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Tools and Techniques

Minimal invasive surgical technique in midline lumbar inter-body fusion: A technique note

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ABSTRACT

Midline lumbar inter-body fusion (MIDLF) surgery with cortical bone trajectory (CBT) screw insertion is a modern fusion technique for spinal surgery. The difference in entry point of this trajectory from conventional pedicle screw surgery offers the potential benefits of less soft tissue dissection and reduced blood loss, post-operative wound pain, and infection risks. Because this is a newly developed technique first announced by Santoni in 2009, most surgeons perform this surgery in a mini-open fashion and require more intra-operative fluoroscopy and ionizing radiation exposure during screw placement. In this article, we demonstrate a minimally invasive midline lumbar interbody fusion (MIS-MIDLF) technique with percutaneous CBT screw placement. Using a designed cannulated awl, we only need a single dimensional fluoroscopy view from anterior to posterior (AP view) to achieve an accurate trajectory and therefore reduce radiation exposure. We report our first ten consecutive patients with degenerative spondylolithesis who underwent MISS-MIDLF and were followed up for more than 18 months. The procedure required a single wound of about 3 cm in length in one to two level fusion surgery and only three to four shots of fluoroscopy were needed for each screw placement. There were no screws malpositioned in subsequent plain films or computer tomography scans. We demonstrate a case with detailed surgical procedures and provide this technique as an alternative approach for surgeons performing MILDF surgery.

1. Introduction

Spinal fusion is currently the standard surgical treatment for various lumbar spinal disorders. Pedicle screw fixation is the most common and reliable procedure in fusion surgery. However, there has been concern regarding conventional pedicle screw placement. Exposure lateral to the facet joint for screw placement needs a relatively long incision wound and wide muscle dissection, and this may lead to postoperative back pain from injury of the posteromedial branch of the nerve root crossing the facet joint and excessive muscular damage. Therefore, alternative options for screw placement have been advocated such as minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) with percutaneous pedicle screw insertion [1]. However, several clinical issues were raised including multiple wound incision, learning curve, radiation exposure, inadequate bilateral neuroforamen decompression, etc [2]. Cortical bone trajectory CBT screw insertion is a novel fusion technique in spinal surgery that was first described by Santoni et al. in 2009 [3] and may address some of these surgical concerns. Due to the difference in trajectory compared with the conventional pathway, the technique can reduce incision length, resulting in less muscle dissection and blood loss. Midline lumbar inter-body fusion (MIDLF) surgery with CBT, which was first reported by Mizuno [4] in 2014, requires only a single midline incision wound which eliminates the disadvantages of the MIS-TILF technique. MIDLF is becoming more and more popular with spine surgeons, most of whom perform this surgery using a mini-open approach. During the learning period, surgeons often require consequent two-dimensional fluoroscopy (anterior-posterior and lateral dimensions) and gantry adjustment to achieve an accurate trajectory, especially when the computer navigation system is not worldwide accessible, or is in some facility-limited institutions. Therefore, surgeons often are exposed to a greater dose of ionizing radiation than in traditional screw placement.

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In this article, we report a MIS-MILDF technique with the first ten consequent cases who were followed up for more than 18 months in which a minimal surgical wound approach was used. There was less tissue damage compared with mini-open MIDLF surgery. And, by using a single dimensional fluoroscopy technique, the ionizing radiation exposure to surgeons was reduced.

2. Case illustration and technique note

2.1. Instrument and technique design

The instrument that we used for MIS-MILDF surgery is a specially designed cannulated awl (Fig. 1A). It is composed of two parts. One part is a cap fixed with a Kirschner wire that has a sharp tip. The other part has a metallic handle, a 120-mm cannulated trocar that is 8 mm in diameter and another 40-mm anterior portion that is 3 mm in diameter (Fig. 1B, C). The anterior portion contains a 10-mm long screw thread at the tip that can provide purchasing power of the screw. The 40-mm long anterior portion is a special marker in our technique. Under the anterior-posterior (AP) view in fluoroscopy, the length from the entry point (5 o'clock of left side or 7 o'clock of right side) to the ideal point of the screw tip (11 o'clock of left side or 1 o'clock of right side) is important. If the length is shorter than the anterior slender 40-mm portion of the awl (Fig. 2A), the slope will be too steep under lateral view and the trajectory may enter the disc space or breach the upper wall of the pedicle (Fig. 2a). On the other hand, if the length is longer than the anterior portion of the awl (Fig. 2B), the trajectory may be too straight and not reach the outer cortex of the vertebra (Fig. 2b). Therefore, when the length approximates the anterior 40 mm of the instrument, the tip will nearly reach the superior endplate on lateral view (Fig. 2C, c, D, d).

2.2. Case and technique illustration

A 55-year-old male security guard with a body mass index (BMI) of 34.4 kg/m^2 had suffered from low back pain and lower limb numbness with intermittent claudication for more than one year. He received physical therapy but there was no improvement. A lumbar spine magnetic resonance image showed L3/4/5 disc degeneration with herniation. We decided to perform MIS-MILDF for L3/4/5 fusion surgery on this patient after thorough explain.

