Smith–Petersen and early development of hip arthroplasty

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Abstract Dr. Marius N. Smith-Petersen, in Boston, MA, USA, introduced the mould arthroplasty (1923). He used a reactive synovial-like membrane that he found had developed around a piece of glass he had removed from a workman's back, which had been imbedded there for a year. The original design was a ball-shaped, hollow hemisphere of glass that could fit over the femoral head of the hip joint. The objective was to stimulate cartilage regeneration on both sides of the moulded glass joint. Smith-Petersen intended to remove the glass after the cartilage had been restored. Glass provided a new, smooth surface for movement, and although proving biocompatible, it could not withstand the stresses of walking and quickly failed. Smith-Petersen succeeded in his endeavour by using Vitallium alloy.

Marius Nygaard Smith-Petersen (Fig. 1) was born 14 November 1886 in the coastal town of Grimstad (Fig. 2), in Aust-Agder County, just southwest of Oslo, Norway. He died 16 June 1953 in Boston, MA, USA. He was born into a merchant marine family, the son of Morten Smith-Petersen, and Kaia Jensine Ursin an acclaimed violinist. The Smith-Petersens were a prominent and influential family. His grandfather, a member of Stortinget (Parliament), owned a shipbuilding company, and many great sailing vessels were built in his shipyard, known as Hasseldalen, in Grimstad. His grandfather was also a skillful businessman, amassing a great fortune in the import–export business. Marius emigrated with his mother to Milwaukee, WI, USA, in 1903, at age 16. Initially unable to speak English, well, he completed high school there in 1906 and attended the University of Chicago for one year, graduating from the University of Wisconsin in 1910. At the Medical School of the University of Wisconsin, he worked as a laboratory assistant

Fig. 1 Marius Nygaard Smith-Petersen

to physiologist Dr. Joseph Erlanger, who won the Nobel Prize for Physiology and Medicine in 1944 for discovering different types of nerve fibres. Smith-Petersen graduated from Harvard Medical School in 1914 and served a surgical internship at the Peter Bent Brigham Hospital, Boston, MA, USA, under Harvey Williams Cushing, M.D.

During World War I, he served with the Harvard Unit at the American Ambulance Hospital in Paris, France, where, in 1914, the American Colony of Paris organised an “ambulance,” the French term for a temporary military hospital, just as it had done in the Franco-Prussian War of 1870 when the “American Ambulance” functioned under tents set up near the Paris home of its founder, the celebrated French American dentist Dr. Thomas W. Evans. The American Ambulance (Fig. 3) of 1914 took over the premises of the unfinished Lycée Pasteur in the suburb of Neuilly-sur-Seine and was run by the nearby American Hospital of Paris.

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Fig. 2 Coastal town of Grimstad, Norway, in the nineteenth century

Fig. 3 American Ambulance Hospital of Paris, France, in the Lycée Pasteur

Fig. 4 Post card representing the first ten ambulances of the American Hospital in Paris, France. The volunteer drivers of 1914 found themselves behind the wheels of motorised, not horse-driven, vehicles: Model-Ts, purchased from the nearby Ford plant in Levallois-Perret

Fig. 5 Harvard Unit at the American Ambulance (World War I Hospital) at Lycée Pasteur, Neuilly, Paris, France. *Standing:* Wilson, Benet, Barton, Rogers, Collier, Cutler, Smith-Petersen (*red square*). *Nurses:* Wilson, Cox, Martin, Parks. *Seated:* Boothby, Vincent, Greenough, Cushing, Strong, Osgood

The American Ambulance was established as a military hospital for wounded soldiers by members of the American Colony in Paris, and especially by those on the staff of or interested in the long-established American Hospital in that city. The Ambulance was generously supported by Americans both in Paris and at home and it was directly under the control of the Service de Santé of the French War Department and independent of French, English, or American Red Cross Societies. The Lycée Pasteur—a very large school building still under construction at that time—in Neuilly, a suburb of Paris, was secured by the War Office, and after some alterations and finishing work—most admirably done in a very short space of time—was converted into an excellent hospital. All administrative departments found in a modern hospital of that era were put into operation: kitchen, laundry, supply room, diet kitchen, apothecary, etc. With the beginning of the medical work in the hospital, the Ambulance Service also started (Fig. 4), and in this corps, Harvard men were enrolled from the beginning. At the request of the Medical Board of the American Ambulance, a surgical contingent was organised by the Harvard Medical School and sent to France to take

charge of the so-called University Service in that hospital from 1 April to 1 July 1915. This contingent, commonly known as the Harvard Unit, was composed of 17 surgeons and nurses (Fig. 5). The funds needed for their equipment and transportation were generously provided by William Lindsey of Boston, MA, USA. The unit's personnel comprised the following: Dr. Harvey Cushing, professor of surgery, surgeon; Dr. Robert B. Greenough, assistant professor of surgery, surgeon and executive officer; Dr. Richard P. Strong, professor of tropical medicine, bacteriologist; Dr. Robert B. Osgood, orthopedic surgeon; Dr. Beth Vincent, assistant surgeon; Dr. Walter M. Boothby, anaesthetist; Drs. Fred A. Collier and Elliott C. Cutler, resident surgeons; Drs. Philip D. Wilson, M. Smith-Petersen and Lymon G. Barton, Jr., house officers; Dr. Orville F. Rogers, medical assistant; Dr. George Benet, laboratory assistant; Misses Edith I. Cox, Geraldine Martin, Helen Parks, and Marion Wilson, operating-room nurses.

