

Segment Based MR-Compatible catheter steering mechanism

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Technology description

The Problem

Increasingly clinicians are using cardiac ablation to cure atrial fibrillation. During cardiac ablation, energy is delivered through a catheter to areas of the heart muscle causing the abnormal heart rhythm. This energy “disconnects” the pathway of the abnormal rhythm. Recently, the procedures have been extended to more complex arrhythmias, such as scar-related ventricular tachycardia, but with more modest clinical success. This is largely related to the technical difficulties of electrical mapping and ablation by manipulating catheters within the cardiac chambers.

Whilst x-ray fluoroscopy is the imaging modality used today, cardiac-guided MRI offers advantages for the navigation of electrophysiological catheter probes. It provides high-resolution 3D visualisation of the true anatomy, cardiac function and depiction of fibrosis with high spatial resolution. However, the advantages of MRI in guiding electrophysiological procedures have yet to be fully explored due to the lack of available MR-compatible EP-catheter devices.

The Solution

An image-guidance system for EP-procedures has been developed which consists of a novel MRI-compatible catheter device having flexible 3 degrees of motion without twisting the shaft (see Figure 1 below). This device lends itself to robotic control allowing remote steering inside a heart chamber and provision of good mechanical contact in all directions. MR-compatible components allow its use under MRI-guidance, as well as with conventional fluoroscopy. In particular MR-tracking coil technology can be integrated allowing rapid localization of the device with MRI.

Figure 1. MR-compatible multi-segment catheter incorporating control tendons allows flexible steering in 3 directions without twisting the shaft. This approach allows navigation through complex anatomy.

Application area

Applications Atrial fibrillation (AF) is the most common cardiac arrhythmia worldwide Radiofrequency ablation (RFA) is an effective cure for chronic and debilitating arrhythmias such as AF.

Another important arrhythmia is ventricular tachycardia (VT) which often arises from structural

disorders of the heart such as ventricular scar post myocardial infarction. VT is a life threatening arrhythmia and is now commonly treated with the insertion of intra-cardiac defibrillators. However, RFA has the potential of being a better and cheaper alternative therapy.

Ability to visualise the substrate for the arrhythmia (myocardial scar in VT) during the ablation under MR guidance and visualise the ablation lesions should lead to significant increase in the success rate of RFA in conditions such as AF and allow it to be extended to more challenging problems such as VT.

Advantages

Offers the clinician a “gold standard” approach to ablation of cardiac dysrhythmias whilst transferring this clinical intervention from the X-ray suite into the MRI suite, thus removing radiation exposure from the clinician and the patient. Furthermore, cardiac MRI offers several advantages over x-ray fluoroscopy and conventional EAM systems; it provides high-resolution 3D visualisation of the true anatomy, cardiac function and depiction of fibrosis, with high spatial resolution.

Catheter navigation requires highly-skilled clinicians, who determine the clinical outcome. Under X-ray guidance, procedures commonly take between 2 and 4 hours and success rates can vary widely; ablation of atrial fibrillation has a success rate of 60-70%, so about one third of patients have to be treated more than once, at a cost of £15,000 – £20,000 each time. reduce costs related to treatment of this patient population through higher numbers of successful ablations on the first occasion especially in the hands of non-expert centres, fewer patients returning for a second or third ablation in the years after initial intervention and fewer adverse events.

Socio-economic: In 1999 cardiovascular disease (CVD) contributed to a third of global deaths according to the WHO. By 2010, CVD (most commonly coronary artery disease (CAD), cardiac arrhythmias and congestive heart failure (CHF)) was estimated to be the leading cause of death in both developed and developing countries

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