In the surgical procedure, the patient was placed in the prone position. We made the skin marking of the entry points of each level under fluoroscopy localization and the incision was made between pedicle lines of L3 to L5 (Fig. 3A). After the skin and fascia were incised, dissection of the bilateral interspinalis and multifidus muscle with a Penfield dissector was made (Fig. 3B). Under AP view in fluoroscopy, a pilot hole was made with the sharp tip of the cannulated awl at the left pars interartiularis of L3 that was about 5

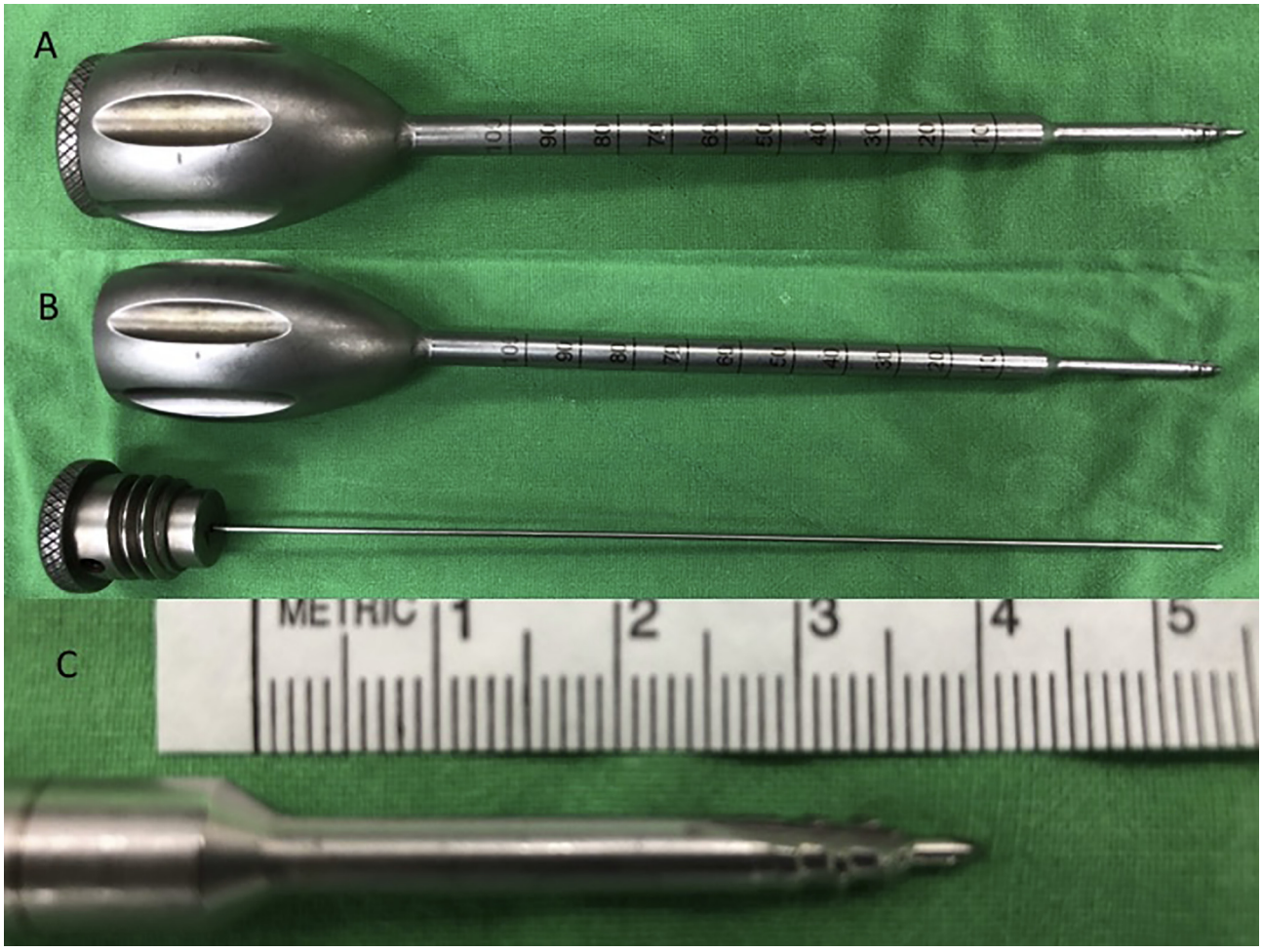

Fig. 1. (A) The special designed cannulated awl is all metallic. (B, C) The awl is composed of two parts. One part is a cap fixed with a Kirschner wire that has a sharp tip. The other part has a handle, a 120-mm cannulated trocar that is 8-mm in diameter and another 40-mm anterior portion that is 3-mm in diameter.