Hip hemiarthroplasty: from Venable and Bohlman to Moore and Thompson

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Abstract In 1939, Frederick R. Thompson of New York and Austin T. Moore of South Carolina separately developed replacements for the entire ball of the hip. These were used to treat hip fractures and also certain arthritis cases. This type of hemiarthroplasty addressed the problem of the arthritic femoral head only. The diseased acetabulum (hip socket) was not replaced. This prosthesis consisted of a metal stem that was placed into the marrow cavity of the femur, connected in one piece with a metal ball fitted into the hip socket. Bohlman and Austin T. Moore (1939) collaborated for the fabrication and implantation of a custom made 12-inch-long vitallium (metal alloy invented by Venable) femoral head prosthesis for a patient with a recurrent giant cell tumour. This prosthesis functioned well and later on influenced the development of long stem femoral head prostheses.

Keywords Thompson · Austin Moore · Femoral head replacement

In 1937, the dentist of Smith Petersen, John Cooke, suggested the use of vitallium for the hip arthroplasty. Between 1937 and 1939, Smith-Petersen and Nathaniel Allison developed the vitallium cup arthroplasty (Fig. 1). This was possible due to the introduction of vitallium in orthopaedic surgery by Charles Scott Venable in 1932.

Charles Scott Venable was born in Charlottesville, Virginia, on June 13, 1877. His father was a Lieutenant Colonel during the Civil War, and later professor of mathematics at the University of Virginia. His mother, Mary Southall, was descended from Virginia politicians. He attended the University of Virginia and received his medical

degree in 1900. He continued his studies at medical clinics in Dublin, Ireland; Graz, Austria; Paris, France; and London, England. After his return from Europe, he interned at the Hudson Street Hospital in New York City and the Union Protestant Infirmary in Baltimore. Charles Venable married Madge J. Bonney in Charlottesville, Virginia, on September 5, 1900. They had four daughters: Bonney, Polly, Page, and Natalie. Madge died in 1925. On December 9, 1932, he married Eleanor A. Herff. Venable passed away of congestive heart failure in San Antonio on September 20, 1961.

He accepted an appointment as Instructor in the Medical Department at the University of Virginia. Unhappy with the lack of advancement opportunities, he moved to San Antonio in 1908 and opened a private practice. Dr. Venable specialised in surgery and gynaecology. In 1908, he founded the Lee Surgical Hospital, which operated for nearly 20 years. In 1911, he was instrumental in the establishment of the San Antonio Free Clinic. For many years he was a consultant at Brook Army Hospital, Fort Sam Houston, Texas, and the Robert B. Green Hospital, San Antonio, Texas. He was an attending surgeon at the Nix Hospital and the Crippled Children's Division at the Santa Rosa Hospital, and was an honorary professor at the University of Texas Medical Branch in Galveston. He was a charter member of the Texas Surgical Society when it was founded in March 6, 1915. He remained a member for 46 years and was the last survivor of the charter group of surgeons. In 1915, he was elected a fellow of the American College of Surgeons. He was president of the Texas Surgical Society in 1924, the Bexar County Medical Society in 1930, and the Texas Medical Association in 1943. When he was not practising medicine, he was teaching it, writing about it, or conducting experiments. He authored some 40 plus papers on medical subjects. His passion for research and his collaboration with Dr. Walter Stuck [6] and Asa Beach led him to the discovery of the use of vitallium in bone surgery (Fig. 2). In spite of much research, the solid ideal material which was well tolerated by the human organism was not found before 1932. He first described the effects of electrolysis on

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Fig. 1 one of the first advertisements for hip arthroplasty

metals in bone [9–15] and showed by his research that electrolysis was the principal cause of failure of metal appliances in bone. While conducting experiments, he found only one alloy among all those tested that was completely passive (electrically inert) in the presence of body fluids, that caused no pathological changes in bone, and that was not itself corroded. This alloy, vitallium, composed of cobalt, chromium, and molybdenum seemed so inert that he recommended its use in bone surgery. In 1932, Reiner Erdle and Charles Prange introduce the vitallium metal alloy, a mix of cobalt, chromium, and molybdenum (Fig. 3). This product was originally used for dental prosthetics, which explains the remark of the dentist John Cooke to Smith Petersen. Erdle and Prange also formed *Austen Laboratories*. As to the history of the manufacturers' firms, *Austen Laboratories* was at the origin of *Howmedica Inc.*, now replaced with *Stryker® Corporation* East Rutherford, New Jersey, United States. After having experimented for many years with the effects of various metals on bone, Dr. Venable concluded with the superiority of the Alliage chromium-cobalt-molibdenum for orthopaedic applications, and called it vitallium. The first successful operation implanting a vitallium alloy orthopaedic device by D.S. Venable, MD and W.G. Stuck, MD, marks the beginning of vitallium alloy plates and screws used for orthopaedic fracture fixation. Additionally, Dr. Venable designed the first artificial elbow made of vitallium for a local band director and

