Introduction

The 3D stereotactic implantation systems for percutaneous insertion of patients with refractory epilepsy still represent a challenge due to the intricate complexity of the method and the number of the electrodes implanted.

In order to stereotactically implant depth electrodes, a number of frame-based and frameless (robotic) stereotactic implantation approaches have been developed.

The workflow for standard stereotactic frames includes: a significant number of steps to achieve an registration with the patient and adjusting frame (horizontal, 2 cm, and frontal), followed by the actual stereotactic implantation.

The robotic implantation allows a quick reproducibility of the tool guide from trajectory to trajectory, and it requires a complex workflow for performing the patient registration, including the attachment to the patient's head and the implantation of a few fiducials.

We are proposing a simplified workflow for the implantation of 3D depth electrodes, using only rigid fiducial markers and a patient-customized stereotactic fixture built using 3D printer that incorporates all the planned trajectories into its construction, therefore requiring no adjustments for the registration of the trajectories. The stereotactic fixture is based on the "StarFix™" technology of FHC, Inc. (Bowdoin, ME, USA), and has been used in more than 3,000 DBS implantation procedures for invasive procedures since being FDA cleared and CE approved.

A CT scan with the fiducial markers is placed in a performed and reconstructed with the prior multiplanar anatomical and functional imaging in the "VectorNav"-based (HNC, Bouwlo, Maine) planning software. The fiducial's location and orientation is automatically detected by the planning software.

In order to stereotactically implant SEEG depth electrodes, a number of frame-based and frameless (robotic) stereotactic implantation approaches have been developed.

The anatomical (AC, PC, mid-plane), trajectory and anchor coordinates are used by the planning software to create a digital 3-D stereotactic fixture that incorporates rings for holding the grids that will guide the electrode implantation tool, as illustrated in figure 3. The 3-D model is built on a relational geometric (Aerohydro, Southwest Harbor, Maine) base model that is automatically morphed to the patient specific 3-D scan coordinates of the anatomical (AC, PC, mid-plane) and oblique trajectories have to be entered before building the stereotactic fixture. The oblique trajectories can be defined at the later time, in the time interval while the platform is being built.

The stereotactic fixture significantly simplifies the surgical procedures for SEEG depth electrode implantation while maintaining sub-millimeter accuracy. It presents the following advantages:

1. Stereotactic fixture integrates all the necessary markers and guides needed for the planned trajectories.
2. Stereotactic fixture is based on the StarFix™ mTPlatform technology (FHC, Bowdoin, Maine), that has been used in more than 3,000 DBS implantation procedures for movement disorders since being FDA cleared and CE approved.
3. Stereotactic fixture is based on the low cost and time efficient 3D printing technology (Figure 1).
4. Stereotactic fixture is based on the StarFix™ mTPlatform technology (FHC, Bowdoin, Maine), that has been used in more than 3,000 DBS implantation procedures for movement disorders since being FDA cleared and CE approved.
5. Stereotactic fixture is based on the low cost and time efficient 3D printing technology (Figure 1).
6. Stereotactic fixture is based on the StarFix™ mTPlatform technology (FHC, Bowdoin, Maine), that has been used in more than 3,000 DBS implantation procedures for movement disorders since being FDA cleared and CE approved.