A Review of Microchip Implant in Human

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Abstract. Implantable devices are devices implanted into human bodies either for a lifetime or for a short period of time. They are mainly used for diagnostic, monitoring, or therapeutic purposes. With their unique responsiveness and rational design in terms of clinical needs, biomedical implants have been the best treatment with minimum damage to the host tissue and support the function of current devices to treat ailments, deliver drugs, control infection, or monitor physiological factors or biomolecules. Biomedical implants have a wide range of applications in wide application areas, which include but are not limited to cardiovascular, ophthalmic, surgical, gastrointestinal, urogenital, drug delivery, and biosensors. Despite the concern of infringing personal information and potentially risking a patient's health, biomedical implants have contributed to human health in all different application areas.

Keywords: Bioengineering · Biomedical Implant · Implantable Devices · Microchip

1 Introduction

Since history, humans have been altering their bodies either to replace malfunctioning organs or Throughout history, humans have been altering their bodies either to replace a malfunctioning organ or to enhance their life expectancy. The earliest alteration of human body recorded was a tooth implant found on the body of an Egyptian King who lived over 3000 years ago, who replaced his teeth with metal to aid biting and munching mechanisms.

Now, with thousands of years of technological advancement, we are able to implant sophisticated electronic devices under our skin to bring a more convenient, and a more efficient lifestyle. Currently, implantable systems for biomedical research and clinical care are a flourishing field of activity in academia as well as industrial institutions. Experiments in electronics, mechanical, chemical, and biological components and systems, as well as their combinations, are all part of the broad field.

Today, almost all implants involve both electronic circuits and micro-electro-mechanical-systems (MEMS). Bioelectronics is a branch of science consisting of the application of biological materials and processes in electronics or the use of electronic devices in living systems. Most biomedical implants aim to provide better aid for the disabled patients and to enhance the life quality and life expectancy for the population. Take RFID (Radio-frequency identification) as an example, it uses electromagnetic

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fields to automatically identify and track tags attached to objects [1]. This technology, among others, allows for instant identity verification and solves more problem regarding to identification.

This paper aims to summarize important breakthroughs regarding implantable devices to the date of publishing and to review the advantages and drawbacks of this area for future reference. It hopes to provide some insightful suggestions for the research in this field.

2 Current Applications: Recent Studies and Patents

Telemetry was the first step of an implantable electronic system, then stimulation, and then closed-loop control. The first pacemaker implant was in 1958, which is 10 years after the transistor was invented. But from 1960 to 1975, none entered the market for consumer purchase except for the cardiac pacemaker. An early telemetry transmitter has a relatively large size and more invasive to carry out the implant surgery.

Radio-frequency identification (RFID) implants were conceptualized by British scientist Kevin Warwick in 1998, and their first experiments with them were conducted in that year. His implant was utilized to activate lights, unlock doors, and produce verbal output inside a structure. Despite only spending nine days in the patient's body, this implant was significant, and Warwick's work is now on display in the Science Museum in London [2]. The first electrochemically triggered drug delivery microchip was introduced in 1999 by Santini Jr. et al. [3].

Their technology uses an electric potential charge between the cathode and the anode to activate release from separately dosed reservoirs (a thin gold membrane covering the specific reservoir to be deployed). The group has now made a significant number of additional breakthroughs, including (but not restricted to) greater versatility, improved ophthalmic microchip flexibility, ways of operation, and specifics of wireless data and power transfer [8].

Farra et al. (2012) looked into osteopenia and osteoporosis microchip implant treatments. Osteoporosis is characterized by an imbalance between the processes of bone resorption and bone creation [4]. As a result, there may be a loss of bone mineral density and a disruption of the bone microarchitecture, which may increase the risk of bone fractures. Annual disability rates have been significantly impacted by osteoporosis, and the total cost of treatment in the US is expected to exceed $20 million in 2015.

When used to treat osteoporosis, bisphosphonates might cause heartburn and upset stomach [5]. In eight female patients with osteopenia, devices were implanted. Release from the device was started for the tissue formulation eight weeks following implantation. Comparing the pharmacokinetic profiles of the hormone delivered by the implants to those used to treat osteopenia and osteoporosis commercially, it was discovered that they were bioequivalent (FORSTEO injection).

The study showed the viability and promise of microchip-based implantable drug delivery systems. Each device discharged its dose exactly and successfully, and the implants were accepted by the patients and exhibited no adverse immunological reaction. This is the very first example of an drug delivery implantable device in reality, and demonstrates future implications of such devices.

A patent for a record-holder implant was released in 2016. Under the patient's epidermis, a microchip with the patient's identification information and medical history was inserted [6]. The patient's distinctive numbers and characteristics, such as their NI number, passport number, eye color, ethnicity, sex, date of birth, and current address, have been used to identify them [7]. At each visit to hospitals and other medical institutions, the patient's medical history was updated in the medical data. This implant, if published to the majority of the population, would save time in all medical facilities. A doctor at ER could have all access to all the medical information of a patient, thus save more time to give emergency treatments to patients.

Researchers significantly trimmed down the RFID implant's size in 2021. The implant created by Columbia Engineers, which is a fully operational electronic circuit with a total volume of less than 0.1 cubic millimeters [8], sets new records as the smallest single-chip system in the world. It is then only detectable under a microscope and is the size of a dust mite.