Smith-Petersen did his postgraduate orthopaedic training under Dr. Elliott Gray Brackett at the Massachusetts General Hospital (MGH) and became his assistant in practice in 1917. That same year, as an intern, he conceived the idea of the

Fig. 6 A plaster model of the Smith-Petersen's glass mould

Fig. 7 Viscaloid mould

Fig. 8 Pyrex mould

anterior supra-articular subperiosteal approach to the hip, disturbed by the frequent shock the patient experienced after hip surgery when he used other approaches. In 1922, he entered private practice in Boston at the MGH. He continued working there with a heavy clinic load and operating schedule until shortly before his death from a brief illness in 1953 at the age of 67. From 1923 until his death, he also successively

Fig. 9 Bakelite mould

served as instructor, assistant clinical professor, and clinical professor of orthopaedic surgery at Harvard. In 1929 he was appointed chief of orthopaedic surgery at the MGH.

He introduced the mould arthroplasty in 1923 after he removed a piece of glass from the back of a patient. The glass had been imbedded there for one year and was surrounded by fibrous tissue lined by a glistening synovial sac containing a few drops of clear yellow fluid. The original arthroplasty design was a ball-shaped, hollow hemisphere of glass that could fit over the ball of the hip joint. The objective was to stimulate cartilage regeneration on both sides of the moulded glass joint and then remove the glass after the cartilage had been restored. Glass provided a new, smooth surface for movement, and although proving biocompatible, it could not withstand the stresses of walking and the hip quickly failed. Figure 6 represents a plaster model, which was created in three sizes. A wax cup was used to produce glass moulds; the designs drawn by Smith–Petersen were created by the same the same glass blower (MacAlister Bicknell, Cambridge, MA, USA) who made the first X-ray tube for Walter Dodd, one of the first radiologists in the USA. There is no known surviving glass mould; all broke in situ and were removed. According to Smith–Petersen hip function achieved before the glass broke was encouraging. In 1925, Viscaloid moulds (Fig. 7) were tested; however, Viscaloid, a form of celluloid, produced a foreign-body reaction and was abandoned eight years later.

From 1930 to 1936, Smith–Petersen returned to glass using Pyrex (Fig. 8); the moulds were more resistant than glass and were tested under polariscope before implantation. Eighteen moulds were implanted, and only one was removed before breakage; this intact mould was exchanged for a Vitallium cup in 1938. In 1937, Smith–Petersen also tested a Bakelite mould (Fig. 9); only one was inserted, and this in a man working as filling-station attendant. Following a fall, his hip began squeaking, caused by the broken Bakelite. This is probably the first report of a squeaking in hip surgery. The mould was exchanged with a Viscaloid mould. So, Smith–Petersen experimented with a number of materials in the 1930s in order to perfect his interpositional cup arthroplasty, until he had

Fig. 10 **a** Vitallium® mould (cobalt–chromium–molybdenum alloy) arthroplasty interposed between refashioned surfaces of acetabulum and femoral head. **b** Vitallium® mould arthroplasty removed from the left and implanted on the right

Fig. 11 Smith-Petersen at Massachusetts General Hospital, WI, USA

some success with Vitallium® (Fig. 10a, b). In 1937, his dentist, John Cooke, suggested he use Vitallium for all moulds. Several designs were created, one with a rim of preventing intra-pelvic protrusion of the cup, but it was never used. Between 1937 and 1939, Smith-Petersen and Nathaniel Allison developed the Vitallium cup arthroplasty. During

Fig. 12 Medal of the Grand Cross of the Royal Norwegian Order of St. Olav

these years and the decade that followed, Smith-Petersen and his two new assistants in private practice, Carroll Larson and Otto Aufranc, designed the instruments and techniques to perfect this operation. Larson remained an associate of Smith-Petersen until 1950. He was certified by the American Board of Orthopaedic Surgery in 1942 and became a member of the Academy in 1943. During World War II he was assigned by the Office of Procurement and Assignment as a full-time teacher in the Department of Orthopaedic Surgery, Harvard Medical School. He supervised undergraduate and graduate teaching of orthopaedic surgery at MGH during those four years and directed a continuing trauma course for armed forces' medical officers.

Smith-Petersen was amongst the most prominent and innovative orthopaedic surgeons of the first half of the twentieth century. Readers can access his work on a new approach to treating fractures of the femoral neck [1], mould arthroplasty [2], spinal osteotomy [3] and continuous irrigation for osteomyelitis [4]. He was perhaps the first surgeon to recognise and describe in detail an approach to treating impingement [5].

From 1929 to 1946, Smith-Petersen served the MGH (Fig. 11) as the chief of orthopedic surgery, and he served on the Board of Consultation from 1946 to 1953. He was a member of the International Society of Surgery, Boston Surgical Society, and New England Surgical Society. Additionally, he was appointed a consulting surgeon to the Surgeon General of the United States during World War II. He was president of the American Academy of Orthopedic Surgeons from 1944 to 1945. In 1946 he was honoured with the award of Commander of the Royal Norwegian Order of Saint Olaf, and received the Grand Cross in 1947 (Fig. 12). He travelled to Norway to perform cup arthroplasties on some preselected, difficult hip problems in 1947. In 1948, assisted by Larson, he performed back surgery on Princess Martha of Oslo. He was internationally famed for developing the hip-nailing technique and the hip mould arthroplasty. Together, these new procedures significantly increased the repair success rate for broken hips, which at one time were considered unresolvable fractures. It was these techniques Smith-Petersen used to perform surgery on the television personality Arthur Godfrey in 1953, who had been in pain for more than 20 years after an auto accident. Smith-Petersen died just days [6–10] after performing that operation.

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