POSTER 205 ***BEST PAPER AWARD***

COMPUTER ASSISTED S3 NERVE ROOT NEUROMODULATION BY CT SCAN AND ECHOGRAPHIC FUSION

P.Mozer [1,2], A.Leroy [2,3], J. Troccaz [1], Y. Payan [1], A. Vidart [1], F. Richard [1], E. Chartier-Kastler [1]

[1] Department of Urology, Pitié -Salpêtrière Hospital, Pierre et Marie Curie University, Paris, France
[2] TIMC Laboratory, Faculté de Médecine, Domaine de la Merci, 38706 La Tronche cedex, France
[3] KOELIS© - www.koelis.com

Introduction: S3 nerve root neuromodulation is an accepted therapy for individuals afflicted with lower urinary tract symptoms, such as idiopathic urinary urge incontinence, frequency, urgency, and urinary retention, who failed current standard therapies. Temporary sacral nerve stimulation is the first step as a test for final indication. It comprises the temporary application of neuromodulation as a diagnostic test to determine the best location for the implant and clinical efficiency. The implantation is done under local anaesthesia, with the patient in the prone position. In clinical practice, a needle is inserted in the S3 foramen and the proper location of the needle is confirmed both by the functional response and by fluoroscopy. If this test is positive, a permanent implantation is performed few weeks later. The accuracy of the placement of the electrode is a key criterion for the success of test and permanent implantation. We present a system, test on phantom and cadaver data, able to improve the precision and the reproducibility of this procedure, matching a preoperative CT scan with peroperative ultrasonic images into a navigation system.

Materials and Methods: The general approach included the following steps:

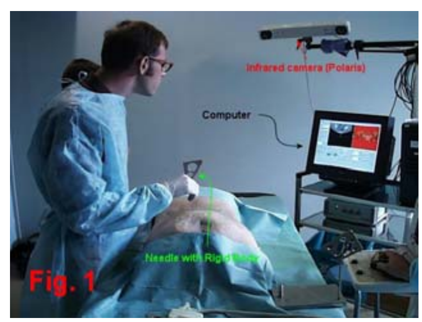

Fig. 1

- A 3D pre-operative model was reconstructed from pelvis CT images (less than 5 minutes are necessary). The surgeon used this model to define a planning by selecting two points, a target and an entry point, which defined the needle trajectory.
- Just before puncture, intra-operative ultrasonic images, space localised by an infrared camera (Polaris® system, NDI Inc), are collected to get a set of 3D points located onto the posterior pelvis surface (Fig. 1 and 2). As echography was used here like a tool to locate the surface of the pelvis, it is not necessary that the target and the entry point be visible in the ultrasound images. For this step, the pelvis was segmented manually but this process can be automated.
- This set of 3D points was matched onto the preoperative model of the pelvis, by the mean of a registration technique. The matching transformation applied to the planned trajectory allowed transferring it to the operating room conditions and guarantees its correct execution. The position of the needle (18 Gauge) was known in real-time during the surgical action (thanks to the localizer and a rigid body fixed on the needle) and compared to the planned trajectory. Therefore, no further image acquisition was needed for this guiding phase.

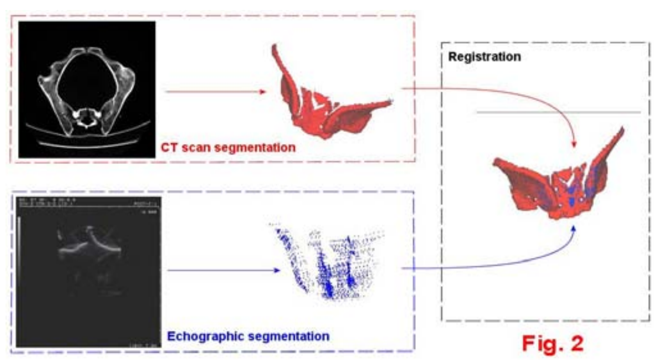

Fig. 2

In a first step, we tested this system on a pelvis bone to visually evaluate the precision. In a second step, we punctured three foramens on each side of a cadaver. We evaluated the precision of the punctures by carrying out a postoperative scanner with needles in place. By the mean of registration technique, we computed the distance between the preoperative target and the tip of the needle.

Results: On the phantom, the accuracy was visually estimated at ~ 1 mm (Fig. 3). On the cadaver, we computed a distance of 2.5 mm [1.7-3.2] between the preoperative target and the tip of the needle. The precision's difference between tests on pelvis bone and cadaver was due to the deformation of the needle during the puncture.

Conclusion: These results are encouraging. We currently are working on the ability to perform the puncture without deformation of the needle. We think that this kind of tool could improve the precision of the implantation, decrease X-ray exposure and decrease local pain at site of puncture (anesthesia can be done exactly on the same way than the puncture of the implant).

3D Model navigation

CT scan navigation

Real World

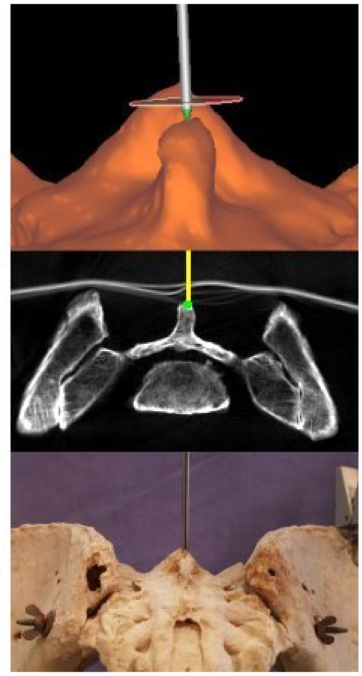

Fig. 3