3 Controversy Over the Use of Microchip Implants

The application of implantable device technology has undoubtedly raised a variety of issues, conflicts, and debates relating to morality vs. legality, business profit vs. genuine altruism, and religion vs. science and technology. Implantable device technology has the potential to alter how humans perceive the world. In this degree, certain philosophical questions surfaced, such as: Will people cease to be "human" at some point? If true, when will this take place—when will people turn into what we now refer to as machines? Where exactly does that distinction occur?

3.1 Pros: Saves Lives

According to VeriChip Corp [9], approximately 2,000 RFID implants have taken place in people throughout the world thus far. The RFLD chip is about the size of a grain of rice [10], but it can still store and transmit many kinds of data. When scanned, it is embedded beneath the skin and offers data. In times of need, this kind of chip might be useful. It might provide clinicians with immediate access to biomedical data, and its speed could be the difference between life and death. With increasingly sophisticated implants, it may be feasible to send out alerts before specific diseases.

Can your medical history, including past illnesses, medications used, and other details rapidly be obtained via an RFID chip, especially for individuals who frequently encounter emergencies? Additionally, it offers specific information for those who have Alzheimer's disease, diabetes, or cardiovascular conditions. According to a newly released study by neurosurgeon Kevin J. Tracey [12], bioelectronic medical devices may also be used to treat autoimmune diseases [13].

3.2 Pros: Increase Life Quality of People with Diseases

Medical implant makers incorporate chemicals or medications to increase efficacy and morbidity. Microchips are a new technology that can deliver numerous medications on-demand over a lengthy period of time using a reservoir of multiple distinct drug doses [14].

3.3 Cons: Poses Certain Threats Towards Privacy

Every new technology has its share of flaws and vulnerabilities. In the case of implantable devices used to store personal information. They are prime targets for hackers since they rely so much on a single chip and contain abundant, whether general or personal, information of the carrier. In addition to being readable, information that can be edited may also be used to commit fraud or at risk of data corruption. Unfortunately, there is not an unified card that can support all of the different digital identifying schemes that are now in use.

Implanting an RFID chip each for all different services is required. For example, you might need a RFID chip implant for each of the following: using the subway, paying via credit cards, using library cards, storing emergency medical information for medical facilities, and so forth (or at the very least, it would be implanting a rewriteable chip in the human body and storing one of the aforementioned at a time) [15].

3.4 Cons: Uncertain, Poses a Threat Towards Health

The maker of the microchips said it would save lives by enabling doctors to scan the micro transponder nearly immediately to access the patient's medical records when the U.S. FDA (Food and Drug Administration) approved its implantation in human bodies. The FDA determined that the product was a "reasonable guarantee" of safety, and one of the year's most "innovative innovations" according to a sub-agency [15]. Although a number of veterinary and toxicological studies from the middle of the 1990s demonstrated that chip implants "caused" malignant tumors in some laboratory mice and rats, neither the corporation nor the regulatory body made this information public.

Transponders, according to retired toxicological pathologist Keith Johnson, are the root of malignancies. Leading cancer specialists cautioned that the results of animal tests may not necessarily apply to humans when they evaluated the study for the Associated Press, but they all advised additional research before glass-encapsulated transponders were widely implanted in people.

Laboratory mice and mice implanted with microchips occasionally developed subcutaneous "sarcomas"—malignant tumors, the majority of which were enclosed in implants, according to studies published in the journals of veterinary medicine and toxicology between 1996 and 2006.

The migration of implants within the human body is another worrying aspect. Chips that have been implanted may travel within the body if necessary precautions are not taken. If chips were more widely available, this would be less of a problem, but until then, it's perfectly feasible that they would go completely unnoticed if not discovered in the typical spot. Some microimplant with small sizes could migrate within human tissues and damage their natural functions.

Several concerns associated with human microchipping was brought up by the FDA, which include negative tissue reactions and electrical hazards. FDA then issued a dire warning regarding the potentially fatal effects of incompatibility with powerful magnet medical devices like magnetic resonance imaging (MRI) machines. MRIs provide images of the organs and tissues inside a patient's body using a magnetic field and radio waves [16].

In this scenario, electrical devices would cause temperature rise and induced currents. This implies that implants contain metals, such as pacemakers, aneurysm clips, dental implants, hip or knee replacements, and embedded microchips are harmful to the patient when they are going through magnetic resonance imaging. Additionally, the static magnetic wave field would be distorted by metal implants, lowering the quality of the MRI image, and potentially led to a delay or error of patient treatments.

4 Conclusion

The paper provided an overview of the recent development of implantable devices and their impacts on humans. The widespread application of microchip technology has the potential to change the modern healthcare system. The treatment process will be changed, unnecessary expenses worth billions of dollars will be avoided, and the quality of life of the patient population will be improved.

Biomedical implant devices have a bright future, but we are facing some hard challenges in both physical and psychological aspects. The author would say our society is still not ready for some of the future bioelectric implants, such as the brain-machine interface. They are more invasive and could potentially carry greater moral risks. Thus, personally, the author would rather work on less invasive devices such as cardiovascular pacemakers and portable EEG. By the time our technology enables us to have more powerful implants, the author is confident that certain regulations and supervision will be carried out.

Considering this paper only provided a brief overview of microchip implants in humans for the past century, further research must be carried out in order to retrieve more data regarding to the safety of microchip implants and to provide a clearer benchmark for future researchers.

This brief overview summarized recent advancements of microchip implant technology in the past and future researches must be carried out to inspire more innovations is this field and to protect the safety of the patients. In the future, the author will conduct and plan more comprehensive researches to demonstrate more convincing data regarding microchip implant technology in human.

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