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In Focus

Biohacking and Chip Implantation in the Human Hand: An Introduction

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Biohacking is a term used to describe people making changes to their bodies to improve their well-being. This includes the implantation of radiofrequency identification implants. This technology for wireless communication is already incorporated into our daily lives as in the use of contactless payment and badges to open doors. Since the first radiofrequency identification implantation in a human in 1998, the possibilities of this technology have dramatically increased, and the number of persons that have been chipped is growing. The hand seems to be the most popular body part to implant these chips because it can easily be positioned close to a reader. Currently, implantation is typically not performed in a medical environment. However, implantation of these devices in humans can result in complications, such as infection and tendon attrition, and the relevant safety implications have not been extensively studied. The scope of this review was to inform the hand surgeon community about the existence of these implants, why they are used, and to open the debate about the possible future role of the hand surgeon in safely implanting these devices and dealing with possible complications.

Biohacking refers to using biology with the mindset of a hacker to enhance your body and life. This includes commonly used applications on your smartphone or wearables that measure whether you are getting enough exercise during the day or how well you sleep. On the other end of the spectrum, there is human augmentation. Augmentation refers to adding elements to the body, for example, electronics. The goal is to upgrade your body by creating a symbiosis between the human body and technology. Most popular is the implantation of radiofrequency identification (RFID) implants. Similar to many technologies, RFID owes its origins to the Second World War when it was invented to differentiate between enemy and friendly aircraft using radar. It uses a microchip attached to an antenna that passively reacts to an incoming signal of its reader using a shared magnetic field; hence, there is no need for batteries. They do not actively emit radiofrequency signals, such as Bluetooth or Wi-Fi devices. For the past 50 years, this technology has been incorporated into our daily lives, as in the use of contactless payment or ID badges to open doors.[1] The use in health care is expanding, including tracking of medical equipment, instruments, and drugs.[2,3] In veterinary medicine, the implantation of RFID chips to identify animals has been part of standard care for decades. Professor Kevin Warwick was the first human to undergo RFID implantation in 1998.[4] One survey of 2,000 people in the United Kingdom and the European Union stated that 51% would consider the implantation of an RFID chip in their hand as a contactless payment method.[5] Other possible features of RFID implants include opening doors and access to medical and vaccination records.[6,7] It is estimated that between 50,000 and 100,000 people already have been chipped.[8] These implants are available online and are delivered sterile. Presently, chip insertion is typically performed by a tattoo or piercing artist. You have to program the chip yourself with a special contactless reader, preferably before implantation, so that proper functioning can be checked. Programming is still possible after implantation. The implantation of these devices in humans and the relevant safety implications have not been extensively studied. The scope of this review was to consider the future role of the hand surgeon in placing these implants and dealing with possible complications.

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Figure 1. Two main types of RFID implants. On the left, a cylinder-shaped implant. On the right, a flat rectangular-shaped implant.

Implant Types and Location

There are two main types of chips that are implanted. The first type is a small tube-shaped glass cylinder that can be injected into the subcutaneous tissue using a preloaded syringe. The second type is a larger flat rectangular implant that requires a more extensive incision to place the implant (Fig. 1). Optimal implantation technique and location have not been established yet. Most frequently, an RFID chip is implanted in the dorsal web space between the first and second metacarpal (Fig. 2). Alternative anatomic locations for chip implantation have been suggested: between each metacarpal and dorsally over the first phalanx of each finger. It is advised not to place glass implants within 5 mm of each other or within 5 mm of bone to minimize the risk of shattering. Also, chips that operate on the same frequency should be placed at least 5 cm apart to avoid interference.[9]

Concerns

The US Food and Drug Administration released a guidance document concerning implantable RFID chips in 2004. They stated potential risks of adverse tissue reactions, migration of the transponder, electromagnetic interference, information compromise, magnetic resonance imaging (MRI) incompatibility, and failure of the implanted transponder.[10]

Infection

An RFID chip is considered a foreign body, currently most often introduced by nonmedical professionals, such as tattoo artists. This raises questions about the sterility of such procedures. Similar to other medical devices, the implantation of an RFID chip carries the risk of a foreign body related–infection. A variety of microorganisms may be involved as pathogens, of which *Staphylococcus aureus* is the most frequent. *S. aureus* has the ability to adhere to materials and form a biofilm, making removal of the foreign body often inevitable because of the ineffectiveness of antibiotic treatment alone.[11] If neglected, delayed diagnosis of hand infections can result in poor outcomes with functional deficits. We found one case report describing a foreign body related–infection after implantation of an RFID chip that was adequately treated with implant removal and antibiotic therapy.[12]

Adverse tissue reactions

Radiofrequency identification implants have been used in animals for decades. Most of them are placed subcutaneously in dogs, cats, rodents, and birds without issues and complications.[13] A foreign body granuloma can form secondary to foreign material. In humans, cases have been described where an implant causes

Figure 2. Radiographic image of a hand with an implanted RFID chip in the first dorsal web space.

tendinopathy and even sterile osteitis if the foreign body is in contact with the periosteum.[14] In animals, rare reports of microchip-associated fibrosarcoma have been published. The local inflammatory reaction caused by the implant could have been responsible for neoplastic initiation.[15]

Magnetic resonance compatibility

There have been multiple studies to evaluate the effect of MRI on RFID functioning in veterinary medicine. These studies evaluated magnetic field interactions, such as translation and torque, MRI-related heating, and artifacts. These studies found that measurable movements can occur, causing imaging artifacts. There was no heating or RFID chip dysfunction afterward.[16] Similar studies of RFID implants in humans have not been performed. However, multiple authors tested externally worn RFID chips. Equivalent to the veterinary studies, they showed possible imaging artifacts that increased when using a stronger magnetic field. There was no measurable heating or movement of the chip.[17] One case report of artifacts caused by an RFID chip inside silicone breast implants stated that these artifacts are not negligible.[18] In the human hand, one can imagine the possible difficulties these artifacts could raise in diagnosing pathologies.

In conclusion, radiofrequency identification technology makes our lives more convenient. It allows contactless opening of doors and cars, payment, computer login, and storing all necessary personal and medical information. Implantation of this technology makes it permanently available for its carrier. The hand seems to be the most useful and accessible receptor body part. Although these devices have yet been implanted by mostly nonmedical professionals and only in a small subgroup of the population, the hand surgeon community should acknowledge the existence of this practice. The likelihood of encountering one in a hand surgery clinic is growing. Having notice of the technology involved and the different types of implants allows us to understand possible complications and eventual interference with clinical and radiological examinations. Magnetic resonance imaging studies are presumably safe. The threshold for removing these implants should be low in cases of soft tissue reaction or infection. We could raise the question if the hand surgeon community should take a more active role in formulating an optimal implantation technique, regarding the numerous important anatomical structures in the hand, given that they know the potential hazards.

Conflicts of Interest

No benefits in any form have been received or will be received related directly to this article.

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