potentials provided by this tool, alternative interests in designing the suturing devices will be obtained, and these features make this device an acceptable MIS suturing one.

6826 Th, 12:15-12:30 (P41)

An instrumented wireless compliant brain retractor

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During certain brain surgeries, access is required to regions deep within cortical tissue. Common practice is to use a thin metallic retractor blade to facilitate this access. However the resulting compression of tissue can result in tissue damage by mechanically tearing tissue and/or reducing local blood perfusion. The incidence of brain injury during surgery involving brain retractors has been reported to be 5–10% (Andrews and Bringas 1993).

Mechanical tearing of tissue is typically caused by large stresses at the edge of the retractor blade. To better understand this a three-dimensional finite element model of brain tissue deformation under typical operational retraction pressures has been developed. We used the mechanical constitutive relation suggested by Miller and Chinzei (1997). The shape of the retractor was optimized to produce deformation profiles that minimize stress concentration. We will report on a compliant retractor, the design of which has been guided by the above modelling results. The compliant geometry of this retractor has been tested on a silicon gel phantom.

A new instrumented brain retractor has been developed which incorporates pressure and electroencephalogram (EEG) measurement. It has been reported that retraction pressure above 5 kPa contributes to long term tissue damage, and that EEG signal magnitude can be considered as an indicator of tissue health. The new retractor has been used to obtain experimental data relating pressure, EEG magnitude, and time to tissue damage.

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8.3. Advances in Surgical Navigation

6417 Th, 14:00-14:15 (P43)

Prototype CO_2 laser system for osteotomy

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Laser osteotomy – laser cutting of bone – can be a useful tool for many disciplines of operative medicine. It offers unique incision geometries, which cannot be achieved with conventional mechanical tools. This advantage could lead to new operation techniques for different surgical disciplines. Our group has developed a prototype laser osteotome based on a pulsed CO_2-laser.

Laser ablation of bone is not a straightforward task, since bone consists of very strong and temperature stable hydroxyapatite with a melting point above 1200ºC and of living cells, which will be damaged even by small temperature rises. Pulsed CO_2 lasers in combination with fast multi-pass beam scanning and the additional use of a fine water spray [1] offer a biologically compliant way to cut bony tissue [2]. Hard tissue ablation is based on fast explosion-like evaporation of internal bone liquid mainly water, which removes thermo-mechanically a thin tissue layer [3]. The prototype laser system for osteotomy was already tested in several series of animal trials which proved good healing after laser osteotomy [4]. In laboratory experiments a navigation technique with marker screws and laser navigation with a pilot beam was developed and implemented in first in-vitro experiments. The existing technology could also offer new opportunities in the laser-assisted implantation of neuro-prosthetic cochlea implants in combination with an image guided process-control.

References

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7356 Th, 14:15-14:30 (P43)

Evaluation of an in-situ visualization system for navigated trauma surgery

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We present an intraoperative guidance system using augmented reality visualization, a technique that superimposes acquired patient data in-situ. This means the imaging data is projected spatially registered onto the surgeon's real view of the region of interest. This is an intuitive and ergonomic visualization and navigation interface that enables enhancements onto the operating site especially for minimally invasive procedures, where the view of the surgeon is limited to a small field of view. A general design goal for a navigation system is an easy integrated user interface that does not require any additional interaction, calibration, and registration steps by the surgeons. Our hardware setup was originally developed by Sauer et al. (2000). It is based on a stereoscopic video see through head mounted display. Two color cameras are rigidly attached to the head-mounted display that are used to feed the displays with video frames of the real world in real-time. An infrared camera on the head-mounted display tracks the position and orientation of the color cameras, thus the user's perspective.

We tested our head mounted augmented reality system on phantoms and cadaver experiments. Trauma surgeons performed the interlocking of intramedullary nails on the cadaver, representing a standard operating procedure in minimally invasive trauma surgery that requires high precision (Whatling and Nokes 2005). We chose this as an exemplary procedure to validate the usability and overall accuracy of the head-mounted augmented reality visualization system.

References

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7666 Th, 14:30-14:45 (P43)

A new algorithm for recovering distal holes' pose in intramedullary nail

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Numerous orthopedic operations require locating of implants and internal organs such as bone. Currently, this requires x-ray exposure during the surgery to allow the surgeon to indicate the position and orientation of the patient's internal organs and medical inserting devices. An orthopedic operation, called "Closed Intramedullary Nailing of Femur (Closed Nailing)", is one of the frequent cases among orthopedic surgeries. This surgery also requires accurate positioning and orientating of the implant. One of the most difficult tasks for surgeons is to identify the position and orientation of the screwing holes (typically in circular shape) at both ends of the intramedullary nail (IMN) after being inserted into a patient's femoral canal. The distal hole locations may be shifted by external forces and torques applied to the IMN during the insertion procedure resulting in the IMN to deform.

In the conventional closed nailing surgery, surgeons require high experience, and a number of trial-and-error adjustments to correct the path for inserting the screws through those distal holes. The process can be done by gradually adjusting the shooting angle until the projection of the two distal holes is seen as circular as possible on the x-ray image. Therefore, both surgeon and patient are continuously exposed by a great amount of x-ray exposure from the fluoroscopic imaging system. This could harm the surgeon and patient for their long term health.

This study investigates a new algorithm to recover the 3-D pose (position and orientation) of distal holes in the intramedullary nail by using only three x-ray imaging projections, such as, AP (anterior/posterior) and lateral views. The algorithm is based on inverse kinematics approach. A mathematical model and an algorithm are developed and described using group theory. The study includes mathematical modeling, algorithm formulations, simulation and experimental results and conclusion of the algorithm performance.