D14-063

An Implantable Microsystem for Long-Term Study on the Mechanism of Deep Brain Stimulation

長期研究深腦刺激機制之可植入式微系統

隊伍名稱
CMEA / CMEA

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作品摘要 Abstract

巴金森病為一種漸進式神經退化疾病，其主要病理特徵是腦深部basal ganglia中substantia nigra之神經細胞嚴重退化。近二十年來，醫師利用長軸電極對subthalamic nucleus（為basal ganglia之部分組成）進行電刺激，統稱腦深層刺激（Deep Brain Stimulation，DBS）。DBS雖可治療巴金森病人運動失調病癥，增進病人對運動控制能力，但對於disturbance及postural instability病癥療效卻有限。

本團隊將研發小型、無線可攜式記錄刺激系統，可利用DBS電極偵測病人腦深層活動，連續取得與病情及電極正確位置相關訊息，亦可就Basal Ganglia參與運動之生理機轉作深入探討。本系統之研究將基於鼠腦模型進行研究，本系統一共分為三個部分，分別為植入式裝置、外部裝置及電腦端控制與資料擷取介面。外部裝置提供植入式晶片無線電源供應以及資料中繼功用，本系統並透過藍芽介面將資料傳輸至使用者端。本系統之優勢為透過植入式晶片，可讓醫生長期的進行訊號擷取並研究神經的刺激針對帕金森氏症相關腦區影響。且本系統透過無線介面供應電源及傳輸資料，可以降低感染的風險及避免更換電池，達到長期監控的功能。本系統一共可提供8個訊號擷取通道以及8個神經刺激通道，並透過可編程的數位核心，由外部電腦直接修改植入裝置紀錄與刺激參數設定，包括單相雙相刺激、刺激頻率、刺激寬度、資料擷取速率、紀錄增益大小等控制。由於本系統為可攜式裝置，所以在研究方面可以提供不受有線的約束，且可以進一步的研究在不同行為下之鼠腦活動，包括睡眠、跑動、一般性的活動，並可透過刺激觀察不同的行為變化。

Parkinson's disease is a progressive neurodegenerative disease. The main pathological feature of Parkinson's disease is the mesencephalic dopaminergic degradation of basal ganglia in brain. In the past two decades, medical doctors use the long axis electrode to stimulate the subthalamic nucleus (part of the basal ganglia), which is called deep brain stimulation (DBS). Although DBS help to improve movement disorders of patients suffering from Parkinson disease, it has limited effect on improving motor disturbance and postural instability.

Our team develops a portable recording and stimulation system with wireless power and data transceiver. The system can record brain activity continuously, stimulate neurons via DBS electrodes, and obtain the information regarding Parkinson's disease and electrode location. The system also enables the study on the Basal Ganglia in the rat brain. The system contains three parts: an implantable chip, external module and an user interface. The external module supplies power wirelessly and relay data between the implanted chop and the user interface. The system has the main advantage of wireless power and data transmission without any battery. This avoids the risk of infection and facilitates long-term monitoring. Moreover, the system provides eight recording and eight stimulating channels, whose parameters (e.g. recording gain and stimulating pattern) are programmable by a digital core according to the commands from an external computer. Therefore, the system is applicable to various studies with freely-moving rats.

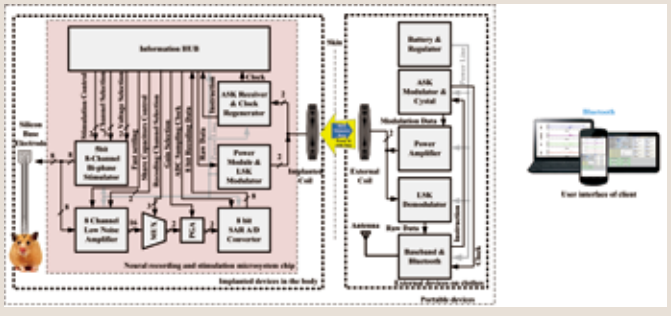

Fig.1 > The architecture of the implantable microsystem with wireless power and data transmission

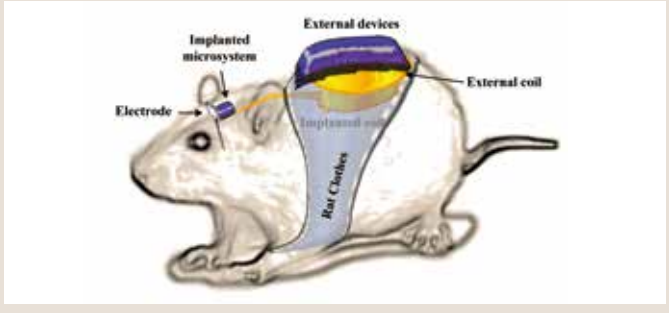

Fig.2 > Schematic diagram of the implanted configuration