Comparison of Surgical Outcomes between Cortical Bone Trajectory and Conventional Pedicle Screw Technique for Lumbar Degenerative Spondylolisthesis

A Systematic Review

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

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List of Abbreviations

Abb.	Full term
ASD	**Adjacent Segment Disease**
CBT	**Cortical Bone Trajectory**
CBT-TLIF	**Transforaminal Lumbar Interbody Fusion with screw insertion with cortical bone trajectory**
DDD	**Degenerative Disc Disease**
FL	**Focal lordosis**
JOA	**Japanese Orthopaedic Association**
LL	**Lumbar lordosis**
MISS	**Minimally Invasive Spinal Surgery**
MRI	**Magnetic resonance imaging**
M-TLIF	**Transforaminal Lumbar Interbody Fusion with minimally invasive pedicle screw insertion**
ODI	**Oswestry Disability Index**
PEEK	**Poly Ether Ether Ketone**
PLIF	**Posterior Lumbar Interbody Fusion**
PS	**Pedicle Screw**
P-TLIF	**Transforaminal Lumbar Interbody Fusion with percutaneous pedicle screw insertion**
Pts	**Patients**
RCT	**Randomized Control Trial**
SD	**Standard Deviation**
SP	**Starting Point**
TT	**Traditional Trajectory**
VAS	**Visual Analog Scale**
Vs	**VERSUS**

INTRODUCTION

Pedicle screw fixation has been the main technique for lumbar spine stabilization for several decades. Pedicle screw fixation offers multiple advantages, allowing superior correction of spinal deformities, and reduced rates of loss of fixation and non-union. Therefore, this technique has been used in the treatment of a number of lumbar disorders such as treatment of fractures, tumors and degenerative disease [(1)].

The traditional insertion pathway for pedicle screws involves a transpedicular lateral to medial trajectory with the initial insertion point at the junction of the transverse process and lateral wall of the facet [(2)]. Several complications are associated with traditional trajectory screw fixation. Screw misplacement rates for pedicle fixation reportedly range from 21%–40% despite the use of navigation technique [(3).] Screw loosening and loss of surgical construct stability may occur, particularly in patients with osteopenia or osteoporosis [(1)].

Additional drawbacks include the significant muscle dissection required for pedicle screw insertion because of its lateral to medial trajectory and increased risk of neurovascular injury documented by multiple reports of incorrect placement of pedicle screws [(4)]. Over recent years, there have been a number of developments in screw design and implantation techniques, including alternative trajectory for screw fixation aimed at increasing purchase of the pedicle screw in higher density bone [(1)].

Santoni et al. [5] were the first one to report the cortical bone trajectory (CBT), in which screws follow a caudal-to-cephalad path in the sagittal plane and a medial-to-lateral directed path in the transverse plane. In contrast to conventional pedicle screw fixation, CBT screws do not penetrate the vertebral body trabecular space. Although several morphometric and biomechanical studies have supported the use of the CBT approach, there have been few clinical studies investigating outcomes of this technique in patients with lumbar spine pathologies [2, 5]. The trajectory of the CBT screw is demonstrated in (Fig.1) [6].

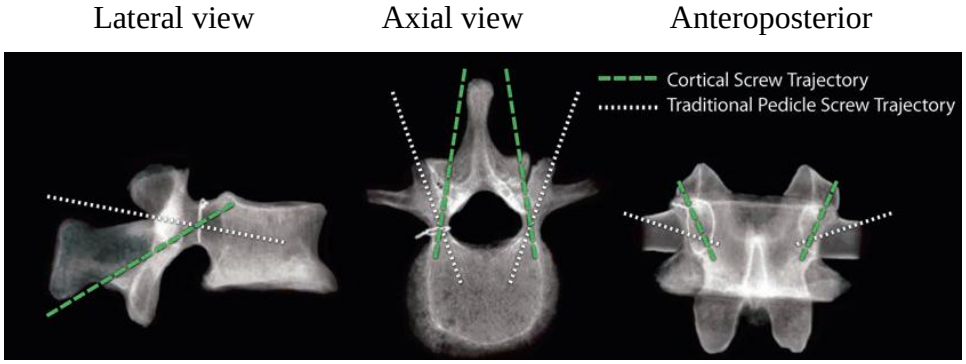

Figure (1): Comparison of the cortical bone screw trajectory with the traditional pedicle screw trajectory (*green line*=CBT, *dashed white line* =TT) [6].

