POSSIBILITIES TO APPLY FREE-HAND SONOGRAPHY IN CORRECTION OF BONE DEFORIMITIES.

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INTRODUCTION

The main aim of this work was to perform a free-hand ultrasonography as an alternative solution to help surgeon to design and perform correction of lower limb deformities.

Ethiology of bone deformities is often posttraumatic or congenital. Nowadays state of the art for planning of deformities' corrections is based on long standing radiograms. The accuracy of correction is decisive. Planning of the correction on two-dimensional radiograms provide limited characterization of bone deformity. Three-dimensional dataset acquired by Computed Tomography or Magnetic Resonance are required in case of complicated deformities. However, these techniques are practically unavailable intraoperatively, time-consuming and expensive. For these reasons the free-hand ultrasonic system was developed to get intra-operative, non-invasive tool to aid planning and intra-operative corrections.

METHODS

The free-hand ultrasonographic system combines sonographic probe and optical localizer. EchoBlaster 128, portable ultrasonic system with multi frequency linear probe (central frequency 5MHz) from Telemed and Infrared Tracking System Polaris from NDI were applied. The authors developed software to design bone correction on reconstructed shape of bone basing on dataset registered by free-hand ultrasonic system [1].

Design of bone deformity correction is performed with online control of crucial geometrical parameters. Relevant parameters are mechanical axis of limb and anatomical axes of femur and tibia. The physician designs cutting plane position and performs reposition of obtained bone segments. During the reposition any changes of mechanical axis course are controlled. The biomechanical analysis enables designing of various surgical scenarios. Developed system provide various osteotoms: straight (Fig.1) and dome (Fig.2). Dome-shaped osteotomy enhances mechanical stability at the osteotomy site [2].

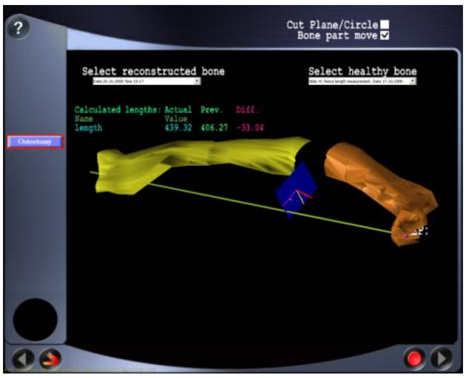

Figure 1: Straight osteotomy (visible mechanical axis of femur).

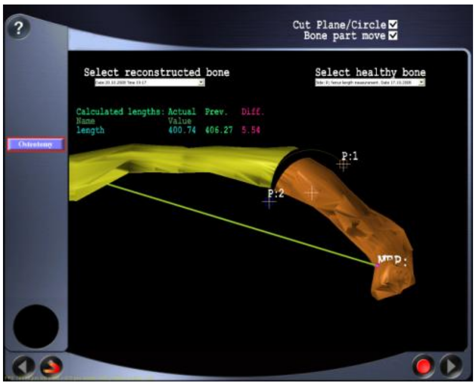

Figure 2: Dome-shaped osteotomy.

Developed system provides module for bone segments intraoperative reposition (Fig. 3). Bone segments require sensors to be navigated. The software provides graphic visualization of angles between anatomical axes of segments.

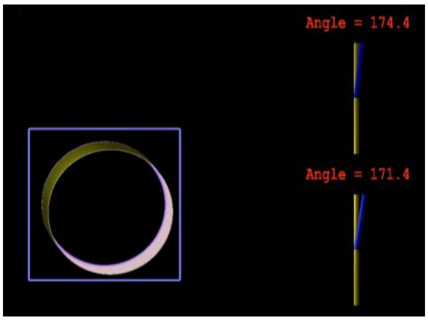

Figure 3: Bone segments reposition (intra-operative).

RESULTS AND DISCUSSION

Tested accuracy of system is defined by error of localizer, so called Fiducial Localization Error=0.35mm and accuracy of registration procedure (real error introduced by the system intraoperatively) Target Registration Error= 2.05mm. The accuracy was validated on synbone with mounted markers, easily addressed with a navigated pointer providing reference dataset. Obtained accuracy is limited by identification of bone tissue on ultrasound scans, and registration algorithm. Currently, we are working on clinical verification of system: tests of geometrical parameters on probants and validation of these results.

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