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ning and post deformation analysis was performed and an attempt at a simulation model of deformation was performed. 3. Human Kidney Intraoperative Robotic Registration: Initial alignment was then performed using four anatomical points and ICP registration. Registration to the segmented CT imaging was then performed.

Results

RIGS: The analysis shows that the hybrid optical robot tracker is accurate within 2 mm for each arm and 3 mm between any two arms and is largely attributed to calibration error. The inclusion of hybrid localization mitigates the large error present in the setup joints. For this reason, the hybrid localization scheme is superior to the intrinsic kinematics of the robot localizer. Implementation of the hybrid localization system with tracked targets on each arm of the robot places all arms in the same coordinate system. Because of the use of a common coordinate system, it is possible to register the entire daVinci system to preoperative image data and maintain position even with setup joint motion. In console, display of real time RIGS registered with preoperative CT imaging was set up in combination with standard 3D endoscopic images. Use of the system for resection in our phantom subsurface gel tumor model demonstrated a valid concept with increased accuracy of resection in phantoms using the RIGS system defined in our study as a reduction in additional margin tissue resected (resection ratio).

IGKS: 1. Surface Registration: LRS surface based registration results revealed 15-20 % of total surface of kidney phantom surface was required, unique anatomical features such as curvature and vasculature markedly reduced the required surface subset. 2. Deformation: Average amount of deformation was 3-6 mm with a downward and lateral deformation. The model could correct for some of the non-rigid deformation but further study of the material properties of the kidney components is needed. 3. Human Kidney Intraoperative Robotic Registration: Kidney CT surface mesh and captured robotic surface were aligned and closest distance measured (mean 1.4mm +/- 1.1mm) revealing that the robot can acquire adequate surface for registration.

Conclusions

Incorporation of accurate image-guidance into robotic surgical procedures, especially partial nephrectomy and solid abdominal organ surgery, holds great promise. A variety of important base concepts is required knowledge for robotic surgeons and will be defined. We present our initial engineering and assessment of the creation of a daVinci based RIGS system and ongoing work towards image guided kidney surgery. ■

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SP1, Surgical Navigation, Wednesday October 7th, 10.30 – 12.00, Room: Atlanta

The Piezoelectric ESWL

More than 20 years of clinical success worldwide

KNITTLINGEN – The continuous development of the "Piezolith" extracorporeal lithotripter family has enabled medical instrument manufacturer Richard Wolf GmbH (Knittlingen, Germany) to make a significant contribution to non-invasive stone therapy for more than 20 years. Today, Richard Wolf is the only provider of ESWL units with piezoelectric shockwave technology.

Over 700 Piezolith systems sold worldwide and a high level of user satisfaction bear an impressive testimony to the excellent performance of these units. The cornerstone for this sustained period of success

Fig. 1-1 and 1-2: The Piezolith 3000 "Triple Focus" – system overview.

is a superbly engineered system concept, continuous integration of ESWL research results and a process of continuously perfecting piezoelectric shockwave technology. The PIEZOLITH 3000 "Triple Focus" is one of the most innovative and flexible shockwave systems currently offered in the ESWL market.

The System

Figs. 1-1 and 1-2 shows the Piezolith 3000 "Triple Focus". The system has a modular structure and comprises a positionable patient table, an X-ray C-arc, an ultrasound unit and the piezoelectric shockwave source with control unit. In addition to CE certification, the PIEZOLITH 3000 "Triple Focus" has also FDA approval since 2008.

The system philosophy can be described with the following four attributes: „efficient & gentle" in stone treatment, "simple" to handle and "cost-effective" to operate. The two core components described in detail in the following sections provide a significant contribution to success: Dual-simultaneous-realtime localization (DSR) and the piezoelectric shockwave source in Double-Layer Technology (DLT).

