The use of surface electrography as a troubleshooting tool in deep brain stimulation

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Introduction

Hardware failures related to both, pulse generators, and leads can be a challenge in patients with deep brain stimulation. The available onboard tools of the implantable pulse generators (IPG) are often unsatisfactory, making an efficient troubleshooting difficult. Moreover they may deliver ambiguous information. Especially in therapy failures this can be a problem, because it remains open whether the reason for this failure is either medical or hardware related. False positive alerts may lead to unnecessary surgical steps like replacement of the leads or the extensions.

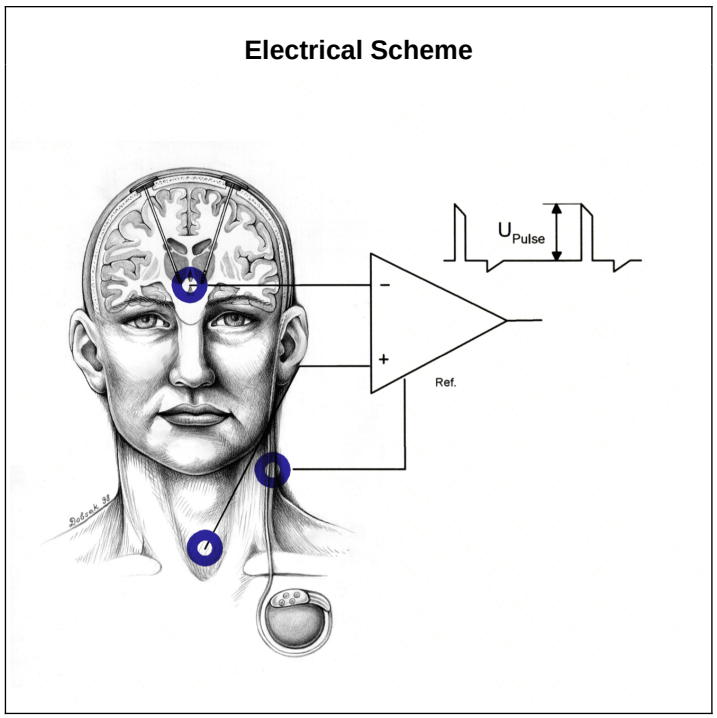
Methods

The principle of surface electrography is that every single pulse emitted by an implanted pulse generator can be recorded using standard skin electrodes, amplified and displayed by a medical oscilloscope. The voltage drop is proportional to the tissue impedance. The latter is a constant for an individual body. Differences in voltage drop or missing spikes are highly suspicious for contact problems respectively lead fractures. According to the used stimulation technology, constant current or constant voltage, the stimulation pulse shapes are either rectangular or more complex. Every single pole is analysed individually. We are using an iOS based (iPad Apple) oscilloscope for performing these tests.

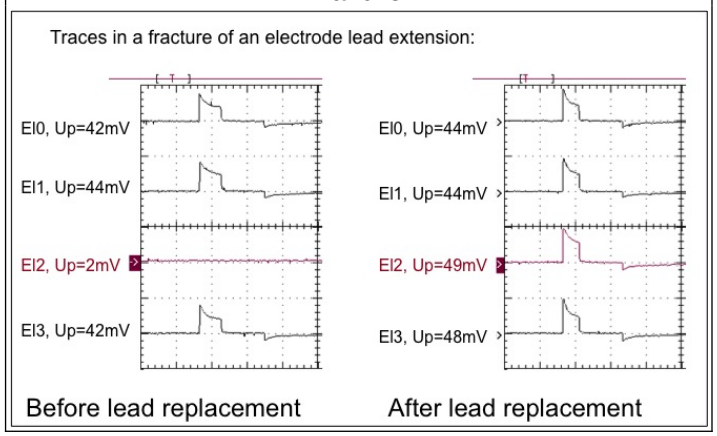
Results

The present procedure was performed in a total of 60 patients with DBS systems where routine measurements of the impedance using the standard procedure (self test of the IPG) had either given ambiguous results or values suggesting a fracture of the lead extension. Only in six of these patients surface electrography corroborated these findings and consecutive replacement of the lead extension finally confirmed the presumed fracture. In another five patients the sudden loss of therapy was related to the IPG resulting in a change of the pulse curve. In all eleven patients efficient therapy resumed after surgical revision and they returned to normal surface electrography. We did not observe false positive results.

Electrical Scheme



Failure



Conclusions

Surface electrography a safe and easy diagnostic and troubleshooting procedure in cases where hardware failures are suspected to be the reason for a loss of DBS therapy.