

Obituary

David H. Sutherland, MD (1923–2006)  
Pediatric Orthopedic Surgeon  
Founder Father of Clinical Gait Analysis



David Hollingworth Sutherland, MD was born of missionary parents in Taming, China on June 18th, 1923. Owing to the political instability of pre-war China, his parents sent him back to the United States to grow up in Nampa, Idaho where he had a typical rural upbringing doing chores and learning to ride the unicycle. He graduated from the University of Washington in 1944 and Marquette University School of Medicine in 1946. After an internship in St Louis and a year of general surgery training, he joined the new United States Air Force, where he was a general medical officer and surgeon from 1949 to 1952. He journeyed to a vibrant post war San Francisco for an orthopedic residency from 1952 to 1955. During this time, he came to appreciate the importance of understanding the mechanisms of how people walk and how orthopedic conditions such as cerebral palsy and amputations altered their gait. One of his mentors, Dr. Vern Inman, was instrumental in the understanding of the biomechanics of human locomotion. Two of Dr. Inman's residents: David Sutherland and Dr. Jacquelin Perry, a former World War II physical therapist who became a physician, appreciated that this was a fertile area for research.

After completing his residency, Dr. Sutherland began his career in 1956 at Shriners Hospital in San Francisco. His first research efforts were directed toward understanding the phasic activity of transferred knee muscles in polio patients. This study used an innovative method of synchronizing three channels of EMG on cinematographic film. The study revealed that muscle phasic alterations in polio patients are frequent in both transferred and non-transferred muscles. The surgical innovation coming out of this clinical research consisted of transferring the muscle origin to the femur in addition to transferring the muscle insertion to the patella. Although the success of these transfers was limited by the small size and limited strength of the sartorius and tensor fascia latae muscles, the concept of converting a two joint muscle to a single joint function and thereby improving phase conversion was demonstrated.

As a result of his work with EMG, he realized that accurate measurement of movements would be necessary if progress was to be made in understanding pathological gait. The specific stimulus for the development of an accurate movement measurement system, capable of measuring movement in three planes, came via a request from Edwin R. Schottstaedt, former Chief Surgeon of the Shriners Hospital San Francisco. He challenged him to find a means of measuring rotational abnormalities in patients with cerebral palsy. After a period of investigating goniometric methods of accomplishing this task, a photographic method, using high-speed cinematographic cameras, was selected because of the ease of gaining multiple measurements with relatively few encumbrances on the subject. The project to develop techniques to measure movements of the lower extremity was started with Lockheed engineers, John Hagy and Richard Oyama, in 1965. A method of digitizing cinematographic film with a Vanguard Motion Analyzer to provide a two-dimensional coordinate system for measuring human movement was developed from this collaboration. The film digitization method was labor intensive but it laid an essential foundation for development of the current motion measurement systems.

At the same time, work was begun to develop a force plate. Doctor Sutherland worked with John Hagy, Cecil Keller and John Hawthorn to develop the first 3-component force plate. The force plate used Kistler components. Dr. Jurg Baumann visited Dr. Sutherland's lab, saw the force plate, took the idea back to Switzerland and worked with Kistler to develop the first commercial force plates that are still used today.

Dr. Sutherland moved to San Diego from the San Francisco Shriners Hospital in 1972 when he was recruited by Dr. Wayne Akesson who was forming the first orthopedic department at the University of California, San Diego. Dr. Sutherland founded one of the world's first comprehensive Motion Analysis Laboratories at San Diego Children's Hospital in 1976. A consummate teacher, Dr. Sutherland spent countless hours teaching medical students and residents. Realizing that further training in pediatric orthopedics was critical to understand the growing child, he, along with Doctor Dennis Wenger and Dr. Scott Mubarak, established a fellowship program which quickly rose to preeminence at San Diego Children's Hospital.

Doctor Sutherland's research efforts accelerated in the Motion Analysis Laboratory at San Diego Children's Hospital. Gait studies were performed on normal adult subjects before and immediately after a tibial nerve block. This classic study defined the role of the ankle plantar flexors in gait. Identification of calcaneal weakness in myelodysplasia, cerebral palsy and other conditions occurred as a natural outgrowth of the study on the function of the ankle plantarflexors. In another classic paper, Dr. Sutherland used gait analysis techniques to characterize the pathomechanics and the stages of gait in Duchenne muscular dystrophy. This work led to the idea of bracing in the late stage of ambulation that would provide complete stability in stance yet permit unhampered knee movements in swing. Dr. Sutherland began working on this concept with engineer Larry Malcom in the late 1970s. This concept has matured into the stance control orthoses which have come into the market in the past 3 years. Doctor Sutherland also pioneered the concept of using intramuscular pressure to quantify in vivo muscle force and published the first article on this topic in 1977. This research work is continued today.