This new trajectory allows the pedicular screws to engage the cortical bone of the dorsal lamina and the pedicle, enhancing biomechanical stability and the pullout strength of the CBT screws and decreasing the incidence of screw loosening [5, 7].

Recently, attention has been paid to minimally invasive spinal surgery (MISS) as a successful, leading treatment choice compared with open conventional methods for the management of different spinal disorders [8]. This is attributable to the rapid development of intraoperative imaging systems and the production of novel spinal instrumentation and fusion devices in addition to modern retraction equipment. Consequently, newer methods of MISS such as CBT are being established, and the scope of its effectiveness has increased to include patients with deformity, trauma, spondylolisthesis, and even tumor. The basic aim of MISS is to limit surgical incision and soft tissue damage that is usually associated with open conventional methods. Therefore, MISS achieves superior results in terms of lower postoperative back pain, intraoperative bleeding amount, and postoperative hospitalization period, with improved quality of life. CBT is associated with lesser paraspial muscle atrophy, better improvement in trunk extension strength The incidence of the initial complications and consumption of time reduce [8, 9].

Surgical notes for CBT *(as described by Mori et. al) [10]:*

Exposure of laminae by spinous process splitting then neural decompression with bilateral total facetectomy to achieve wide exposure of the disc space and the neural elements, prevent possible nerve root impingements during preserving the area for PS entry [Fig. 2] [11].

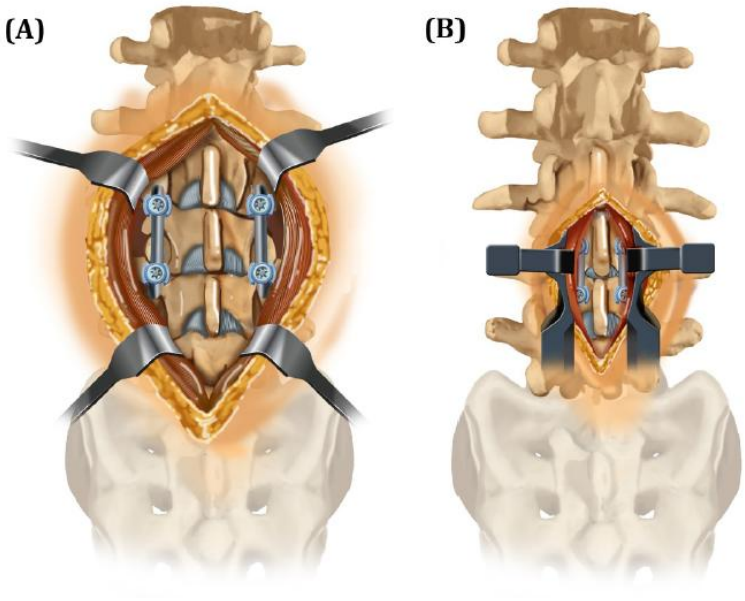

Figure (2): Soft Tissue Exposure Required for One-Level Lumbar Fixation (A) Traditional pedicle fixation. (B) Cortical screw fixation. [11]

Screw diameter is 5.5 mm and length is 35–40 mm are placed under fluoroscopy guidance by CBT. The upper corner of the vertebra in the anterior-posterior view and upper endplate of the posterior one-third area are targeted to gain significant medial-to-lateral and caudal-to-cephalad angle under fluoroscopy control. The screw length measures by inserting a probe along screw trajectory Fig. 3 [1].

