A comparison of feasibility and safety of percutaneous fluoroscopic guided thoracic pedicle screws between Europeans and Asians: is there any difference?

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Abstract
Purpose To directly compare the safety of fluoroscopic guided percutaneous thoracic pedicle screws placement between Caucasians and Asians.
Methods This was a retrospective computerized tomography (CT) evaluation study of 880 fluoroscopic guided percutaneous pedicle screws. 440 screws were inserted in 73 European patients and 440 screws were inserted in 75 Asian patients. Screw perforations were classified into Grade 0: no violation; Grade 1: <2 mm perforation; Grade 2: 2–4 mm perforation; and Grade 3: ≥4 mm perforation. For anterior perforations, the pedicle perforations were classified into Grade 0: no violation, Grade 1: <4 mm perforation, Grade 2: 4–6 mm perforation; and Grade 3: ≥6 mm perforation.
Results The inter-rater reliability was adequate with a kappa value of 0.83. The mean age of the study group was 58.3 ± 15.6 years. The indications for surgery were tumor (70.3 %), infection (18.2 %), trauma (6.8 %), osteoporotic fracture (2.7 %) and degenerative diseases (2.0 %). The overall screw perforation rate was 9.7 %, in Europeans 9.1 % and in Asians 10.2 % (p > 0.05). Grade 1 perforation rate was 8.4 %, Grade 2 was 1.2 % and Grade 3 was 0.1 % with no difference in the grade of perforations between Europeans and Asians (p > 0.05). The perforation rate was the highest in T1 (33.3 %), followed by T6 (14.5 %) and T4 (14.0 %). Majority of perforations occurred medially (43.5 %), followed by laterally (25.9 %), and anteriorly (23.5 %). There was no statistical significant difference (p > 0.05) in the perforation rates between right-sided pedicle screws and left-sided pedicle screws (R: 10.0 %, L: 9.3 %).
Conclusions There were no statistical significant differences in the overall perforation rates, grades of perforations, direction of perforations for implantation of percutaneous thoracic pedicle screws insertion using fluoroscopic guidance between Europeans and Asians. The safety profile for this technique was comparable to the current reported perforation rates for conventional open pedicle screw technique.

Keywords Pedicle screws · Minimal invasive surgery · Spine · Patient safety · Intraoperative complications

Introduction
Pedicule screws instrumentation was first introduced by Roy-Camille [1]. Pedicle screws system had been proven to have a superior biomechanical and clinical results compared to the older methods of fixation (i.e. wires and hooks) [2, 3]. It also had been shown to be an effective instrument for fracture fixations, spinal deformities, spinal tumors and infection [4–7]. In the conventional open pedicle screw placement technique, muscle dissection and stripping is needed to expose and to identify anatomical bony landmarks before screw is inserted. With the new percutaneous fluoroscopic-guided technique, muscle dissection is reduced and no stripping from its bony attachment is required, thus leading to better muscular function, less blood loss, shorter operative time, less post-operative...
pain and faster recovery [8–10]. In addition, minimally invasive surgery had been shown to have a lower risk of infection [11] and to have better overall clinical results [12, 13].

In the English literature, several studies had reported on the clinical safety of percutaneous pedicle screw technique for the thoracic and lumbar spinal with a pedicle perforation rate ranging from 0.4 to 23% [14–21]. There has been evidence that showed differences in the thoracic pedicle morphometry between Caucasians and Asians [22–24] which may alter the feasibility or safety of percutaneous pedicle screw technique among Asians. Therefore, this study was done to directly compare the safety of fluoroscopic guided percutaneous thoracic pedicle screw placement between Caucasians and Asians.

Materials and methods

Study design

This was a retrospective evaluation study of computerized tomography (CT) scans of patients chosen from two centers: (1) European data from the University Medical Center Hamburg-Eppendorf, Germany and (2) Asian data from the University Malaya Medical Centre, Kuala Lumpur, Malaysia. The study duration was between Jan 2008 and Dec 2012. The percutaneous screws used were the MANGIS system (Stryker Spine, Allendale, NJ, USA).

Technique of fluoroscopic percutaneous pedicle screw insertion

This technique can be used only if good visualization of the thoracic pedicles can be easily obtained using the image intensifier. Contraindications for insertion of fluoroscopic percutaneous thoracic pedicle screw were conditions where the planned instrumented thoracic pedicles were not able to be visualized well (i.e., obese patients or extensive scoliotic and lytic pedicles in patients with metastatic spinal disease). A true anterior–posterior (AP) view of the corresponding vertebra was initially obtained (Fig. 1). A skin incision of 1.5 cm was made. At T1 and T2 levels, skin incisions were placed 5–10 mm lateral to the lateral border of the pedicle due to the lateral angulation of the T1 and T2 pedicles. For T3 to T12 levels, skin incisions were centered at the lateral border of the pedicle margin. Starting points for T1 to T10 were placed slightly higher (right side at 2 o’clock or left side at 10 o’clock position), as entry into the sloping transverse processes may be difficult and starting points above the transverse processes were chosen. For T11 and T12, the trocar was placed at 3 o’clock on the right side and 9 o’clock on the left side. The trocar was then advanced medially parallel to the endplate. When the tip of the trocar approached the medial border of the pedicle on an AP view (Figs. 1a, 2), a lateral view was obtained (Figs. 1b, 2). At this point, the trocar on lateral view should be at or slightly deeper than the posterior vertebral margin. The trocar was advanced until the middle of the vertebral body before a guide wire was inserted (Figs. 1a–c, 3). The length of the screw was measured and the screw was then inserted with caution not to allow the guide wire to advance with the screw. The screw size and length was determined based on pre-operative radiographs or CT scan assessment and intra-operative image intensifier estimation.

Extra-pedicular screws were inserted for very small pedicles (i.e., less than 3 mm in diameter), in the mid-thoracic region. Longer screws were chosen in the thoracic region to leave the head of the screws floating so that rod placement will not be interfered by the prominence of the transverse processes.

Computerized tomography (CT) examination

Evaluation of screw perforation was performed on PACs system (Centricity PACs, version 5.0, GE Healthcare) that allowed window adjustment of the scans to remove implant artifact and to visualize accurately the screw threads. The

![Fig. 1](https://example.com/fig1.png)  
**Fig. 1** Stages of trocar positions in T12 vertebra; a anterior-posterior image, b lateral image, and c axial CT views; (1) starting point, (2) when tip reaches medial border of the pedicle, and (3) final position.

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