ziehm imaging

Increasing confidence with intraoperative 3D image-navigated surgery in minimally invasive transforaminal lumbar interbody fusion

A clinical case report for the Ziehm Vision RFD 3D and Stryker SpineMask® Tracker Navigation at University Hospital Freiburg, Germany

Overweight and obesity are major risk factors linked to a number of chronic diseases, including diabetes, cardiovascular diseases and cancer.[1] Both chronic illnesses and the number of degenerative diseases of the muscular and skeletal systems are rising in parallel with higher body mass indexes (BMI).

Spondylosis deformations, lumbar spinal stenosis and degenerative lumbar scoliosis can result in and from herniated discs or a significant constriction of the spinal cord. Complex surgery is necessary to improve the condition and quality of life of patients with these conditions.

Image-guided surgery that supports less invasive procedures is regarded as the latest technology in the OR in terms of improved patient outcomes, including better recovery processes and increased OR efficiency.[2,3]

When combined with navigation for image-guided surgery, the open navigation interface Ziehm NaviPort on the mobile C-arm Ziehm Vision RFD 3D delivers all that intraoperative 3D imaging has to offer. In this case report in cooperation with University Hospital Freiburg, we will demonstrate how state-of-the-art image-guided intraoperative 3D imaging helps increase confidence and accuracy in the OR while ensuring optimized patient outcomes – even during surgery on obese patients, where imaging technology usually encounters its limits.

Method

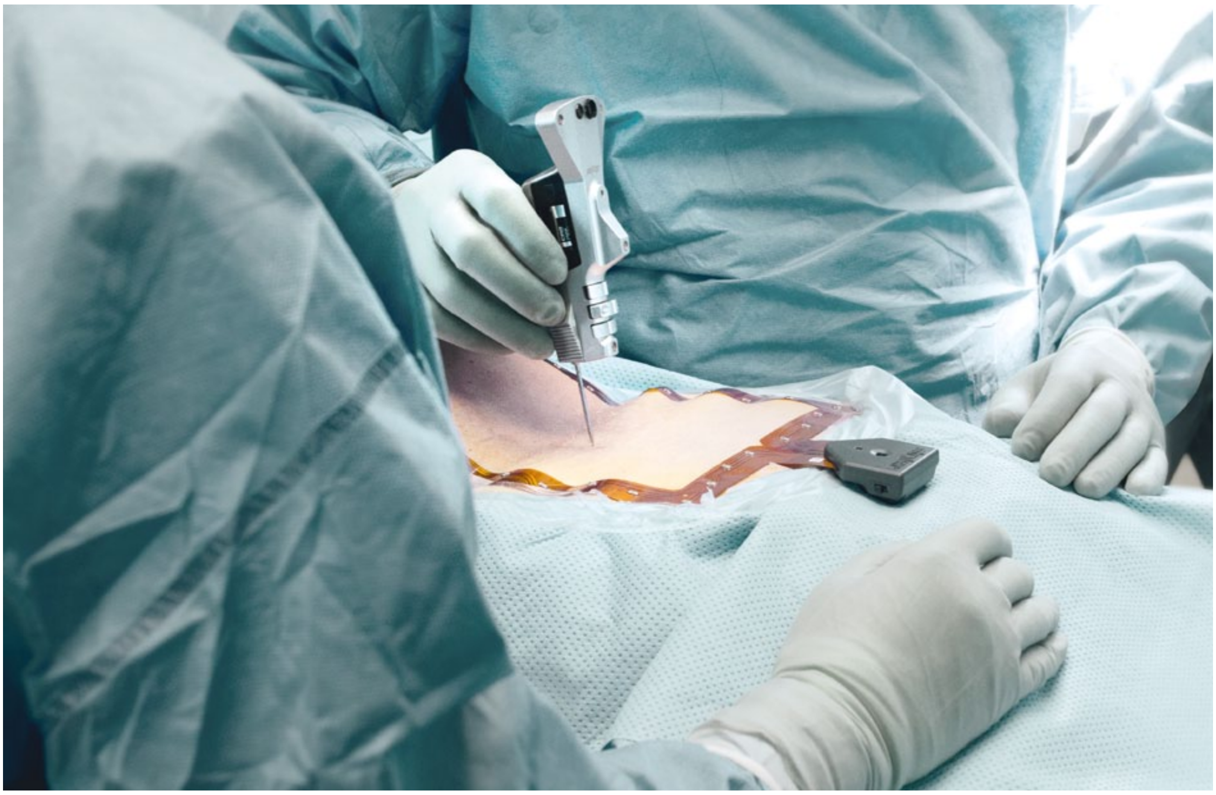
An obese 62-year-old woman (BMI of over 30) with an anamnesis of preceding lumbar disc herniation in L5/S1 arrived at University Hospital Freiburg in tremendous sciatic pain. Degenerative anterolisthesis L5/S1 and foraminal stenosis at L4/L5 on the left as well as at L5/S1 on both sides were identified, and long-standing X-rays revealed sagittal imbalance as well.

