# First experience with laser guided percutaneous pedicle screw placement in the lumbar spine

Peter H Richter MD[1], Florian Gebhard MD[1], Michael Kraus MD[2]

[1] Ulm University, Department of Trauma-, Hand- and Reconstructive Surgery, Albert-Einstein-Allee 23, 89081 Ulm, Germany, peter.richter@uniklinik-ulm.de

[2] Donau-Ries Hospital Donauwoerth, Centre for Orthopaedic, Trauma and Spine Surgery, Neudegger Allee 6, 86609 Donauwoerth, Germany

## INTRODUCTION

Since many years surgeons are trying to optimize pedicle screw placement in spine surgeries to reduce severe complications. Intraoperative image guidance could improve the accuracy in pedicle screw placement (Tain 2011). However no significant reduction of complications could be seen (Verma 2010). With the implementation of robotic 3D flat-panel detectors in hybrid operating rooms a new form of navigation is now accessible. A 3D scan (Dyna-CT) of the target area is acquired. After image reconstruction a start- and endpoint can be planned. Afterwards the C-arm is able to automatically move into different position always visualizing the planned route. With the help of an integrated laser crosshair the endpoint and the angulation of the planned line can be seen. This enables the surgeon to align his tools and puncture with a needle or implant a wire. Until now this planning tool has only been used for needle procedures (Ritter 2013, Freundt 2013). The aim of our study was to find out, if Syngo iGuide® (Siemens Medical Solutions, Erlangen, Germany) is feasible for pedicle screw placement in an ex-vivo model.

## MATERIALS AND METHODS

5 synthetic lumbar spine models embedded in a blinding, radiolucent material with surrounding foam were used for this study (SYNBONE AG, Malans, Switzerland). Two orthopaedic surgeons implanted 10 screws (L1-L5) on each model using the new laser guided fluoroscopic method. For this purpose a Dyna-CT of the lumbar spine models was acquired with the Artis zeego® (Siemens Medical Solutions, Erlangen, Germany) leading to a 3D reconstruction image. In these images a start- and endpoint was planned for each screw. Afterwards the C-arm was automatically positioned in the “Bulls-eye”-position. Thereby the C-arm shows the surgeon with an integrated laser crosshair the endpoint as well as the angulation of the planned screw. After insertion of a k-wire with this technique a cannulated screw was implanted over the guidance wire (USS MIS, DePuy Synthes Spine, Raynham, USA). A separate planning had to be performed for each screw. After implantation of 10 screws in a singular model another Dyna-CT was performed to check implant position.

## RESULTS

Mean planning and implantation time was 5.73 minutes per screw. Mean fluoroscopy time was 0.2 minutes. In two cases, it was impossible to implant the screws in the fifth lumbar vertebra using the guiding system. In this cases the inclination of the C-arm was to strong, leading to a collision with the OR table or the model. In all other models, screw implantation with the new Syngo iGuide® device was rated succesfull. The system was especially helpful to place screws in the upper lumbar spine.

## DISCUSSION

This is the first time pedicle screws were implanted using with this laser guided technique. The feasibility of this system could be shown. In 2000 Schwend et al showed a similar method using a laser crosshair with a 2D C-arm. A pedicle wall perforation rate of 1.6% was

seen using cadaver spines without the surrounding muscles (Schwend 2000). We believe that route planning in 3D reconstruction images will optimize screw position. The Artis zeego® is mostly used for vascular surgery (Tsagakis 2013). In many hospitals this system is already installed without the orthopaedic surgeon knowing about it. Yet it could be an essential help in placement of pedicle screws in challenging anatomic regions without the acquisition cost of a navigation system.

## REFERENCES

Tian NF, Huang QS, Zhou P, Zhou Y, Wu RK, Lou Y, Xu HZ.Pedicle screw insertion accuracy with different assisted methods: a systematic review and meta-analysis of comparative studies. Eur Spine J. 2011 Jun;20(6):846-59.

Verma R, Krishan S, Haendlmayer K, Mohsen A, Functional outcome of computer-assisted spinal pedicle screw placement: a systematic review and meta-analysis of 23 studies including 5,992 pedicle screws. Eur Spine J. 2010 Mar;19(3):370-5.

Ritter M, Rassweiler MC, Häcker A, Michel MS, Laser-guided percutaneous kidney access with the Uro Dyna-CT: first experience of three-dimensional puncture planning with an ex vivo model. World J Urol. 2013 Oct;31(5):1147-51.

Freundt MI, Ritter M, Al-Zghloul M, Groden C, Kerl HU, Laser-guided cervical selective nerve root block with the Dyna-CT: initial experience of three-dimensional puncture planning with an ex-vivo model. PLoS One. 2013 Jul 19;8(7):e69311.

Schwend RM, Dewire PJ, Kowalski TM, Accuracy of fluoroscopically assisted laser targeting of the cadaveric thoracic and lumbar spine to place transpedicular screws. J Spinal Disord. 2000 Oct;13(5):412-8.

Tsagakis K, Konorza T, Dohle DS, Kottenberg E, Buck T, Thielmann M, Erbel R, Jakob H, Hybrid operating room concept for combined diagnostics, intervention and surgery in acute type A dissection. Eur J Cardiothorac Surg. 2013 43(2):397–404.

## DISCLOSURES

There is nothing to disclose.