VALIDITY OF CORTICAL BONE TRAJECTORY SCREWS TO STABILIZE THE LUMBAR SPINE IN OSTEOPOROTIC PATIENTS

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ABSTRACT:

***BACKGROUND*:** osteoporotic elderly patients with lumbar spine problems needing stabilzation are more likely to be encountered with recently and constitute a major concern to the spine surgeon due to the increased rate of mechanical failure at the osteoporotic spine-implant interface

AIM OF THE STUDY: we tried to evaluate the validity of CBT to stabilize the lumbar spine when indicated in osteoporotic patients from Jnuary 2018 till December 2021 at the Neurosurgery department Benha University Hospital.

***PATIENTS AND METHODS*:** a retrospective study for the medical reports of all patients operated upon by the cortical bone trajectory technique (CBT) to stabilize the lumbosacral spine in osteoporotic patientsfrom Jnuary 2018 till December 2021 at the Neurosurgery department Benha University Hospital.

***RESULTS*:** 20 osteoporotic patients were admitted at the Neurosurgery department Benha University Hospital from Jnuary 2018 till December 2021 with the diagnosis pf lumbar instability that required fixation due to lithesis in 10 patients, recurrent disc herniation in 8 patients and foraminal stenosis in 2 patients. After 24 month nean follow up period there were decrease in VAS for low back pain and fusion occurred in 90 % of patients

***CONCLUSIONS*:** Cortical bone trajectory screws are valid to stabilize the lumbar spine in osteoporotic patients with lumbar instability due to different pathologies.

KEYWORDS: Cortical bone trajectory screws – lumbar instability - osteoporosis

INTRODUCTION

Osteoporotic elderly patients with lumbar spine problems needing stabilzation are more likely to be encountered with recently and constitute a major concern to the spine surgeon due to the increased rate of mechanical failure at the Osteoporotic spine-implant interface[1] and complications such as screw loosening, pullout, pseudoarthrosis or adjacent segment kyphosis are more likely to occur.[2]

The distribution of stressing forces allover the osteoporotic spine could be achieved by combined fixation techniques. It was reported that combination of hooks and pedicle screws (pedicullaminar fixation can increase the pull out strength up to 100%.[3] They can also increase the stiffness of the construct and add to torsional stability in Osteoporotic bone. However, clinical studies utilizing these combined techniques are

limited probably because of the technical difficulties in connecting these supplemental fixation points to the rods between screws instrumented fusions with pedicle screw instrumentation have become the standard of care in spinal fusion surgery. Osteoporotic spine, however, complicates the management. Due to its fragile character, it often causes problems with instrumentation. Early complications such as pedicle and compression fractures and late complications such as pseudarthroses with instrumentation failure, adjacent-level disc degeneration with herniation, and progressive junctional kyphosis as a result of compression fractures have been reported after osteoporotic spine fixation.[4] Hardware loosening or pull-out can occur as a result of micro-motion or injuries orexcessive forces at the bone-metal boundaries.[5] Pseudarthroses asa result of excessive osteoclastic activity over osteoblastic activitywhich happens in osteoporosis can result in longer than usualperiod of stress on the implant and thereby contribute to instrumentation failure.[6] Adjacent level kyphosis can alter the number of levels involved in instrumentation.

In 2009, Santoni et al introduced a novel screw trajectory called cortical bone trajectory technique (CBT). They thought that it will improve initial fixation by optimizing contact of the screw with the cortical bone of the vertebrae, andincreased cortical bone contact providing enhanced screw grip and interface strength in certain indications.[7]

In this study, we tried to evaluate the validity of CBT to stabilize the lumbar spine when indicated in osteoporotic patients from Jnuary 2018 till December 2021 at the Neurosurgery department Benha University Hospital.

PATIENTS AND METHODS:

Type of the study: this is a retrospective study for the medical reports of all patients operated upon by the cortical bone trajectory technique (CBT) to stabilize the lumbosacral spine in osteoporotic patientsfrom Jnuary 2018 till December 2021 at the Neurosurgery department Benha University Hospital.

