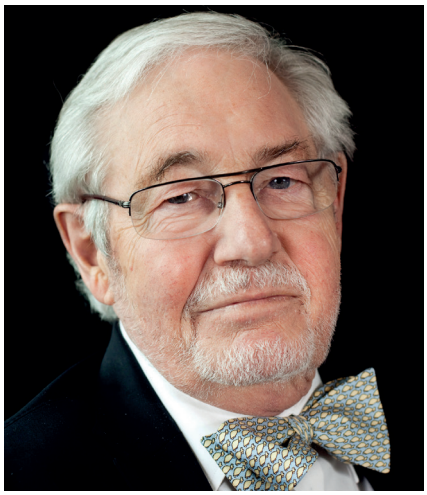
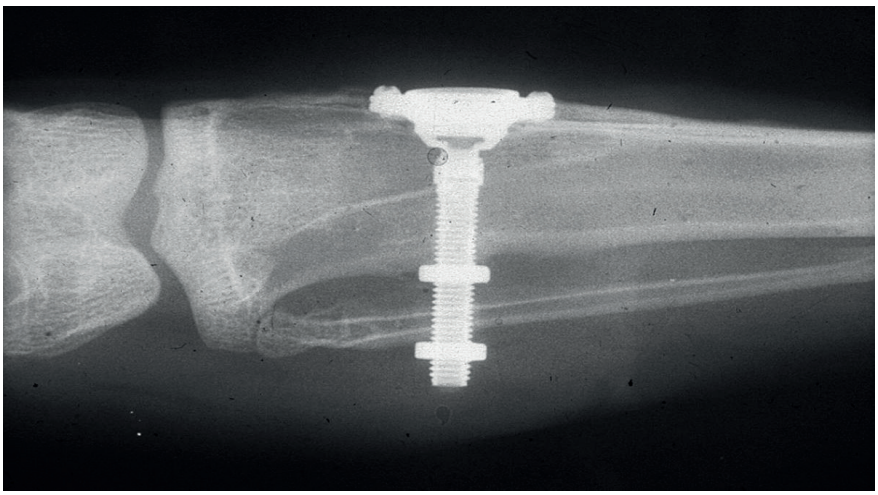
Per-Ingvar Brånemark: father of osseointegration

BY JOHN RIDDINGTON YOUNG

The application of osseointegration has been central to the development of both bone-anchored hearing aids and dental implants. But how did it all come about?



Per-Ingvar Brånemark (1929–2014). Image Johan Wingborg.



The x-ray from Brånemark's original historic experiment on the rabbit's leg. Image courtesy of Wikimedia Commons.

Many hearing-impaired patients owe a great debt of gratitude to the Swede, Dr Per-Ingvar Brånemark, yet he was not in fact an otologist, but an anatomist. Hailed as the father of osseointegration and the godfather of the bone anchored hearing aid (BAHA), Brånemark was born in Karlshamn, Sweden, on 3 May 1929. His name is also revered by modern dentists and he once famously said that "no one should die with their teeth sitting in a glass of water."

> "Titanium was evidently equally as strong as steel but 45% lighter, making it an ideal metal material not just for aeroplanes, but for surgical implants"

He graduated in medicine from the University of Lund, Sweden, in 1956, and completed his PhD in 1959. He was later appointed professor of anatomy and director of the Laboratory of Experimental Biology at the nearby University of Gothenburg in 1963.

Like so many great scientific discoveries, Dr Brånemark discovered osseointegration serendipitously. He was working experimentally on rabbit legs in 1952, investigating the microcirculation of blood in bone marrow. For this study, he had concocted a system using a titanium cylinder containing a miniaturised optical camera, which he inserted and screwed into the rabbit's tibia, enabling him to directly watch the circulation of blood cells in the marrow.

When he had completed his initial study some months later, Brånemark tried to retrieve his micro camera from the tibia to use in a further experiment, but when he tried to remove it, he had great difficulty and was surprised to find that he was almost unable to separate it from the bone to which it had become firmly fused. Brånemark dubbed this process of the assimilation between the titanium and the bone 'osseointegration'.