In 1975, Dr. Sutherland used gait analysis to identify restricted knee motion in swing phase as the primary functional deficit in cerebral palsy patients with rectus spasticity. Improvement in knee flexion in swing phase occurred after proximal release of the rectus femoris. A gait study, combining subjects from two institutions, Shriners Hospital San Francisco and San Diego Children's Hospital, examined the outcome following two different operative procedures, proximal release and distal transfer. The conclusion was drawn that distal transfer is a better procedure. Subsequently, Doctors Jacquelin Perry and James R. Gage advocated distal rectus transfer to retain hip flexion while enhancing swing phase knee flexion.

Dr. Sutherland's experiences in performing gait studies of a wide range of gait abnormalities in childhood and adolescence prompted the writing of a textbook, *Gait Disorder in Childhood and Adolescence*, with the goal of describing pediatric gait abnormalities objectively, using both kinematic and kinetic methods. This was the first textbook to include objective measurements of movements, force and EMG as well as graphic representation of individual case studies. The development of gait analysis and its increasing application to the study of pathological gait created an urgent need for normative data. This was most evident in the study of children. The walking patterns of small children differ substantially from those of adults, therefore measurements at various ages were required for critical comparisons. To meet the need for measurements of gait patterns from onset of walking to 7 years of age, 415 studies of 309 children were performed. The results of this work culminated in his second textbook, *The Development of Mature Walking*. This text provides the most comprehensive description of this subject. The use of prediction regions for normal children in each age group emerged from this work. These prediction regions comprise the normal movement patterns of 95% of children in each age group.

Doctor Sutherland retired from active clinical practice in 1990, but worked in the Motion Analysis Laboratory until a few years ago when his health deteriorated. He served on charitable boards such as Easter Seals. He continued to the end to have ideas for research and ideas to improve the health of children with orthopedic problems.

Through his efforts and those of similarly committed colleagues, motion analysis has swept through the world with over 150 laboratories currently operating to care for children and adults with gait abnormalities. He developed several operations, including one which bears his name, the Sutherland double innominate osteotomy, which corrects problems children have after a hip dislocation. He published nearly 50 papers, secured federal research grants, and served as the President of the American Academy for Cerebral Palsy and Developmental Medicine. He was awarded the Pioneer Award from the Pediatric Orthopaedic Society of North America in 1993 and the Lifetime Achievement Award from the Gait and Clinical Movement Analysis Society in 2002.

However, these eminent accomplishments are inappropriate to fittingly pay tribute to one so human, considerate, and tolerant; so moderate and retiring. His example of modesty and simplicity in the acceptance of international honors and tributes is a monument in itself, but his greatest monument is the blessings he left for us. Passionately fond of work, infinitely patient, undaunted by failures, he brought developments that broadened the lives of all mankind. He knew no class distinctions, no national boundaries. His unselfishness, coupled with his devotion to his patients, students, family and faith has endeared him to the medical and gait community in San Diego and the world.

Doctor Sutherland is survived by his wife Mildred and their six children. The family has asked that all donations be directed to the Motion Analysis Laboratory at Children's Hospital to continue his work (Children's Specialist Foundation, c/o Kit Holm, 3020 Children's Way, San Diego, CA 92123). Their other requests include The Sutherland Scholarship Fund at Northwest Nazarene University 623 Holly Street Nampa, Idaho 83686 (David helped establish this fund in honor of his parents, Francis C. & Ann Sutherland, missionaries to China) and the Medical Benevolence Foundation International Headquarters 3100 S. Gessner, Suite 210 Houston, Texas 77063-3743 [www.MBFoundation.org](http://www.MBFoundation.org) (David and Mildred went to Africa

on a short term medical mission with this Presbyterian medical mission organization in the early 1980s).

Kenton Kaufman\*  
*Mayo Clinic, Biomechanics Laboratory,  
Rochester, MN, United States*

Henry Chambers  
*Motion Analysis Laboratory,  
Children's Hospital and Health Center, San Diego, CA*

\*Corresponding author  
*E-mail address: [Kaufman.Kenton@mayo.edu](mailto:Kaufman.Kenton@mayo.edu)  
(K. Kaufman)*