Marked Guidewire Technique Prevents Complications of Percutaneous Pedicle Screws and Precisely Controls Depth: Technical Note

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OBJECTIVE: **We sought to describe a novel modified guidewire technique used in the placement of percutaneous pedicle screws (PPSs), which enables safe and precise control of the depth of screw placement and prevents excessive advancement of the guidewire with low radiation exposure. PPSs have been widely used and have many advantages. However, inadvertent advancement of the guidewire may damage peripheral tissue or viscera, and repeated confirmation of the depth of screw and guidewire leads to extensive radiation exposure.**

METHODS: **A modified guidewire with markers was used intraoperatively. The reading of the mark on the guidewire increased as the PPS advanced into the pedicle. The depth of the screw in the pedicle was calculated as the mark reading after each screw was rotated into the pedicle minus the initial mark reading. After all pedicle screws were placed, the positions of the screws were checked by C-arm or G-arm fluoroscopy.**

RESULTS: **The modified guidewire was applied in 41 thoracic-lumbar fracture patients. The depths of the percutaneous screws were precisely controlled as planned. There were no inadvertent breaches of the anterior cortices of the vertebrae. No patients reported neurologic symptoms, and there was no screw misplacement detected. Surgeons had no radiation exposure, and patients were only exposed once to the radiation.**

CONCLUSIONS: **The modified guidewire with markers is an effective device to precisely control the depth of PPSs and prevent complications of the guidewire in the placement of pedicle screws.**

INTRODUCTION

The percutaneous pedicle screw (PPS) has many advantages over conventional spine fixation methods, such as lesser tissue damage,[1,2] minimal blood loss, little postoperative pain, and shorter period of bed rest. The PPS technique has been used in the treatment of spine injury,[3,4] degenerative diseases, tumor, and tuberculosis.[5]

The safety of the PPS was reported by several researchers, and the depth of the screw was not always well controlled. The anterior vertebral breach rate of PPS is 6% to 11.3%.[6,7] The anterior breach of the K-wire was reported with postoperative ileus and retroperitoneal hematoma.[8-10] The incidence of inadvertent advancement of the K-wire increases in an osteoporosis patient, and the K-wire may forcefully breach the anterior vertebral wall when the K-wire is hindered by the sclerosis of the bone. To avoid the complications, the position of the K-wire and screws is checked repeatedly by conventional fluoroscopy in operation. The extensive intraoperative radiation exposure might adversely affect the surgeons. Although these complications are discussed in textbooks[11,12] and articles,[13] no sound solutions have been suggested.

Herein, we introduce a novel technique using a modified guidewire with markers, which greatly reduces radiation exposure, effectively prevents inadvertent advancement of the guidewire, and precisely controls the depth of the screw during the placement of PPSs.

METHODS

A new K-wire was used intraoperatively to control the depth of screw placement and avoid inadvertent breaches. The

Key words
- Counting rotation
- Guidewire with gauged mark
- Inadvertent advancement
- Percutaneous pedicle screw
- Radiation protection

Abbreviations and Acronyms
PPS: Percutaneous pedicle screw

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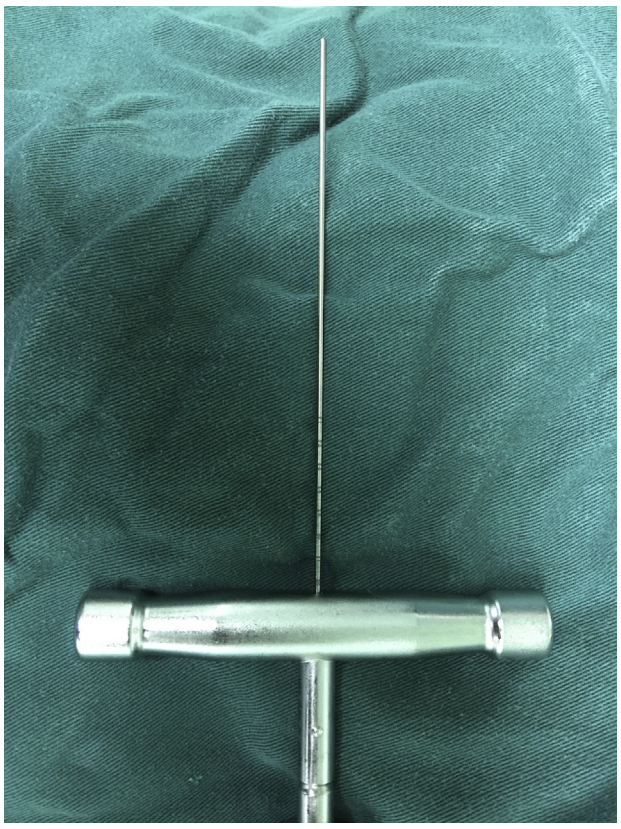