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***Venable, Stuck and Beach, Trans. Southern Surgical Assn., Vol. 45, 1917 • Venable and Stuck, Journal of Indiana Medical Assn., Vol. 11, July, 1918 • Hopkins and Zerk, Medical Bulletin of the Veterans' Administration, Vol. 15, July, 1918 • Venable and Stuck, Journal of American Medical Assn., Vol. 111, No. 13, Oct., 1918 • Hopkins and Zerk, Medical Bulletin of the Veterans' Administration, Vol. 15, No. 3, Jan., 1919 • Smith-Petersen, M. N., The Journal of Bone and Joint Surgery, Vol. 21, No. 2, April, 1919 • Stuck, Abbie E., American Journal of Orthodontics & Oral Surgery, Vol. 23, May, 1919.

Fig. 2 Advertising for vitallium done by the Austenal Laboratories

replaced the first femoral head for a fractured hip with a vitallium ball and spike.

Harold R. Bohlman (1893–1979), orthopaedic surgeon, introduced vitallium as a "substance" to replace injured bones and joints, and specialised in the fields of traumatic surgery, pathology and surgery, and hip and knee surgery at hospitals

Fig. 3 Vitallium medallion for advertising

in the Baltimore, Maryland area. Born near Adams, he lived and attended a rural school near Pickrell, graduated from Beatrice High School in 1914, and from Grinnell College in Grinnell, Iowa in 1919 after becoming a pilot in the U.S. Air Service during World War I. A graduate of John Hopkins Medical School in 1923, he performed the first hip joint replacement using vitallium on September 28, 1940 in Columbia, South Carolina. In 1939 Harold Bohlman, according to the work of Venable, developed the first femoral prosthesis out of vitallium (Fig. 4). This replaced the head of the femur and the cartilage which covers it. Bohlman choose to fix the metal head at the cortical external femoral neck by a nail.

Between 1939 and 1950 several designs of arthroplasties with a short stem and different materials (metal, nylon, acylic) were tested (Figs. 5 and 6).

Dr. Jean Judet and his brother, Dr. Robert Judet (1938) of Paris, developed a short-stemmed prosthesis as shown in Fig. 7. The Judet brothers attempted to use an acrylic material to replace arthritic hip surfaces. This acrylic provided a smooth surface, but unfortunately became loose very quickly after implantation.

The most important progress for the introduction of hemiarthroplasty in orthopaedic surgery was obtained when Austin Moore conceived a mega metal prosthesis with Bohlman in 1940 [1, 4, 5] for a patient with a neck fracture after a bone tumour. This case was presented to the Columbia Medical Society of Richland

Fig. 4 Vitallium Bohlman hemiarthroplasty with short stem implanted between 1939 and 1940

Fig. 5 Anderson arthroplasty in 1950 with nylon; wear was important and deformation of the head occurred in one or two years

County, South Carolina, December 14, 1942, and was reported in The Recorder of the Columbia Medical Society, VI, on 12 December 1942.

The patient, at 46 years old and weighing about 125 kg, had a fracture that had occurred in June 1933. He was first seen in September 1934 with a non-union of a fracture of the neck of the right femur. He suffered severe pain and walked with difficulty using crutches. Bohlman decided to try to secure union by nailing the fragments together and drilling holes up through the neck and into the head to allow revascularisation of the head and the fracture line as proposed by Phemister

Fig. 6 Anderson metal arthroplasty

Fig. 7 Circa prosthesis of the Judet brothers

during that period. The fragments were held well together with the nails, and in spite of weight-bearing solid bony union did result, with no pain and with good function of the hip joint. In February 1936, he began to complain of some pain in the hip. On reviewing the original roentgenograms, a small cyst had been present at the time of his injury. The cyst was curetted, and microscopic section revealed a giant-cell tumour that was treated first by roentgenotherapy.

Approximately four years later a pathological fracture occurred. Roentgenotherapy was again administered, and the fracture was treated by bed rest and skin traction until some healing of the tumour region was obtained. Later, the tumour again began to increase in size, and on re-examination in September 1940 a large cystic mass approximately the size of a grapefruit was found in the upper end of the femur. The cortex of the bone was very thin, and it was realised that another pathological fracture would soon occur.

