Analysis of radiological accuracy among different intraoperative imaging systems for screw fixation in cervico-thoracic region

Nermine Habib¹, Giuseppe Filardo², Christian Candrian², Pietro Scarone³

¹Fribourg Cantonal Hospital, Department of Orthopaedics and Traumatology, ²Lugano Regional Hospital, Department of Orthopaedics and Traumatology, ³Lugano Regional Hospital, Department of Neurosurgery

Study Design

Retrospective comparative analysis.

Objective

To compare the accuracy of posterior subaxial cervico-thoracic fixation using three different techniques: intraoperative computed tomography (iCT-AIRO) scanner-guided navigation, three-dimensional (O-arm) based spinal navigation and fluoroscopy based posterior stabilization.

Background

Surgical techniques for posterior fixation of cervico-thoracic pathologies are challenged by the great variation in pedicle dimension and angulations as well as the risky neurovascular anatomy with the proximity of the spinal cord, nerve roots, and vertebral artery. Intraoperative computed tomography navigation promises improved accuracy of spinal navigation with the benefit of increased visualization of a pedicle's trajectory. Even though multiple studies have demonstrated improved accuracy using navigated instrumentation, it remains a debate how useful iCT imaging is for posterior pedicle and lateral mass screw implantation in the subaxial cervico-thoracic spine.

Methods

In the period between August 2007 and October 2018, a total of 495 screws were implanted in 67 patients with cervico-thoracic instability who underwent posterior fixation; 163 screws with the

use of the iCT based spinal navigation (group A), 310 screws were implanted using the O-arm navigation system (group B), 22 screws under the guidance of fluoroscopy (group C). Screw positions were evaluated using postoperative CT scans according to the Neo et al (cervical pedicles) and Gertzbein and Robbins (thoracic) classifications. The screws in the cervical lateral mass were evaluated according to a new classification created by the authors.

Accurate positioning was defined as screws that were correctly placed completely within the pedicle as well as screws with a breach of less than 2 mm or screws that were correctly placed within the lateral mass as well as screws with incomplete perforation of the cortex.

Results

iCT-based navigation permitted a more accurate intraoperative evaluation of the implanted screws and allowed the immediate correction of misplaced screws. With the use of the iCT, the accuracy rate has reached 97.55% with a much better resolution of the images acquired, while with the O-arm navigation, the accuracy rate has reached 90.32% and with fluoroscopy was 90.90%. The most significant difference in accuracy was in the positioning of cervical pedicle screws: 96% with iCT compared to an accuracy of 64% with the O-Arm.

Conclusion

In subaxial cervico-thoracic posterior fixation, especially of pedicle screws, the use of iCT-based spinal navigation demonstrated higher accuracy rates as well as higher quality images allowing more accurate evaluation than with the O-arm-based spinal navigation or fluoroscopy-based systems.

Grade 0

Grade 1

Grade 2

	<u>Cervical Lateral Mass screws</u>	<u>Cervical Pedicle screws</u>	<u>Thoracic Pedicle screws</u>
i-CT	98%	96%	98%
O-Arm	95%	64%	84%
Fluoroscopy	91%	NA	NA