Introduction

- Cortical bone trajectory (CBT) pedicle fixation is a novel technique for instrumentation in spinal disorders.
- This fixation method maximizes screw and cortical bone contact with a medical to lateral path, instead of traversing the pedicle anatomically, seen in the traditional method (Figure 1).
- Some of the benefits of this technique are:
  - Less invasive
  - Comparable or superior mechanical properties.
- There is limited data on accuracy of screw placement, complications, and learning curve of this technique.

Methods

- Adult (age >18 y.o) patients with lumbar degenerative disease and spinal instability were prospectively enrolled.
- All patients underwent posterior lumbar decompression and fusion with CBT screw fixation by the senior author.
- Patients with pedicle diameter <7 mm were excluded to prevent introduction of lateral vertebral body breach.

Outcome Measurements:
- Accuracy of screw placement
- Technique-related and overall complication rates
- Effect of learning curve on CBT screw placement.

Results: Screw Accuracy and Complications

- 22 patients were enrolled in the study.
- 30 vertebral levels were fused with total of 100 screws placed.
- Accuracy of CBT screw placement was divided into 3 categories:
  1) Medial Vertebral Body Breach (Figure 2.A-C)
  2) Lateral Vertebral body breach (Figure 2.D)
  3) Accurate Screw Placement

Figure 1. (A and B) Traditional pedicle screw trajectories in (A) axial and (B) sagittal views. (C and D) Cortical screw trajectories in (C) axial and (D) sagittal views.

Figure 2. (A-C) axial imaging for 3 different cases of medial pedicle breach. (D) Imaging findings of lateral pedicle breach, indicated by the arrow.

Figure 3. Frequency distribution of cortical screw placement based on accuracy reported by evaluation of post-op CT scan.

Figure 4. Frequency distribution of stimulus evoked thresholds for 100 screws using CBT fixation. False positive and false-negative rate were 0%, 6% respectively. All the screws with a medial breach on CT imaging had stimulation threshold values of 11-24 mA. Seven screws stimulated at threshold values <7 mA with no evidence of medial breach on imaging.

Table 1. Technique-related Complications and their Incidence

<table>
<thead>
<tr>
<th>Complications</th>
<th>N(%)</th>
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<tbody>
<tr>
<td>CSF leak due to hardware placement</td>
<td>1(4.5)</td>
</tr>
<tr>
<td>Surgical Site Infection</td>
<td>3(13.6)</td>
</tr>
<tr>
<td>Hardware Misplacement/Malfunction</td>
<td>0(0)</td>
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</tbody>
</table>

Table 2. Learning Curve and its Implications on Clinical Outcomes

<table>
<thead>
<tr>
<th>Screw Accuracy</th>
<th>Early Experience</th>
<th>Late Experience</th>
<th>P Value</th>
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<tbody>
<tr>
<td>Medial Breach</td>
<td>4</td>
<td>2</td>
<td>0.42</td>
</tr>
<tr>
<td>Lateral Breach</td>
<td>1</td>
<td>0</td>
<td>0.48</td>
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</tbody>
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Complications

| CSF Leaks    | 1     | 0     | 0.48 |
| Surgical Site Infection | 2     | 1     | 0.61 |

Conclusion

- CBCT screw fixation is a novel alternative to traditional pedicle fixation with increasing popularity due to being minimally invasive and having comparable biomechanical properties.
- Inaccurate screw placement indicators including medial and lateral breaches have low incidence rate.
- Neuro-monitoring can provide additional information about accuracy of screw placement and should be used intra-operatively to improve surgical outcomes.
- With increasing experience and modified surgical technique, the incidence of inaccurate screw placements and complications decreased. Although this difference did not reach significance.

Future Directions

- Future studies should aim to identify surgical modifications to this technique to reduce the incidence of inaccurate screw placement and complications. Moreover, future studies should investigate the impact of fluoroscopic guidance vs. intraoperative CT guided CBCT on screw accuracy, surgical time and surgical complications.

References