THREE-DIMENSIONAL PRINTED DRILL GUIDES VERSUS FLUOROSCOPIC-GUIDED FREEHAND TECHNIQUE FOR PEDICLE SCREW PLACEMENT: A SYSTEMATIC REVIEW AND META-ANALYSIS OF RADIOGRAPHIC, OPERATIVE AND CLINICAL OUTCOMES

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Study Design: Systematic review and meta-analysis.

Objective: To compare surgical, clinical, and radiographic outcomes of three-dimensional printed (3DP) drill guides to fluoroscopic-guided, freehand placement of pedicle screws in cervical, thoracic, and lumbar spine.

Summary of Background Data: 3DP is a budding technology in spine surgery. Initially utilized for pre-operative planning using 3DP biomodels, the technology has recently been applied to 3DP drill guides for pedicle screw placement. Several authors have demonstrated the benefits of these drill guides on operative, clinical, and radiographic outcomes over the last three years. Though still in its infant stages, additive manufacturing has shown immense promise. The technology’s accessibility and customization can help to placate the cost, complexity and often patient-specific needs of spine surgery.

Methods: A comprehensive search of the literature was conducted using Ovid MEDLINE, Embase, and Scopus, which resulted in 1801 unique articles. Two independent reviewers (NW, BB) assessed eligibility and risk of bias for included studies. The following outcomes were analyzed: total operation time, estimated blood loss, screw accuracy (as measured using the Richter grading scale), pain score, Japanese Orthopedic Association (JOA) score, and post-operative complications. Weighted mean differences (WMD) and weighted risk differences (WRD) were calculated using a random-effects model.

Results: Six studies with a total of 205 patients were included in the meta-analysis. There was a significantly lower operation time (WMD = -32.32 min, 95% CI = -53.19 to -11.45) and estimated blood loss (WMD = -51.42 mL, 95% CI = -81.12 to -21.72) in procedures performed with 3DP drill guides as compared to freehand technique. In addition, probability of ‘excellent’ screw placement was significantly higher in 3DP guides versus freehand (WRD = -0.12, 95% CI = -0.17 to 0.07); however, no differences were observed in ‘poor’ and ‘good’ screw placement. There was no significant difference between 3DP and freehand groups in pain scores or JOA scores at baseline and one-year follow up. There was also no group difference in rates of surgical complications.

Conclusion: Results of our meta-analysis indicate that pedicle screws placed with 3DP drill guides result in shorter operative time, less blood loss, and greater probability of excellent screw placement as compared to pedicle screws placed with conventional, freehand technique. Similar clinical outcomes and post-operative complication rates were seen in both groups. We conclude that 3DP drill guides can offer a more efficient and accurate option for pedicle screw placement in challenging spinal anatomy.