The Accuracy of Facet Injections Using Bone-Enhanced Ultrasound with a CT-Trained Artificial Intelligence Algorithm

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Aims: Ultrasound (US)-guided facet injections (FIs) have been explored as an alternative to fluoroscopy or CT guidance due to concerns about their cost and radiation exposure. In several studies, US-FIs have demonstrated comparable accuracy to CT (86.5%) [1], but meta-analyses have highlighted limitations in US regarding resolution, depth penetration, and precise placement for targeted anatomy [2]. We aim to investigate the potential of the SpineUs™ system, which creates a 3D reconstruction of the cortical surface of the spine, to enable accurate needle placement.

Materials and Methods: A controlled, virtual experimental study was designed to assess the accuracy of simulated FIs in T12-L1 through L3-4 using the SpineUs™ system models. We did not perform landmarking on L4-5 due to patient convenience. Three Interventional Radiologists and nine patient models were randomly selected. The radiologist was instructed to place the simulated needle into the facet joint of each patient's SpineUs™ 3D spine reconstructions. The CT was used as the ground truth for the needle placement. The outcome was the accuracy of needle placement at the target compared to standard positioning determined by an independent evaluator.

Figure 1: Image of the ultrasound probe and positioning belt being used to generate theSpineUs™ models (left) and image of the infrared cameras utilized to localize the position of the ultrasound probe (right)

Results:

Joint	T12/L1	L1/L2	L3/L4
Accuracy	74%	83%	81%

Table 1: Success Rates of FIs

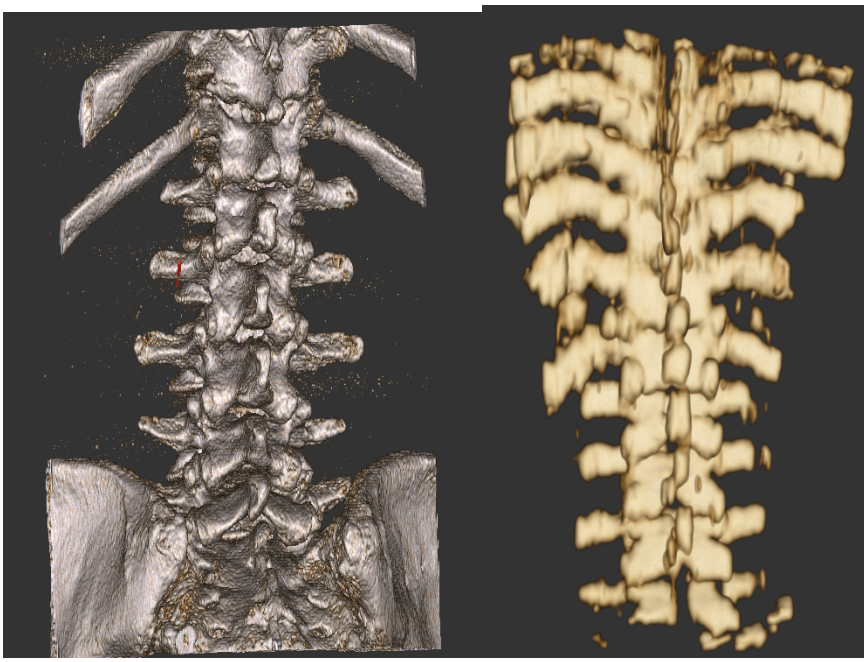

Figure 2: A comparison of a CT-generated model (left) versus a BEUS-image CT-AI-generated model of the spine

Conclusion: We conclude that SpineUs™ 3D spine reconstruction images are a potential innovation in facet injections that are accurate, effective, and harm-reducing. Currently, fluoroscopic-guided methods are the most precise method for lumbar FIs.[3] Despite its widespread use, concerns about its cost and radiation exposure persist. US-guided FIs may serve as an alternative. However, no complete synthesis has demonstrated the superiority or inferiority of this technique.[4] US-guided interventions may have advantages, offering real-time visualization, avoidance of radiation, reduced procedural costs, and reduced infrastructure costs.[4] Future studies should aim to improve SpineUs™ 3D spine reconstruction images to improve accuracy and reduce variability in US-guided procedures.

References

{1} Ye L, Wen C, Liu H. Ultrasound-guided versus low-dose computed tomography scanning guidance for lumbar facet joint injections: same accuracy and efficiency. BMC Anesthesiol. 2018;18(1):160. Published 2018 Nov 7. doi:10.1186/s12871-018-0620-7

{2} Ashmore ZM, Bies MM, Meiling JB, et al. Ultrasound-guided lumbar medial branch blocks and intra-articular facet joint injections: a systematic review and meta-analysis. Pain Rep. 2022;7(3):e1008. Published 2022 May 16. doi:10.1097/PR9.0000000000001008

{3} Won HS, Yang M, Kim YD. Facet joint injections for management of low back pain: a clinically focused review. Anesth Pain Med (Seoul). 2020;15(1):8-18. doi:10.17085/apm.2020.15.1.8

{4} Hofmeister, M., Dowsett, L.E., Lorenzetti, D.L. *et al.* Ultrasound versus fluoroscopy-guided injections in the lower back for the management of pain: a systematic review. *Eur Radiol* **29**, 3401–3409 (2019). https://doi.org/10.1007/s00330-019-06065-3