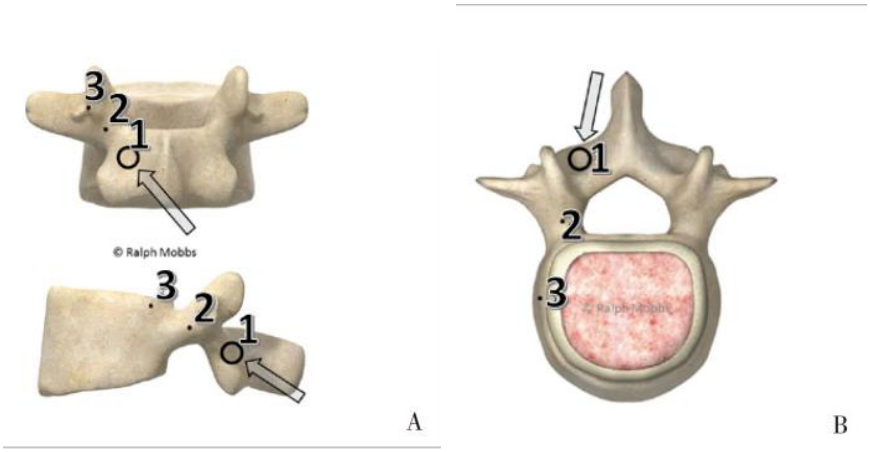

Figure (3): (A) The starting point (pars interarticularis for the CBT (Point 1). Points 2 and 3 demonstrate the trajectories that the surgeon can use during lateral or anteroposterior radiography. **(B)** The axial trajectory(arrow). The screw follows a medial to lateral path, thus avoiding lateral dissection of the paraspinal musculature. [(1)]

Reduction screws are used for slipped vertebrae. The total discectomy consisted of excision of the annulus and cartilaginous end plate performed as much as possible, whereas the osseous end plate was preserved. Bilateral rods inserted to caudal vertebra first, and then the slipped vertebra gently lift by tightening the bilateral rods towards the reduction screws inserted to the cranial slipped vertebra. The screw compress to restore the natural lumbar lordosis figure 4 [(12)].

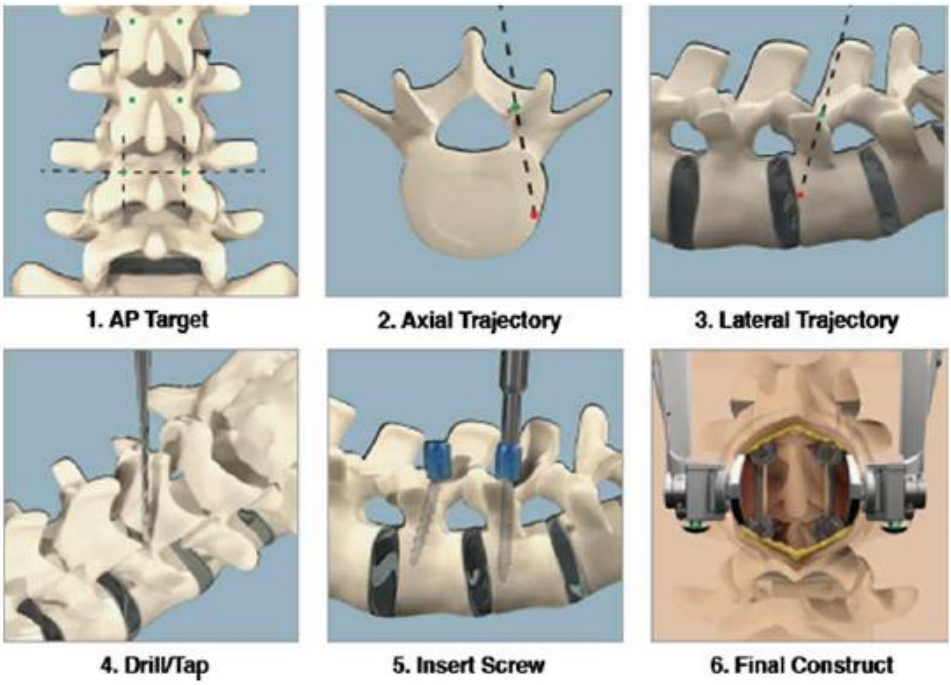

Figure (4): Summary of technique steps of placement of CBT. [12]