Preoperative work-up:

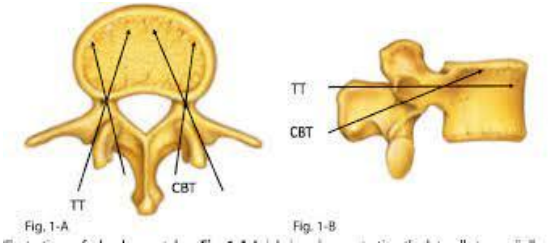
1- History taking.
2- Clinical evaluation: full neurological examination.
3- Radiological evaluuation: static and dynamic X-ray, CT, MRI and DEXA scan.

Operative details:

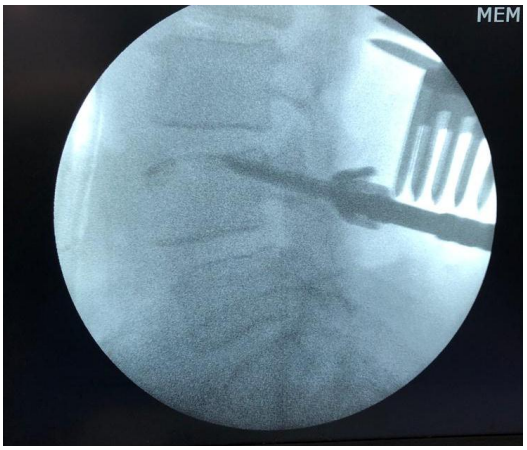
A starting point was defined at the junction of the center of the superior articular facet and a line 1 mm inferior to the inferior border of the transverse process of the lumbar vertebra. Radiographically, the starting point was determined to lie in the 5 o'clock position of the left pedicle

and in the 7 o'clock position of the right pedicle when viewed from the traditional posterior approach. For S1 vertebra, the entry point was located 3mm caudal to the most inferior border of the descending L5 articular process, cranially angulated towards the anterosuperior sacral edge.

The measurements of the track were made from the starting point at the dorsal cortex to the most anterior part of the track, which was formed by a line from the starting point to the midpoint of the pedicle in the mediolateral plane (axial) and the cephalocaudal plane (sagittal) and was extended as ventrally as possible to the vertebral body. This yielded an approximate transverse angle of insertion of 10° and a mean sagittal angle of insertion of 25°. The distance from the screw to the lateral edge of the pars depended on the vertebra, increasing in a caudal direction. For the cephalad vertebral levels, the starting point is about 1 mm from the edge of the pars, which predisposes to a potential pars fracture. However, studies have found that the upper lumbar vertebral levels have a thicker pars than the caudal levels and the bone at the pars is thicker laterally than medially, both mitigating fracture risk



Figs. 1-A and 1-B Illustrations of a lumbar vertebra.[8] Fig. 1-A Axial view demonstrating the laterally to medially directed traditional trajectory (TT) compared with the medially to laterally directed cortical bone track (CBT). Fig. 1-B Sagittal projection showing the straight-forward screw path of TT compared with the caudal to cranial trajectory of the CBT screw.



Figs. 2 intraop fluoroscopic guided L4 CBT screw insertion

Followup:

directly after surgery then at the 3 month, 6 month, 1 year period then annual thereafter including:

1) Clinical evaluation: post-operative back pain using the visual analogue score (VAS), motor power, sensations and sphinteric improvement.
2) Radiological evaluation: dynamic X-ray, CT to evaluate strenght of screw fixation.
3) Complications.

Statistical analysis:

Data are presented as median and range for continuous variables and as frequency for categorical variables. Statistical analysis was carried out with $SPSS_{22}$.Independent Student's *t*-tests were used for continuous variables and the Fisher exact test was used for proportional variables. Two-sided p values < 0.05 were considered to be statistically significant.

