was born. Harrison's team began investigating how to repair spina bifida in utero through experiments performed on sheep in the early 1990s, and successfully repaired spina bifida in a sheep in 1995.

In 1999, Harrison and his team began investigating fetal repair of spina bifida in humans. In 2003, they published the results of treatment on thirteen human patients in the paper "In utero repair of myelomeningocele: experimental pathophysiology, initial clinical experience, and outcomes" in The Archives of Surgery. There, they report that they completely repaired the condition in one fetus, but had mixed results with other patients. Also in 2003, the results of a nationwide study called the MOMS study, which aimed to determine whether in utero fetal intervention or surgical repair after birth was more effective at treating spina bifida, published their results. That study found that open fetal surgery was more effective at treating spina bifida than surgical repair after birth. Since then, open fetal surgery to repair spina bifida has become a more commonplace practice using the techniques Harrison's team developed at UCSF.

Harrison retired from surgical practice in 2006, but continued working to develop new devices for fetal surgery. In 2009, the US Food and Drug Administration, or the FDA, awarded UCSF with a grant to develop pediatric devices. Harrison helped use that grant money to establish the UCSF Pediatric Device Consortium, which hosts regular meetings of interdisciplinary specialists who work together to develop technologies to treat conditions in children. Among the devices their team has created are a magnetic mini-mover that helps treat chest deformities in children and MagNap, a treatment that helps open up the airways of patients who have sleep apnea, a condition that occurs when a person's airways become narrowed or blocked during sleep. Both devices are non-invasive treatments, meaning they do not require surgery as some other treatments for those conditions do.

Over the course of his career, Harrison published over four hundred peer-reviewed articles, some of which discuss different fetal abnormalities that can occur in utero. Harrison received much recognition throughout his career. According to USCF, Harrison is widely regarded as the father of fetal surgery. He served as the President of the American Pediatric Surgical Association, an organization of pediatric surgeons dedicated to promoting optimal surgical care for patients and their families, from 2008 to 2009. He also helped found the International Fetal Medicine and Surgery Society, a society that promotes the development and advancement of fetal diagnosis and therapy, and served as the Society's president three times between its founding in 1981 to 2010. Additionally, the American College of Surgeons awarded Harrison the Jacobson Innovation Award in 2002 for creating the specialty of fetal surgery and developing non-invasive techniques to use during fetal surgery.

As of 2021, Harrison is a Professor Emeritus of Surgery, Pediatrics, Obstetrics, Gynecology and Reproductive Sciences at UCSF and the Director of the UCSF Fetal Treatment Center. Harrison and his wife reside in San Francisco, California, where they have lived for over twenty years.

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