Fig. 2 illustrates the localization concept in the Piezolith 3000. It comprises a high-precision isocentric configuration to the therapy focus with an outline operating X-ray C-arc and an inline positioned ultrasound probe. This technically perfect and logical configuration ensures that the treatment area is visualized at any time without any reconfiguration measures: dual, simultaneous and realtime. Fig. 3 shows a cross-section through a piezoelectric shockwave transducer in Double-Layer Technology (DLT). The principle of direct focusing means that the sound pulse emitted from the transducer surface is focused directly into the target area as a result of the spherical geometry of the therapy head. No

Fig. 2: The dual-simultaneous-realtime localization (DSR).

lenses and no reflectors influence or interfere with the focusing of the shockwaves. The directly focusing shockwave source, with an aperture of 27 cm and a penetration depth of 165 mm allows easy and optimum focusing. Since the introduction of Double-Layer Technology (DLT), in which the piezoelectric active layers are superimposed, the Piezolith 3000 has more than enough fragmentation power available. Figure 3 underscores this impressively on the basis of an in-vitro fragmented crater volume (plaster cube, 30x30mm edge length, 100 shockwaves at maximum intensity). The switchable focus zone identified as "Triple Focus" is a response to international results of ESWL research during recent years. In addition to the F1 focus setting proven in practical applications, two other focus settings F2 and F3 were realized. This is because not every stone is the same. Different sizes of stone and stone hardness require adjusted shockwave fields for optimum treatment. The user can adjust the applied shockwave optimally to the different requirements in the energy range (E5MPa) of 0.9 to 153mJ, in the energy density range (ED-tot) from 0.08 to 2.4mJ/mm2 and in the peak pressure amplitude range (pmax) of 6 to 126MPa.

Clinical studies also underscore the efficiency of the Piezolith 3000 "Triple Focus". Neisius presented 2006 the result of a study with 254 urinary stones (148 kidney stones < 1.5cm, 106 ureteric stones) which were treated with the F1 focus setting without any sedation or anesthesia. In the case of the kidney stone patients, 95% were free of stones after 3 months with a retreatment rate of 1.35. The Piezolith 3000 "Triple Focus" achieved a peak efficiency quotient (EQ) of 0.68. Bölles presented 2006 in a study 71 patients (49 kidney stones, 24 ureteral stones) treated without sedoanalgesia. The user changed from F1 to F2 in the case of ureteric stones after 500 shockwaves. A 3-month stone-free rate of 100% was achieved with a retreatment rate of 1.46 and a requirement for 3 postauxiliary URS. The kidney stones were treated with F1 and after 500 shockwaves with F3. In this case, a 3-month stone-free rate of 91% was achieved with a retreatment rate of 1.35. Changing from F1 to F2 or F3 revealed an increase in pain tolerance of patients in 92 % of the cases and the intensity setting was increased by 2 to 4 levels. No serious complications occurred.

The Piezolith 3000 "Triple Focus" optimally combines efficient powerful treatment with low side effect and low pain level. The absence of anesthesia saves personnel and time

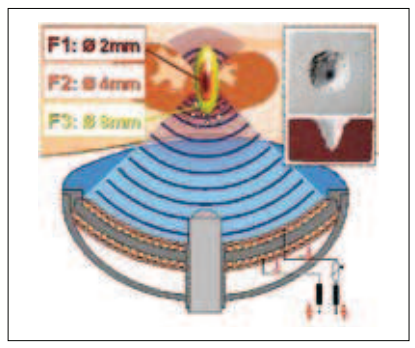

Fig. 3: Schematic cross-section through the piezoelectric shockwave transducer with Double-Layer Technology (DLT), the different focus zones of the "Triple Focus" and an example of a fragmentation crater.

and even permits ESWL to be implemented in out-patient settings without the need for hospitalization. The piezoelectric shockwave source features an extremely long service life with five million shockwaves guaranteed and more than 20 million shockwaves often being achieved in practical application (unique worldwide!). It permits several thousand treatments to be carried out without additional transducer costs. Richard Wolf will continue the development in the future with exciting and innovative features. ■

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SP 7, ESWL – ask the technician and the physician, Thursday October 8th, 10.30 – 12.00, Room: Atlanta