It was therefore decided to resect the entire tumour region and to replace this portion of the bone with a metal appliance made in the form of the natural bone, and to design in it various loops through which the various muscles and tendons could be attached, so that some reasonable postoperative function of the hip might be expected. Apparently no one had ever had the opportunity previously to replace such an extensive amount of bone as this case demanded. Calculations were made from roentgenograms of the bone, wax models (Fig. 8) were fashioned and from these models a mold was made, and a vitallium model of the upper end of the femur was finally produced (Fig. 9). The appliance was about 12 inches long. Bohlman had been interested previously in metal replacements, and had replaced the head of the femur with vitallium. He supervised the construction of the model. It had a smooth, rounded head to fit into the acetabulum, and there were loops for muscle attachments to the upper end. The lower end of the appliance was

Fig. 8 Measurements were made from roentgenograms of the bone, and a wax model was fashioned of the proximal tumour of the femur

Fig. 9 A vitallium model of the upper end of the femur was finally produced

Fig. 10 Radiograph of the prosthesis implanted in the patient

fashioned so that it could be slipped over and be bolted to the lower fragment of the femur.

The operation was performed under spinal anaesthesia on September 28, 1940 at John Hopkins Hospital. The head of the appliance fitted well into the acetabulum. But when an attempt was made to fasten the vitallium appliance to the lower end of the femur, it was found that it was too small and would not slip over the bone. The bone had to be reduced in size, and the outer cortex was chiselled away. The capsule of the hip joint which had been dissected away was sutured, the muscles and tendon attachments about the trochanteric region were fastened to the appliance by suturing their ends through the metal loops provided. During the postoperative convalescence the limb was suspended in balanced traction in a hinged Thomas splint.

A few days after the operation the bone had fractured. By means of skeletal traction the limb was held in suspension, and the lower fragment of the bone was kept in end-to-end apposition with the vitallium appliance. Healing progressed and check-up roentgenograms (Fig. 10) revealed increasing bony union. Within nine months following operation, he walked well without support, and only used a cane for long distances.

Approximately a year and a half following operation, he began to show clinical evidence of cardiac decompensation. There was some swelling of both hands and feet. An acute cardiac attack developed and he was treated in the hospital over a period of three weeks for cardiac failure. He returned to his home and was getting about well when, on June 2, 1942, while sitting on the side of his bed, he toppled forward and

expired. Notice was received of his death, and consent for autopsy was obtained. At autopsy a new hip joint with an almost normal appearing capsule and synovial lining were found. There was no evidence of recurrence of the giant-cell tumour. The vitallium appeared unaffected (Fig. 11) by its period of service in the body. It was just as bright and shiny as the day it was inserted and at no point on it was there any evidence of corrosion. Moore and Bohlman reported the use of this hemiarthroplasty in 1943.

At that time, Austin Moore (1899–1963) was the surgeon of the psychiatric hospital (Fig. 12) in the city of Columbia, which had 7,000 beds. Fractures of the neck of the femur are frequent among patients who are in general older and often in bad general state. Böhlmán and Moore refined their implant. They proposed a revolutionary process of fixing the femoral head, whereby the metal head would be carried by a stem driven into the medullary canal of the femur. In 1952 they described a model [2, 3] that featured a fenestrated stem to allow bone ingrowth (Fig. 13). Both designs were produced in collaboration with *Howmedica Inc.* (at the time, *Austenal Laboratories*, now merged with *Stryker® Corporation*), East

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Fig. 12 Portrait of Austin Moore

Rutherford, New Jersey, United States. These were the first hip arthroplasty products that were widely distributed. They eventually became legendary and are still widely used for replacement of the femoral head and neck, especially following femoral neck fractures in the elderly. Since this time, nearly all of the femoral implants have again taken this concept. The outlook for this lesion was transformed. A few days after the operation patients could walk in the corridors of the hospital, clearly something very new. At the time the fracture of the neck of the femur was a cause of frequent death in older men. The prosthesis of Moore is in vitallium. A

Fig. 13 Moore arthroplasty

FREDERICK ROECK THOMPSON, M.D.
1907-1983

Fig. 14 Portrait of Thompson

window is made in the prosthetic tail to allow bone ingrowth. A hole is placed at the upper part of the collar, to be used, if necessary, to extract the prosthesis.

Frederick Röeck Thompson (Fig. 14) developed a cemented vitallium prosthesis in 1950 which featured a distinctive flared collar [7, 8] below the head and a vertical intramedullary stem (Fig. 15). Thompson and Austin Moore

Fig. 15 Thompson arthroplasty

were gaining popularity in the treatment of various hip conditions including fractures. The Thompson and Austin-Moore prostheses are still used extensively for treatment of femoral neck fractures in some countries today.

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