Furthermore, the patient suffers from scoliosis extending between L4 and S1. Her lumbar disc herniation had already been treated. See Fig. 1 for the preoperative CT scan.

In addition to decompressing the neurological structures caused by foraminal stenosis and lumbar herniated discs, the major goal of treatment was to stabilize and reposition L5/S1 and to restore sagittal balance.

A minimally-invasive procedure with image-guided surgery was planned to ensure a higher level of precision in the OR and improve patient outcomes. The Ziehm Vision RFD 3D offers the opportunity to combine state-of-the-art intraoperative 3D imaging with image-guided navigation, which may lead to a reduced need for postoperative CT scans. The Stryker SpineMask® Tracker is an innovative patient tracker used in image-guided surgical procedures that is non-invasive and avoids the additional skin incision that other tracking devices require. Thanks to innovative imaging technology, the Ziehm Vision RFD 3D delivers high-quality images in the OR that depict the precise position of the patient's anatomy.

Fig. 1: Preoperative CT scan depicting the herniated disc at L5/S1, including foraminal stenosis



There is no need to perform further registration procedures as is the case, for example, when navigation is performed on CT images.

Workflow

Due to the complex degenerative instability in the patient's L5/S1 and foraminal stenosis in varying degrees between L4 and S1, a vertebral body fusion over two levels (L4 - S1), including bi-segmental cage placement (L4/5 + L5/S1) in the intervertebral disc space, was planned for the purpose of stabilizing and recreating the lordosis of the segments.

After placing the non-invasive SpineMask® Tracker on the patient, the infrared camera was set up to track the position of the SpineMask® Tracker.

Using the Ziehm Vision RFD 3D, a high-resolution 3D dataset was generated in apnea, while the team left the OR to reduce the dose exposure to the staff. This took less than five minutes and included draping, hyperoxygenation of the patient, breathing stop, the team leaving the OR, image acquisition, and reconstruction time. The generated 3D dataset was then transferred automatically to the navigation system in less than one minute.

The surgeon confirmed registration accuracy so that the navigation process with the selected navigation tools could be initiated. The six K-wires could be placed without additional 2D radiation exposure, followed by screw placement between L4 and S1 on both sides.

Fig. 2: Intraoperative 3D multiple planar reconstruction of 3D dataset which is transferred to the Stryker navigation system for navigational purposes

