Preliminary Experience With CT/Fluoro Matched Navigation In The Anterior Approach To The Thoracolumbar Spine
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Citation

Abstract
Modern concepts of thoracolumbar spinal fracture repair focus on the reconstruction of the anterior column. Minimal invasive techniques were able to lower the morbidity of the anterior approach and allow patients to recover quickly after the operation.

Computer Aided Orthopedic Surgery (CAOS) should also be able to be advantageous in the anterior approach by adding precision to the operation technique with less x-ray exposition to the operating team and the patient. The authors present a minimal invasive technique using a retractor system and a standardized protocol using CT/fluoro matched navigation which is routinely used for the anterior approach to the thoracolumbar spine.

Between January 2002 and September 2004 32/47 isolated anterior stabilizations of thoracolumbar fractures were completed under navigation control. The data of the patients were prospectively recorded, follow-up was for one year. After initial learning curve we saw tendencies of reduced operation- and radiation-times.

The combination of minimally invasive approaches to the anterior column of the spine with standardized navigation procedures may be able to reduce morbidity, operation times and x-ray exposition and thereby advantageous to surgeon and patient.

INTRODUCTION
Conservative treatment and isolated posterior operative stabilization of thoracolumbar fractures showed disappointing results [1,2]. The study of larger populations concludes in the request to reconstruct the anterior column for better long time results of the kyphotic angle after trauma [3]. However, improved reconstruction results were associated with significant morbidity using open anterior approaches. Minimal invasive techniques were able to lower this morbidity making the anterior approach more common in spine trauma surgery [3,4].

Computer assisted orthopaedic surgery (CAOS) is reported to reduce the misplacement rate of conventionally inserted lumbar pedicle screws in standardized posterior approaches [5,6]. There are only few reports concerning CAOS in the anterior approach to the thoracolumbar spine. The authors present a standardized protocol using CT/fluoro matched navigation which is routinely used for the anterior approach to the thoracolumbar spine.

METHODS
ANTERIOR APPROACH TO THE THORACOLUMBAR SPINE
The patient is placed in prone position on the operating table. Endoscopic equipment and the navigation system are positioned at the foot end, the operating team on the left side of the patient. The image intensifier comes from opposite of the operating team and can be removed after CT/fluoro matching has been done [Fig.1].
Thereby some parts of the operation (e.g. harvesting of the bone graft from the iliac crest) may be performed simultaneously from the right side of the patient. A lateral incision of 5cm is enough to allow the transthoracic access to the spine from T4 to L2. A retractor system (Synframe®, Synthes) allows efficient exposure of the situs [Fig.2].

**Figure 2**
Figure 2: Retractor system for the lateral incision, insertion of the endoscope.

Additional incisions of 1 cm laterally and of 2 cm posteriorly enable the insertion of the endoscope and the navigation system, respectively.

**PRINCIPLES FOR THE RECONSTRUCTION OF THE ANTERIOR COLUMN**
Incomplete compression type fractures with kyphotic angle exceeding 20° were treated by isolated anterior approach with monosegmental fusion using a double rod system in combination with tricortical iliac crest bone graft. According to our algorithm complete burst fractures and Pinzer lesions as well as B and C type fractures according to the AO-classification would require combined anterior and posterior instrumentation. The anterior part may then be monosegmental (single rod instrumentation and bone graft) or bisegmental (corpectomy and insertion of an expandable cage).

**NAVIGATION SYSTEM**
The VectorVision® spine system (BrainLAB) enables navigation in CT images, fluoro images, or a combination of both image modalities simultaneously. The fluoro to CT registration allows to minimal invasively establish a 3D-reference to the CT data set using fluoroscopic images [Fig.3].

**Figure 3**
Figure 3a: Reference array fixed on the spinous process and fluoroscope with fluoro registration device.
Instrument adaptor clamps allow the integration of any required spinal instrument. The standardized CT/fluoro matched navigation requires a reference array which is fixed on the spinous process of the instrumented vertebra. The fluoro registration device is slid onto the image intensifier. Two (ap and lateral) intra-operatively acquired fluoroscopic images of the region of interest are taken. Based on a tungsten marker grid integrated into the fluoro registration device, the registration software of the VectorVision® system calculates all necessary projection parameters [Fig.4]. The touchscreen allows the surgeon to completely control the image guided system during the operation [Fig.5].

**RESULTS**

47 thoracolumbar fractures that have been operated on using isolated anterior approach were recorded prospectively between January 2002 and September 2004. In all cases retractor system, endoscopical assistance and computer navigation were used. 29 male and 18 female patients with a mean age of 39 (21-69) years were included in the study. 32 computer navigations were completed. 14/15 uncompleted procedures were observed in the first 12 months, thereafter all but one operation was completed under navigation control. The learning curve also showed longer anesthesia times during the first year. In 2004, OP- and anesthesia-
times were reduced. However, no significant difference was calculated. Fluoroscope times were reduced significantly in the group of complete navigation compared to conventional technique (p<0.05).

DISCUSSION

Computer assisted orthopaedic surgery (CAOS) is reported to add precision and accuracy to posterior procedures in spine surgery [5,6]. It should be able to do so in anterior approaches. However, there is no significant literature focusing on this particular chapter of CAOS. The authors have been using an image guided navigation system (VectorVision®, BrainLAB) in 47 patients when operating on thoracolumbar spine fractures via isolated anterior approach. A learning curve has been observed with 15 navigation procedures – most of them during the first year – not being completed. However, the standardized CT/fluoro matched protocol was useful for the minimally invasive operation technique and allowed to reduce significantly the x-ray times without loss of precision. This effect has been most effectfully observed during the last third of the study period and was not significant. But it shows that navigation is not mandatory affected with longer operation times compared to conventional techniques.

The combination of minimally invasive approaches to the anterior column of the spine with standardized navigation procedures may be able to reduce morbidity, operation times and x-ray exposition.

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