RESULTS:

Patients: 20 osteoporotic patients were admitted at the Neurosurgery department Benha University Hospital from Jnuary 2018 till December 2021 with the diagnosis pf lumbar instability that required fixation. Table 1 shows their demographic chriteria:

Table 1: Demographic chriteria

item	
Gender	
• **Male**	2 (10%)
• **Female**	18 (90%)
Age	50 (SD 10)
Mean DEXA T score	1.3 (SD 0.9)
Symptom duration	36 month (SD 12)

Surgical details:

Table 2 shows the indications encountered in this study

Table 2 shows the indications:

Indication	Number (percentage)
Spinal/foraminal stenosis	2 (10%)
Spondylolithesis	10 (50%)
Recurrent disc herniation	8 (40%)

Table 3 shows the spinal levels encountered in this study

Table 3 shows the levels:

Level	Number (percentage)
L_{3-4}	3 (15%)
L_{4-5}	6 (30%)
L_5-S_1	10 (50%)
L_{3-4-5}	1 (5%)

Mean surgical time (minutes): 170 (SD 20)

Mean length of hospital stay (days):3.5(SD 1.25)

Mean blood loss (ml): 320 (SD 50)

Complications:

- deep wound infection requiring good antibiotic covering and surgical debridement occured in one patient.
- No Pars and pedicle fractures
- No screw malposition
- No pseudarthrosis,
- No pulmonary embolism or deep vein thrombosis.
- No extradural hematoma,
- No dural tears,
- No nerve-root injuries,

Follow-up: the mean followup period was 24 months ranging from 12 to 48 months

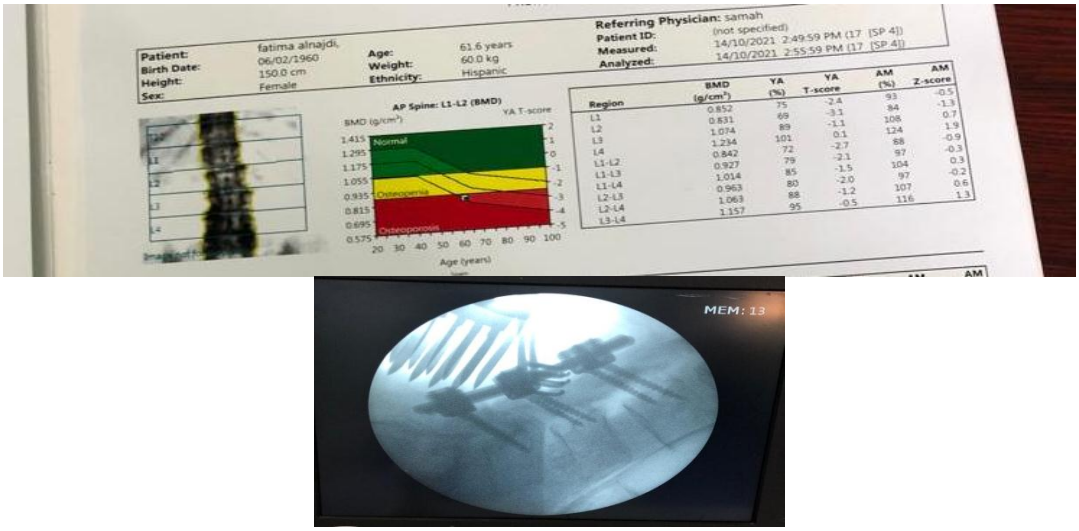
Clinical results: Mean VAS score for low back pain indicated that pain levels at the discharge were significantly lower than preoperative ones decreasing from 7.8 (SD 1.69) to 4.1 (SD 2.32) with a p value < 0.001. The VAS scores at the discharge were also found to be significantly lower 2.2 (SD 0.92) (p = 0.0471)

Radiological results:

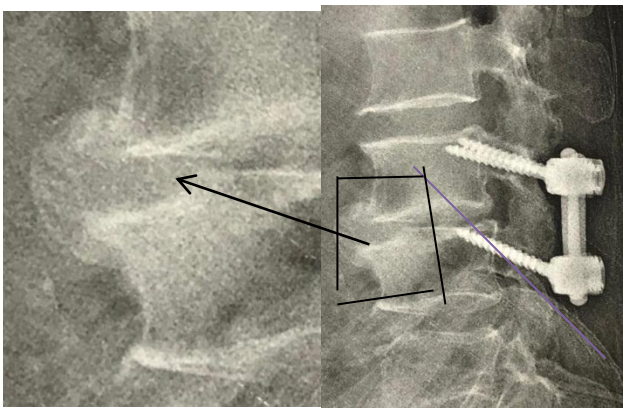
Table 4 shows the radiological outcome obtained at the 12 month followup visit