Figure 1. Marks on the middle to the tail of the guidewire. The distance between each 2 marks was 5 mm.

K-wire was marked along the caudal end, with 5 mm between each mark. Figure 1 shows an image of the screwdriver and marked guidewire. When the screw was placed at the entry site, the head of the guidewire was the part in the vertebra and the tail of the guidewire was the part where the marks were located. Intraoperatively, after the position of the K-wire was checked by C-arm fluoroscopy, the PPS was placed using the screwdriver along the K-wire. When the screw was put in the entry point, the reading on the K-wire was marked by a clamp or remembered. When the screw was rotated into the pedicle, the reading of the mark increased as the PPS advanced in the pedicle. The depth of the screw into the pedicle was indicated by the current K-wire reading minus the initial K-wire reading. As shown in Figure 2, the initial reading on K-wire was 10 mm when the screw was put on the entry site of the facet; this reading increased after we rotated the screw into the pedicle. When the reading increased to 30 mm (Figure 3), this indicated that the screw had advanced 20 mm into the pedicle. The screw we used in this case was 45 mm long and therefore needed to be advanced 25 mm to be fully inserted into the pedicle. When the reading increased to 55 mm, the image taken after screw placement shows that the screw was fully placed into the pedicle (Figure 4). The fluoroscopy used in Figures 2—4 was just for demonstration that the reading calculated was precisely equal to the depth of the screw. In operation, the depth of the screws did not need to be checked by fluoroscopy repeatedly. The positions of the screws were checked only once by C-arm or G-arm fluoroscopy after all 6 pedicle screws were placed. The rest of the procedure was performed in the same manner as in the standard method.

RESULTS

From 2016—2017, the modified guidewire technique was applied in 41 thoracic-lumbar fracture patients with a total of 246 percutaneous pedicle screws. In all operations, the depths of the percutaneous screws were precisely controlled as planned. There were no inadvertent breaches of the anterior cortices of the vertebrae caused by the K-wire. No patients reported neurologic symptoms. The positions of the percutaneous pedicle screws were checked using radiography or computed tomography, and no misplacement of the screws was found. In the whole

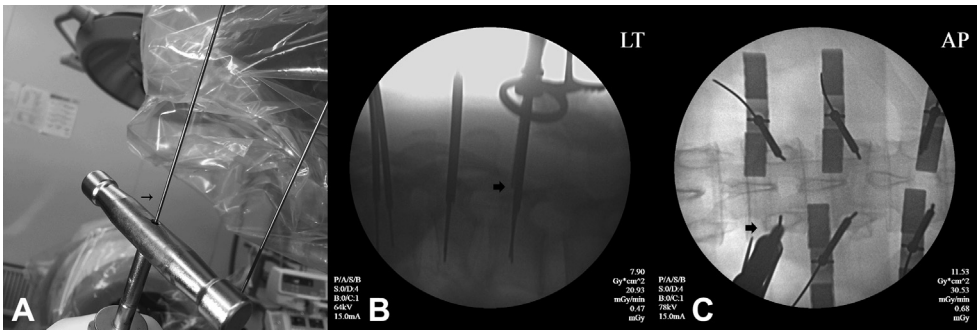

Figure 2. (**A**) The initial reading (*arrow*) on the guidewire is 10 mm. Fluoroscopy showed that the percutaneous pedicle screw was placed on the entry site (*arrow*) (**B** and **C**). In the operation, there is no need for this confirmation by fluoroscopy; the fluoroscopy here is just for demonstration.