Approach-related complications

TT technique is associated with approach-related morbidities that result from iatrogenic soft tissue injury. The long incisions, prolonged wide muscle retraction, injury to the medial branch of posterior ramus of the spinal nerve, can result in ischemic necrosis and denervation of the paraspinal musculature. This may lead to loss of functional muscular support with disturbed segmental mobility and increased biomechanical strain leading to persistent back pain. Severe fat infiltration in the lumbar multifidus muscles was also associated with low back pain in adults **Figure 5 [9].**

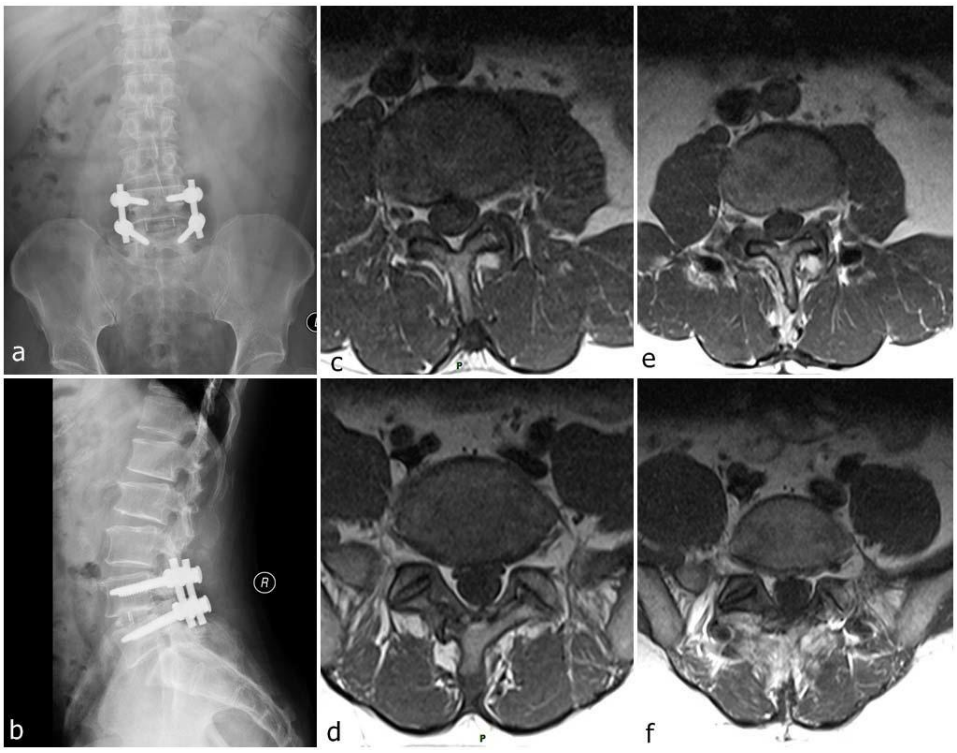

Figure (5): (a) and (b) show plain x-ray findings after TT, (c) and (d) show preoperative MRI findings at the superior and inferior adjacent levels, and (e) and (f) showed postoperative MRI findings at the superior and inferior adjacent levels. Increased fat infiltration is seen on postoperative MRI especially at the inferior adjacent level. [9]

AIM OF THE WORK

A systematic review of literature to Compare the surgical outcomes between Cortical Bone Trajectory and Conventional Pedicle Screw Technique for spinal fusion of Lumbar Degenerative Spondylolisthesis.