

Effectiveness of 3-D printing in customizing spinal cord stimulator lead placement: a systematic review and meta-analysis

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Introduction:

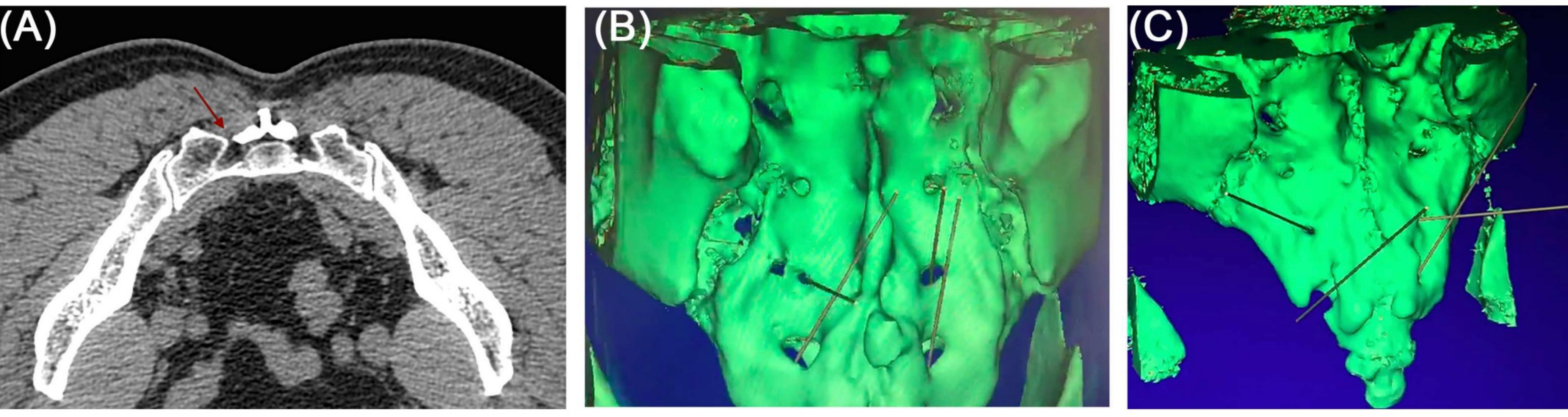
- Spinal cord stimulation (SCS) can be an effective therapy for managing many types of pain, including chronic neuropathic pain.
- Customizing the placement of the SCS leads is critical to achieving optimal pain relief outcomes and minimizing complications
- 3D printing has emerged as a promising modality to create patient-specific models to aid in individualized lead placement.
- This study aims to assess the effectiveness of 3D printing in customizing SCS lead placement and its impact on pain relief outcomes and procedural success.

Materials & Methods:

- The inclusion criteria encompassed studies that evaluated the use of 3D printing technology for creating patient-specific models for SCS lead placement customization.
- Case reports, case series, cohort studies, and randomized controlled trials were eligible for inclusion.
- The main outcome measures included pain relief measures (visual analog scale, numeric rating scale), procedural success rate, and complication rate.

Pain relief outcomes and procedural success rates improved with patients who underwent spinal cord stimulator lead placement using 3D printing technology compared to conventional methods.

FIGURE: (A) CT image showing right S3 stenosis. B: Reconstructed image showing an abnormal angle of the virtual puncture line via the right S3 foramina. C: Reconstructed image showing bilateral S3 foraminal stenosis and an abnormal angle of the virtual puncture line.



Zhang J, Zhang P, Wu L, et al. Application of an individualized and reassemblable 3D printing navigation template for accurate puncture during sacral neuromodulation. *Neurourol Urodyn.* 2018;37(8):2776-2781. doi:10.1002/nau.23769

Results:

- The initial search identified 10 eligible studies for inclusion in the systematic review. Of these, 5 studies were suitable for the meta-analysis.
- Improvement in pain relief outcomes in patients who underwent SCS lead placement using 3D printing technology compared to conventional lead placement methods (pooled effect size -0.76, 95% confidence interval -1.21 to -0.32).
- Higher procedural success rate in the 3D printing group (pooled effect size 0.67, 95% confidence interval 0.29 to 1.06).
- Complication rate was comparable between the 3D printing and control groups (pooled effect size 0.12, 95% confidence interval -0.26 to 0.50).

Discussion:

- The use of patient-specific models allowed for pinpoint preoperative planning.
- This resulted in improved pain relief outcomes and increased procedural success rates.
- 3D printing allows a level of customization that ensures better lead positioning. This optimizes the distribution of electric fields and targets specific pain pathways.
- Furthermore, 3D printing encourages patient-focused healthcare by enabling patients to better understand the procedure and be more involved.
- Due to the limited number of studies, further robust research including an increased number of studies, larger sample sizes, and longer follow-up periods is needed.

References

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4. Zhang J, Zhang P, Wu L, et al. Application of an individualized and reassemblable 3D printing navigation template for accurate puncture during sacral neuromodulation. *Neurourol Urodyn.* 2018;37(8):2776-2781. doi:10.1002/nau.23769