Table 4: The radiological outcome

Item	**Number (percentage)**
Fusion	18 (90%)
Pull out	1 (5%)
Displacement	1 (5%)
Superior facet violation	0 (0%)



Figs. 3 preop DEXA and introp fluoroscopic guided $L_{3,4,5}$ CBT screws insertion



Figs. 4 fused L3-4 level one year after CBT

DISCUSSION:

There were several trials to improve the pull out strength of pedicle screw like increasing the diameter and length of the screw and an insertion technique with a pilot hole size smaller than the core diameter of the screw and undertapping a pilot hole with varying degrees of success.[9] Owing to the thin cortex of the pedicles, larger screws were found to have limited effect on the fixation strength in osteoporotic bone. Other techniques such as use of longer constructs, supplemental anterior fixation, use of transverse connectors and trangulation techniques, use of laminar hooks or sub-laminar wires have been tried as options.[10] Increasing the number of fixation points is often recommended to distribute stress and improve stability in an osteoporotic spine fixation.[3] It can be either by extending the usual number of levels of fixation or by utilizing additional constructs such as laminar hooks or sub laminar wires in addition to the usual pedicle screw fixation. The laminar hook fixation is not adversely affected by osteoporosis as reported by ***Butler et al.*** in his study. Sub laminar hooks show superior biomechanical stability compared to wires or pedicle screws in osteoporotic thoracic spine.[11]

We did CBT on 20 osteoporotic females 19 single but one triple levels and there were marked improvement in the VAS for LBP from mean 7.8 to 4.1 and a fusion rate 90 % was achieved at the end of our follow up period

Lee et al. compared the cortical trajectory technique with the traditional pedicle screws and found comparable rates of fusion.[12]

Glennie et al. presented a case series of 8 patients with a minimum follow-up of 1 year. Most cases were single-level fusions for degenerative spondylolithesis. The rate of fusion failure was high reaching 50%.[13]

In our study only one patient showed short term wound infection and two patients showed hard-ware failure.

Snyder et al. reported their complication rate for 79 patients who underwent cortical bone screw fixation for degenerative disease. Image guidance was used for 87% of cases, with 81% of cases fused with an interbody device. The rate of complication was 8.9% (9 complications in 7 of 79 patients).[14,15]

Until recently, cortical screw use had been limited to the lumbar spine. Matsukawa et al. have proposed a cortical screw track in both the sacrum and the lower thoracic spine.

Matsukawa et al. introduced a thoracic cortical bone track for use from T9 to T12, with more cephalad levels being too unsafe for adequately sized cortical screw placement given the pedicle dimensions.[15]

CONCLUSIONS:

Cortical bone trajectory screws are valid to stabilize the lumbar spine in osteoporotic patients with lumbar instability due to different pathologies.

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الملخص العربي

فاعلية تثبيت الفقرات القطنية بطريقة التوجيه ناحية العظم القشري علي المرضي ذوي هشاشة العظام

الخلفية العلمية: ان المرضي كبار السن ولديهم هشاشة بالعظام ويعانون من مشكلة ما بالعمود الفقري تحتاج الي تثبيت قد تزايد اكتشافهم في الفترة الاخيرة وهم يمثلون اهمية لدي الجراحين حيث انهم معرضون للفشل الميكانيكي علي مستوي تماس العمود الفقري الهش والوحدة المزروعة

الهدف من الدراسة: تقييم فاعلية التثبيت بطريقة التوجيه ناحية العظم القشري علي المرضي ذوي هشاشة العظام وذلك في مستشفي بنها الجامعي في الفترة من يناير ٢٠١٨ حتي ديسمبر ٢٠٢١

المرضي ووسائل الدراسة: دراسة مرجعية لملفات ٢٠ مريض

النتائج: بعد ٢٤ شهر من المتابعة في المتوسط قل مستوي الالم وحدث الالتخام في ٩٠% من المرضي

الخلاصة: هذه الطريقة فعالة لعلاج هذه الفئة من المرضي