Applications and Topics of Physics in Surgery

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Abstract

Physics has many applications in medicine and surgery, it has allowed new ways of curing a patient and, in some cases, has replaced surgery altogether. This essay will discuss various topics, procedures and innovations in surgery that require physics.

Keywords: Physics, Surgery, Medical Physics, Medicine, Imaging, Electromagnetic Spectrum, Nuclear Medicine

Introduction

Surgery has been an essential part of medicine for thousands of years and most people would consider surgery an inseparable part of medicine. However, surgery depends on the type of operation and disease. As a result, there have been various methods, procedures, and technologies that have been developed. They have required a variety of different disciplines in which physics plays a vital role. This can include new technologies being developed, new methods being tried and new innovations replacing surgery. A new form of physics has developed in the last few decades, termed "Medical Physics", which includes disciplines including Nuclear Medicine, Imaging, and Biomedical Engineering.

Imaging and the Electromagnetic Spectrum

Various imaging techniques have played an important role in surgery and in diagnosing various diseases and medical conditions. This includes X-rays, MRIs and CT scans. These are used before and after an operation to diagnose and/or assess a particular medical condition. If the medical condition is so severe that surgery is required, several cameras are used with the doctors. After surgery, the patient can be monitored and various scans (like X-rays) can be used to determine if the patient is recovering.[14,17] It should be noted that various techniques have been developed that have an imaging component as the primary tool in surgery.

CT scans use X-Rays to produce images of the body. Intraoperative CT scanners have been deployed in the operating rooms which allows surgeons to make critical decisions regarding the patient, and has resulted in safer procedures due to computer software and hardware. There is also no need for the patient to be removed from the operating room.[13] CT scans and X-ray imaging works in the same way. X-rays are part of the electromagnetic spectrum and they are able to pass through the body. These rays interact with the different organs of the body differently which is what allows us to create an image when the rays pass through the body to a detector.[10,11,12] Since it passes through the body, it is a form of radiation since they have enough energy to ionize an atom.[9]

The electromagnetic waves can be used in various ways to treat patients without them having to undergo surgery. Lithotripsy is a technique that sends shock waves of ultrasound or X-rays that break kidney stones into smaller pieces, so it goes through. If not too serious, surgery can be avoided altogether.[7,8] Focused Ultrasound Surgery is another method that uses ultrasound and is done while the patient is awake. It uses high frequency sound waves to target and destroy a certain area of tissue. For example, it is used to remove uterine fibroids in the uterus or can be used to treat certain motor symptoms of Parkinson's disease patients.[5,6,18]

A relatively new method of surgery that uses ultrasound has been developed. This is done by inserting a needle and using ultrasound as the primary source to see what is happening inside. This is done to prevent additional scars and trauma from an operation. This is known as "ultrasound guided surgery".[19]

Nuclear Medicine

Nuclear medicine is an ingenious way of removing tumours, cancers, and infected tissues from the body without surgery. A patient is injected with a small amount of radioactive material with a carrying molecule, called the radiotracer. This goes to the problem area or the area that needs to be examined. It may also bind with the proteins at the problem area. The cells will be destroyed by the high amount of radiation.

Another development uses antimatter to destroy cancer cells in the body. This is done with the charged particles that enter the body and destroy the cancerous cells in the target area. It was found that using four times less antiprotons were needed than protons to reach the same level of damage. These antiprotons would destroy the nucleus of an atom in the target area which would be projected to other neighbouring cells. This is currently being developed and is costly, however, such innovation may not be too distant.[1,2]

Contamination

Surgeons must ensure that they are extremely clean in order to avoid bacterial infection. However, even if a mask is worn, and the operating room is cleaned, there are possible sources where bacteria can infect a patient. For example, by placing or pointing at a video screen or any lighting may result in bacteria being spread over a distance. This is possible due to an electrostatic field that was induced which resulted in bacteria spreading over a short distance.[4,15]

Anaesthesiologist's Footwear

In the early 20th century, anaesthesiologists wore specialized conducting shoes that would minimise the risk of sparks induced by static electricity. If it was not worn, a flame could ignite because shoes are likely to cause friction with the floor resulting in sparks that had the potential of igniting flammable anaesthesia.[3,15]

Conclusion

From above-mentioned relationships, it can be said that physics is becoming a source of new innovations in the field of medicine. Various technologies and new surgical procedures have been researched and tested, with physics forming an essential part.

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