Benefits of osseointegration over socket implants for amputees

Dr Taylor Reif, of the Hospital for Special Surgery, New York, USA, has conducted a retrospective review of patients who have undergone amputation reconstruction. His work highlights that osseointegration – the process of inserting a metal implant into the bone – brings significant benefits to patients compared to traditional socket implants. Not only does osseointegration improve quality of life for individuals, it allows for more advanced prosthetic designs that offer improved function.

There are different methods of attaching prosthetic limbs. In the past, the US Food and Drug administration (FDA) limited the use of certain implants, meaning socket implants attached via a strap or suction mechanism were the most popular form of attaching a prosthesis. But over the past two decades, a technique known as bone-anchored osseointegration has become a popular and emerging treatment due to the advantages it offers over traditional socket implants.

Dr Taylor J Reif and his team at the Hospital for Special Surgery, New York, USA, have carried out a series of studies to investigate the positive impact that bone-anchored osseointegration can bring to patients, and discussed whether the benefits that it can bring outweigh the potential risks that accompany surgery, such as infection or other complications.

OSSEOINTEGRATION WORK?

Bone-anchored osseointegration implants are becoming increasingly popular across the world. It removes the need to have a socket fitted at all, as the prosthesis is attached directly to the bone itself. The procedure was first carried out successfully in 1965 by Dr Per-Ingvar Branemark, who attached teeth onto a man's jawbone. In the 1990s his son, Richard Branemark, successfully adapted the technology for use in limbs. It’s been widely used in Europe over the past 25 years and this area of surgery continues to develop.

During the amputation reconstruction, a metal implant is inserted directly into the residual bone of the amputee’s remaining limb. After a few weeks, the bone grows onto the implant’s surface and forms an incredibly strong bond. This strength of this bond means there’s a direct connection between the external prosthesis and the bone of the amputee’s limb. This gives the patient the ability to move the prosthesis with a direct skeletal connection, giving far greater control than a socket implant. Essentially, osseointegration gives people a more natural connection to their artificial limb.

WHAT DOES THE LITERATURE SHOW?

There is little doubt that bone-anchored osseointegration offers patients a better quality of life in terms of range of motion, limb control, and comfort.

There has been scepticism from some, specifically around the risks of infection and implant failure. In particular, concerns have been raised about the potential for an infection with transcutaneous (beneath the skin) metal implants. Through their research, Dr Reif and his team sought to weigh up these risks against patient benefits.

Osseointegration allows more sensory feedback than a traditional socket implant.

The Osteointegrated Prosthetic Limb System is designed to facilitate bone ingrowth.

Bone-anchored osseointegration offers better quality of life in terms of limb control and comfort.
of the osseointegration procedure against socket prosthetics. Their 2021 paper retrospectively reviewed the results of 31 patients who had undergone the implantation of a press-fit osseointegration of the femur (thigh bone) or tibia (shin bone). All patients had had their operation performed at least six months previously. Dr Reif found that osseointegration implants indeed improved the overall experience of patients when compared to that of people with socket prosthetics.

The functional tests demonstrated that patients with osseointegration implants showed significantly better outcomes and were able to walk greater distances when compared with traditional socket prosthetics. The researchers noted that general pain improved on average, and pain interference was significantly improved. The study highlighted a few early problems, but in 93% of those cases the issues were resolved without having to remove the prosthesis. Complications were manageable enough to encourage the ongoing use of the technology. The most common problems were soft-tissue infections and simple mechanical failures.

Another study in 50 Swedish patients found QLFA scores improved significantly across all categories after osseointegration. Even the four patients who did experience problems requested the implantation of their prosthetic after the issue was resolved. Similar results were found in groups of patients from Australia, Germany, and the Netherlands.

A separate 2021 study showed a further benefit of osseointegration – the fact that it allows for better designs of prosthetics. It details the experiences of two patients who underwent osseointegration after arm amputations. They were fitted with myoelectric prosthetics, which are able to sense electrical signals from the muscles in the arm. The patients were trained to use this technology with pattern-recognition software that allowed them to control the hand and wrist of the myoelectric prosthetic.

**Osseointegration offered higher patient satisfaction in both the short and long term, and the main risk of infection was a relatively manageable one.**

After two years the myoelectric prosthetics had shown no signs of loosening, and patients had gradual improvements in their standards of daily living. This exciting new technology would not have been possible using socket prosthetics instead of osseointegration.

**LONG-TERM RESULTS OF OSSEOINTEGRATION**

It can be more challenging to give a long-term answer to whether osseointegration is effective; Dr Reif notes that most centres would like to carry out long-term follow-up appointments with their patients, but are unable to do so as many people don’t return for these appointments. This is especially true if the patients are doing well post-surgery. However, a few studies examined outcomes after five, ten, and 15 years post-osseointegration. Overall, the literature showed that osseointegration offered higher patient satisfaction in both the short and long term, and the risk of infection remains manageable. Dr Reif explains, ‘these studies emphasise the overall satisfaction, deemed revolutionary by many, subjectively reported by patients while using a bone-anchored prosthesis instead of a socket.’

**FUTURE IMPLICATIONS FOR AMPUTEE PROSTHETICS**

Dr Reif’s research shows that there is little doubt that bone-anchored osseointegration offers patients a better quality of life in terms of range of motion, limb control, and comfort, versus socket implants. He notes that the risk of infection will never be removed entirely, patients who do need their prosthesis removed to deal with an infection usually opt to have it reattached via osseointegration.

The researchers did note some limitations of the studies they reviewed, such as the relatively small number of patients and lack of long-term follow-up.

They suggest that studies to explore differences between different implant techniques and implants at different parts of the body would be beneficial, as well as investigating the potential financial benefits of osseointegration. Amputees using socket implants need to have routine socket changes every few years, or sometimes even more regularly if they’ve been experiencing difficulties. Factors worth comparing would include productivity, mental health, and time to return to work.

Osseointegration bestows a direct structural and functional connection between the bone and implant. Dr Reif’s studies highlight the overwhelming benefits of osseointegration over traditional socket implants, and supports its continued adoption and development. Osseointegration offers an exciting opportunity to greatly improve the daily living standards of the millions of people living with limb loss.