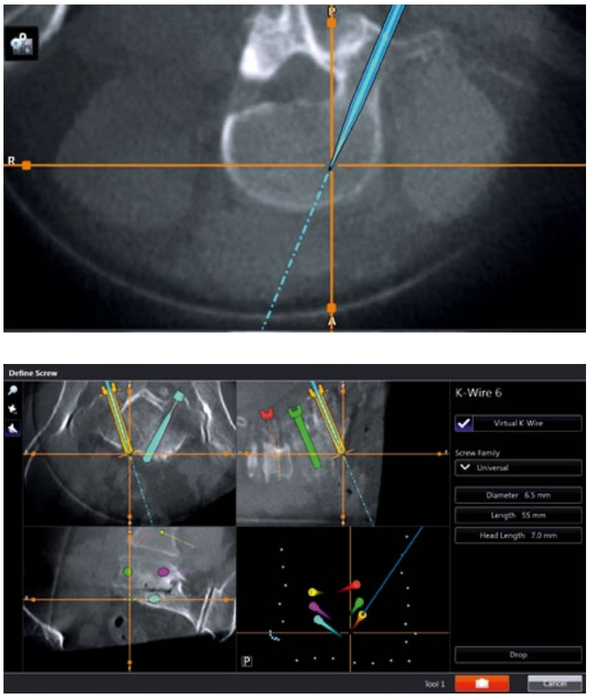


Fig. 3: Stryker's SpineMap® 3D Software showing navigated MIS screw trajectory in conjunction with the SpineMask® Tracker

Following the screw planning process and placement of the K-wires, an additional 3D scan was performed.

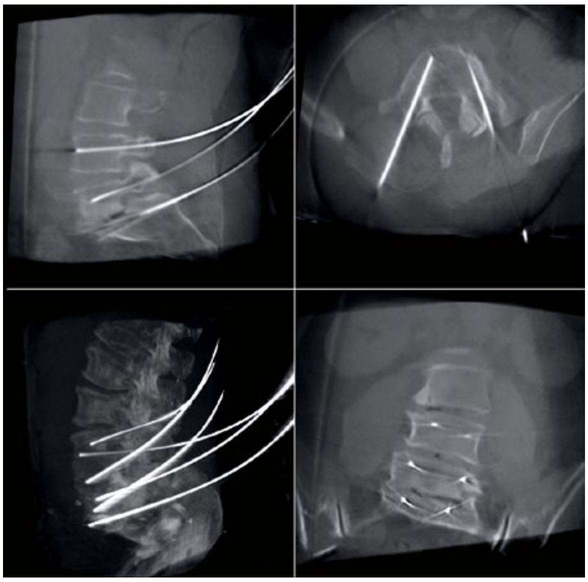
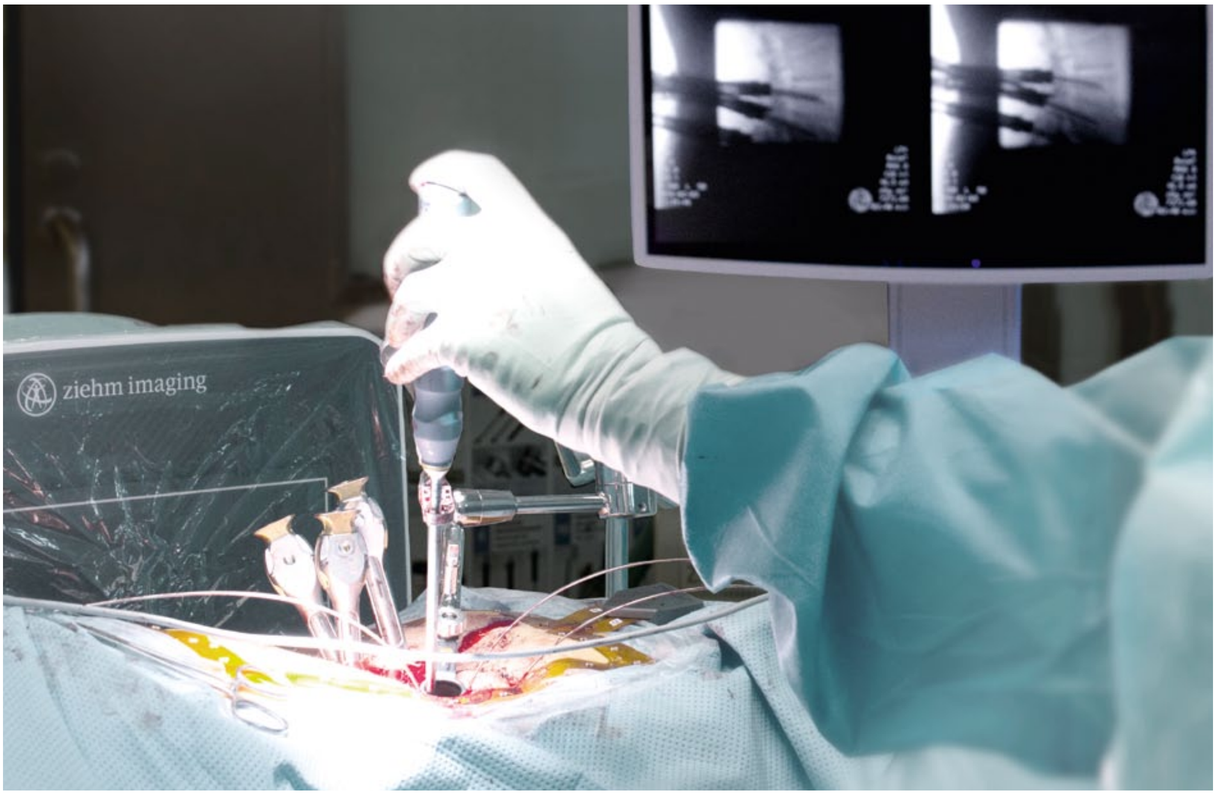


