The use of fluoroscopic guided percutaneous pedicle screws in the upper thoracic spine (T1–T6): Is it safe?

Mun Keong Kwan¹, Chee Kidd Chiu¹, Chris Yin Wei Chan¹, Reza Zamani² and Nils Hansen-Algenstaedt²,³

Abstract
Purpose: This study analysed the accuracy and safety of the fluoroscopic guided percutaneous screws in the upper thoracic vertebrae (T1–T6). Methods: Computed tomography scans from 74 patients were retrospectively evaluated between January 2008 and December 2012. Pedicle perforations were classified by two types of grading systems. For medial, lateral, superior and inferior perforations: grade 0 – no violation; grade 1 – <2 mm; grade 2 – 2–4 mm and grade 3 – >4 mm. For anterior perforations: grade 0 – no violation; grade 1 – <4 mm; grade 2 – 4–6 mm and grade 3 – >6 mm. Results: There were 35 (47.3%) male and 39 (52.7%) female patients with a total 260 thoracic pedicle screws (T1–T6) analysed. There were 32 screw perforations which account to a perforation rate of 12.3% (11.2% grade 1, 0.7% grade 2 and 0.4% grade 3). None led to pedicle screw-related complications. The perforation rate was highest at T1 (33.3%, all grade 1 perforations), followed by T6 (14.5%) and T4 (14.0%). Conclusion: Fluoroscopic guided percutaneous pedicle screws of the upper thoracic spine (T1–T6) are technically more demanding and carry potential risks of serious complications. Extra precautions need to be taken when fluoroscopic guided percutaneous pedicle screws are placed at T1 and T2 levels, due to high medial pedicular angulation and obstruction of lateral fluoroscopic images by the shoulder girdle and at T4–T6 levels, due to smaller pedicular width.

Keywords
accuracy, breach, complication, minimal invasive, pedicle screw, percutaneous, perforation, safety, spine, thoracic

Introduction
Pedicle screw fixation in the spine was first introduced by Roy-Camille et al.¹ Comparing to the older methods of fixation using wires and hooks, pedicle screw fixation has superior biomechanical and clinical results.²-⁴ However, the conventional technique of the open pedicle screw placement technique over the upper thoracic spine requires extensive paravertebral muscle dissection to the lower cervical region to expose and identify anatomical bony landmarks for upper thoracic pedicle screw entry point. With the percutaneous fluoroscopic-guided technique, muscle dissection is minimized and no stripping from its bony attachment is required, thus leading to better muscular function, less blood loss, shorter operative time, reduced post-operative pain and thus results in a faster recovery.⁵-⁹

The T1 and T2 vertebrae have a larger degree of medial angulation among the thoracic vertebrae in the axial plane⁹,¹⁰ and it may be difficult to obtain adequate lateral

¹ Department of Orthopaedic Surgery (NOCERAL), University of Malaya, Kuala Lumpur, Malaysia
² Department of Spine Surgery, Orthocentrum Hamburg, Parklinik Manhagen, Hansastrasse, Hamburg, Germany
³ Department of Orthopaedics, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

Corresponding author:
Chee Kidd Chiu, Department of Orthopaedic Surgery, National Orthopaedic Centre of Excellence for Research and Learning (NOCERAL), Faculty of Medicine, University of Malaya, 50603 Kuala Lumpur, Malaysia.
Email: cheekidd@um.edu.my

Creative Commons CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (http://creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (https://us.sagepub.com/en-us/nam/open-access-at-sage).