Although titanium had been discovered in Cornwall, by a clergyman and amateur mineralogist, Rev William Gregor in 1791, it didn't enter the manufacturing scene until the 20th century. One of Brånemark's colleagues at Lund University, Hans Emnéus, told him about a new material coming from Russia. The Soviets had apparently been using it for military hardware, but Emnéus was testing it in hip prostheses. Titanium was evidently equally as strong as steel but 45% lighter, making it an ideal metal material not just for aeroplanes, but for surgical implants.

This apparent fusion of the titanium camera case with bone had been unexpected. Branemark's scientific professionalism resonates with Fleming's unexpected discovery of penicillin. Many researchers might well have overlooked the difficulty in retrieving the metal casing under the same circumstances, but Brånemark would try to find out why the rabbit's body had not rejected the implant. He went on to use 20 of his co-workers in the lab, whom he cajoled into having a small plate of titanium implanted in their arm. "You have

to understand, every male in the lab was considered a volunteer, including my older brother," said Dr Tomas Albrektsson, whose portrait once appeared on a well-known brand of Swedish toothpicks and who was one of Dr Brånemark's longtime associates at the University of Gothenburg. "They all have a nice scar in their upper arm to this very day." It would seem that researchers in 50s Sweden didn't have the added stress of ethical committees.

Even after years of painstaking ongoing research, Brånemark's work on osseointegration was not initially well received. The accepted wisdom was that foreign material of any kind would eventually be rejected. Grant applications for his studies on bone-anchored implants were usually turned down. The turning point came in 1982, when he presented over 15 years of research to a dental conference in Toronto, Canada. His discovery of the fusion of bone to titanium was accepted and established.

The new material was firstly used mainly in dentistry, leading Brånemark to be christened as 'the man who made people smile again.' When the long-term success of osseointegration had become established in oral surgery, orthopaedic applications followed. Compatriot, Anders Tjellström, pioneered the osseointegrated bone-anchored hearing aid in the early 1990s. I can well remember going to one of his many UK courses. I also remember sharing jokes and our old-school views on mastoidectomy with him over a few pints at the George in Chepstow.

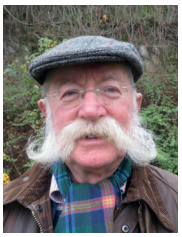
Professor Brånemark received many prestigious awards from the international community in recognition of his work, including the coveted Swedish Society of Medicine's Söderberg Prize in 1992 (sometimes called the 'mini Nobel') and the Swedish Engineering Academy's equally prestigious medal for technical innovation. He held more than 30 honorary positions throughout Europe, Australia and North America, including an Honorary Fellowship of the Royal Society of Medicine. In 2014, he died at the age of 85.

Professor Per-Ingvar Brånemark's tireless efforts in his pursuit of biological truth and clinical excellence have ensured him a unique place in the history of surgery – but that's not all. His legacy is also remembered in 'Good Vibrations Day' (aka BAHA Awareness Day), which has been nominated as 3 May in honour of Brånemark's birthday! I'm sure his family will be delighted.

Further reading

1. Brånemark PI. Rehabilitation and osseointegration in clinical reality. *Int J Oral Maxillofac Implants* 2003;**18(5)**:770-1.
2. Mudry A, Tjellstrom A. Historical background of bone conduction hearing devices and bone conduction hearing aids. *Adv Otorhinolaryngol* 2011;**71**:1-9.
3. Kim TI. A tribute to Dr. Per-Ingvar Brånemark. *J Periodontal Implant Sci*. 2014;**44(6)**:265.
4. Snik A, Agterberg MJH. The History of Bone-Conduction Devices. *ENT & Audiology News* 2023;**34-5.**.
5. Brånemark PI. On looking back with Per-Ingvar Brånemark. *Interview Int J Prosthodont* 2004;**17(4)**:395–6.
6. Tjellström A, Håkansson B. The bone-anchored hearing aid. Design principles, indications, and long-term clinical results. *Otolaryngol Clin North Am* 1995;**28(1)**:53-72.

AUTHOR



John Riddington Young, TD and bar, MPhil, FRCS, DLO,

Retired General ENT Surgeon, North Devon DGH, Barnstaple, UK.