Fig. 4: Multiple planar reconstruction of 3D scan visualizing placement of K-wires on both sides in L4/L5/S1

In addition to the 3D scan, neurophysiological monitoring was performed to ensure safe pedicle screw placement under further conventional fluoroscopy.

Finally, a tubular retractor system was inserted and fastened to the table. During the ensuing transforaminal access, the implantation of the cage (including the additional insertion of an autologous bone into the intervertebral disc space that was collected during the facetectomy) was performed to stabilize the overall structure.[4] The subsequent successful screw insertion via the K-wires and rod insertion were performed without the routine use of conventional fluoroscopy. With distortion-free imaging, less metal artifact and no loss of relevant information, the Ziehm Vision RFD 3D provided excellent image quality – especially when, as here, an obese patient poses a challenge to intraoperative imaging technologies.



After performing the screw and cage placement, final 2D control images were taken in lateral and anterior-posterior projection. The images confirmed the correct placement of the implants, a sufficient reduction of the spondylolisthesis, and the reconstruction of the sagittal profile.

Conclusion

With obesity increasing all over the world,[1] demand is rising for innovative intraoperative imaging technologies that ensure high-image quality for this challenging patient group as well – along with minimally invasive procedures with high accuracy in the OR and improved patient outcomes.

Using the latest flat-panel technology and 3D imaging, Ziehm Imaging offers intraoperative mobile imaging, which can now also be used in combination with intraoperative navigation.

The Ziehm Vision RFD 3D offers state-of-the-art intraoperative 3D imaging, enabling confirmation of the reduction of fractures and optimal screw placement in CT-like image quality – all within a short application time. Furthermore, the opportunity to control surgical results intraoperatively may reduce the overall need for postoperative CT-scans and therefore lower the radiation exposure to the patient.[2] With Ziehm NaviPort in combination with Stryker's navigation systems, surgeons can now work with greater reliability and accuracy. Furthermore, minimally-invasive procedures can help to ease recovery processes and subsequently improve overall healthcare outcomes.[3]

Authors:

Dr. Ulrich Hubbe
Senior Physician of department of Neurosurgery
University Hospital Freiburg

Anne-Kathrin Reif
Clinical Marketing Manager
Ziehm Imaging GmbH

References

[1] World Health Organization – Health Topic Obesity, 2016, http://www.who.int/topics/obesity/en/

[2] Watkins R.G. et al. Cost-Effectiveness of Image-Guided Spine Surgery. Open Orthop J. 2010 Aug 6;4:228-33.

[3] Mason A, Paulsen R, Babuska JM, Rajpal S, Burneikiene S, Nelson EL, Villavicencio AT. The accuracy of pedicle screw placement using intraoperative image guidance systems. J Neurosurg Spine. 2014 Feb;20(2):196-203.

[4] Hubbe et al. Surgeon, staff, and patient radiation exposure in minimally invasive transforaminal lumbar interbody fusion: impact of 3D fluoroscopy-based navigation partially replacing conventional fluoroscopy: study protocol for a randomized controlled trial, 2015