

CT-based navigation systems for the thoracic spine (T1-10). Help or hindrance?

Navigation of pedicle screws in the lower part of the thoracic, thoracolumbar and lumbar spine has become a well established method for the correct placement of pedicle screws over the last few years. However, the accuracy of navigation has not always been sufficient for exact placement of pedicle screws in the upper and middle part of the thoracic spine with thin pedicles. This prospective study asks whether 3D navigation from two methods, namely new preoperative CT navigation matching software and intraoperative 3D navigation using 3D fluoroscopy, increase the accuracy of pedicle screw placement in the thoracic spine.

Materials and Methods

These new 3D navigation techniques were tested in human cadavers (n=2) in preclinical investigations before being used in 27 patients. In these 27 patients, the reasons for stabilization were fractures (n=15), spondylodiscitis (n=5) and metastases (n=7). The anatomy where navigated dorsal instrumentation with internal fixators was used from T1 to T10. A minimum of two vertebral bodies above and below the lesion were included in stabilization in each case. In 17 cases, preoperative CT scans were used with "region based surface matching" (Vector Vision BrainLAB). In the other 10 cases, navigation was guided by intraoperative 3D scans (Ziehm Vision Vario 3D mobile C-arm). Navigated awls prepared the pedicles, the screws were inserted and final

screenshots were taken. The precision of pedicle screw placement was checked in some cases by intraoperative 3D scans and in all cases by a postoperative CT scan.

Results

In cases where intraoperative mobile C-arm 3D scans were used, two scans were always required for planning – one above and one below the lesion. A total number of 180 out of 216 thoracic pedicle screws (83.3%) were navigated. For the other 36 screws, no exact matching (accuracy < 1 mm) was possible or there were various technical problems with the intraoperative 3D scan. Postoperative CT scans showed a central location of the pedicle screw in 196 out of 216 cases (90.7%). The position of navigated screws shown by the CT scan was the same as seen in intraoperative 3D C-arm screenshots. In 20 out of 216 cases (9.3%), the actual position of the pedicle



Ziehm Vision Vario 3D

screw differed from the one seen in the screenshots within a 5 degree tolerance. In these cases the screws perforated the pedicle medially or laterally by less than 2mm – no vascular or neurological complications occurred and no revision surgery was required.

Conclusion

In the middle and upper part of the thoracic vertebrae, the percentage of screws placed incorrectly was low (9.3%), especially considering that no revision was needed. There is still room for improvement in terms of registration, which lead to longer operating times and sometimes made screw navigation impossible (36 out of 216 cases = 16.6%). Contributing factors were obesity and osteoporosis. Higher quality CT scans or intraoperative 3D imaging coupled with navigation software could reduce these problems. In the hands of a skilled surgeon, it can be said that these devices lead to greater safety which placing the pedicle screws in the middle and upper part of the thoracic spine.

Authors: Katscher, S.; Jarvers, J.-S.; Düsing, T.;
Riesner, H.J.; Blattert, T.; Josten, C
University Hospital Leipzig, Department for Trauma
and Reconstructive Surgery
