

Artificial Intelligence Virtual Reality (AI-VR) Training for Interventional Pelvic Cancer Pain: Superior Hypogastric Block

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BACKGROUND

Pelvic cancers, including ovarian, cervical, uterine, and colorectal cancers, can cause severe and refractory pain that traditional approaches may fail to adequately address (1). Superior hypogastric block (SHB) can provide targeted relief by interrupting pain signal transmission from pelvic organs through the superior hypogastric plexus (2). Despite its efficacy, there is a gap in research and training resources for this procedure. We propose a multilingual artificial intelligence (AI) and virtual reality (VR) training module focusing on interventional pelvic cancer pain procedures, with an emphasis on SHB, to improve training efficacy and accessibilities for diverse learners at a global scale.

METHODS

This proof of concept Artificial Intelligence Virtual Reality (AI-VR) module sources high-quality 2D fluoroscopy images from a reputable peer-reviewed journal to serve as foundational visual references for understanding anatomical structures and procedural techniques [3]. Concurrently, 3D models of the spine and ribs, coupled with grayscale enhancements, offer a three-dimensional perspective, enhancing depth perception and anatomical comprehension. The live editing tool provided by a virtual reality software allows instructors and learners to dynamically draw the trajectory of needles directly onto the 3D models. This hands-on approach facilitates a deeper understanding of procedural techniques and fosters interactive learning experiences. Additionally, AI generated voice narration, real-time subtitles, multi-language support for diverse learner populations, and the creation of randomized multiple-choice questions based on the VR module to reinforce the training.

RESULTS

The integration of AI-VR modules enables learners to immerse themselves in simulated environments, where they can practice needle insertion procedures. Trainees are able to be immersed in the virtual environment and guided through the procedures, allowing them to practice C arm adjustments, needle placement, and technique refinement in a realistic setting. The preliminary findings of the proof of concept video highlighted the potential effectiveness of AI-VR in facilitating procedural training among physicians. Trainees can increase confidence and proficiency in performing fluoroscopy guided thoracic symphonic block and radiofrequency ablation after engaging with the simulation. Additionally, the video emphasized the potential of AI-VR to standardize training protocols, reduce the need for cadaveric specimens, and overcome the limitations of traditional teaching methods to increase access to education in underserved areas with limited specialists. These modules also incorporate randomized generated multiple-choice questions to reinforce learning objectives and assess competency effectively. By utilizing AI-VR tools enhanced by artificial intelligence technology, educators can create comprehensive and dynamic learning experiences that cater to the diverse needs of healthcare professionals, ultimately improving patient care outcomes through enhanced training and skill development.

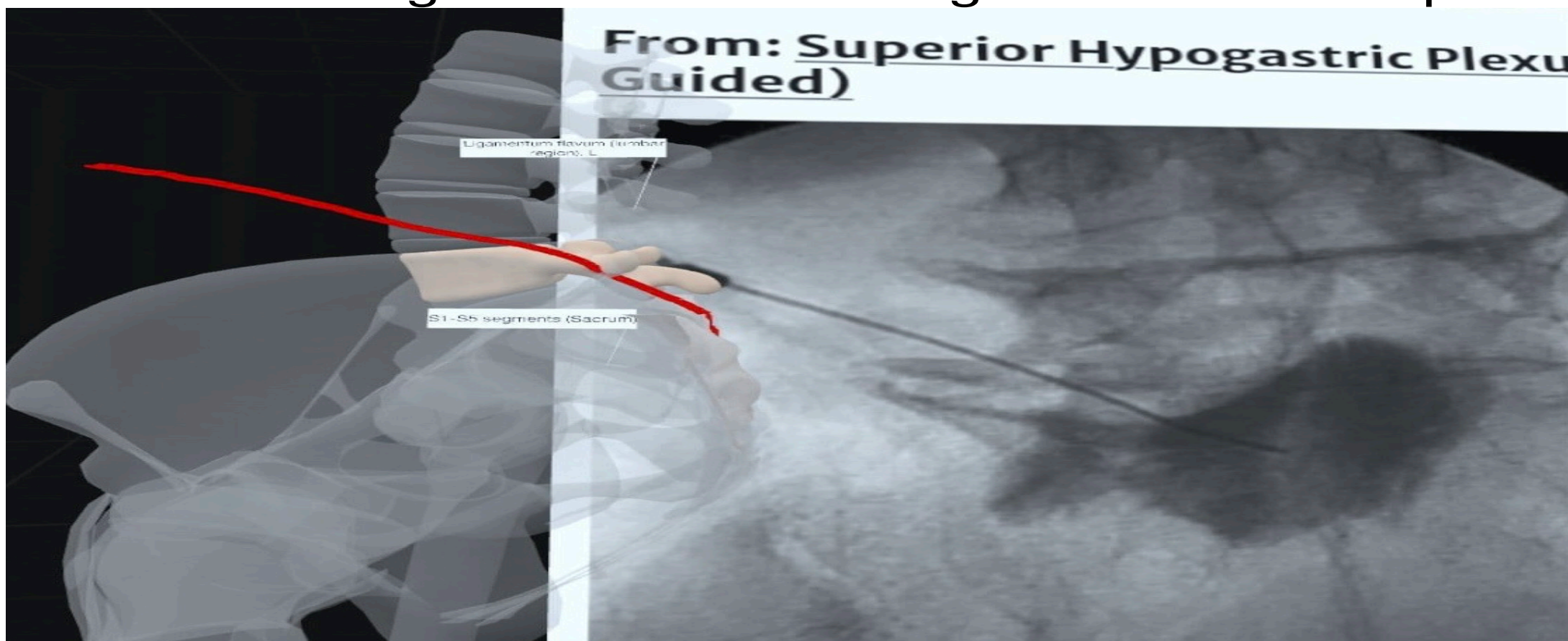


Figure 1. The contrast medium spread in the shape of a mountain along the anterior margins of the L5 vertebra and the sacrum in the lateral view

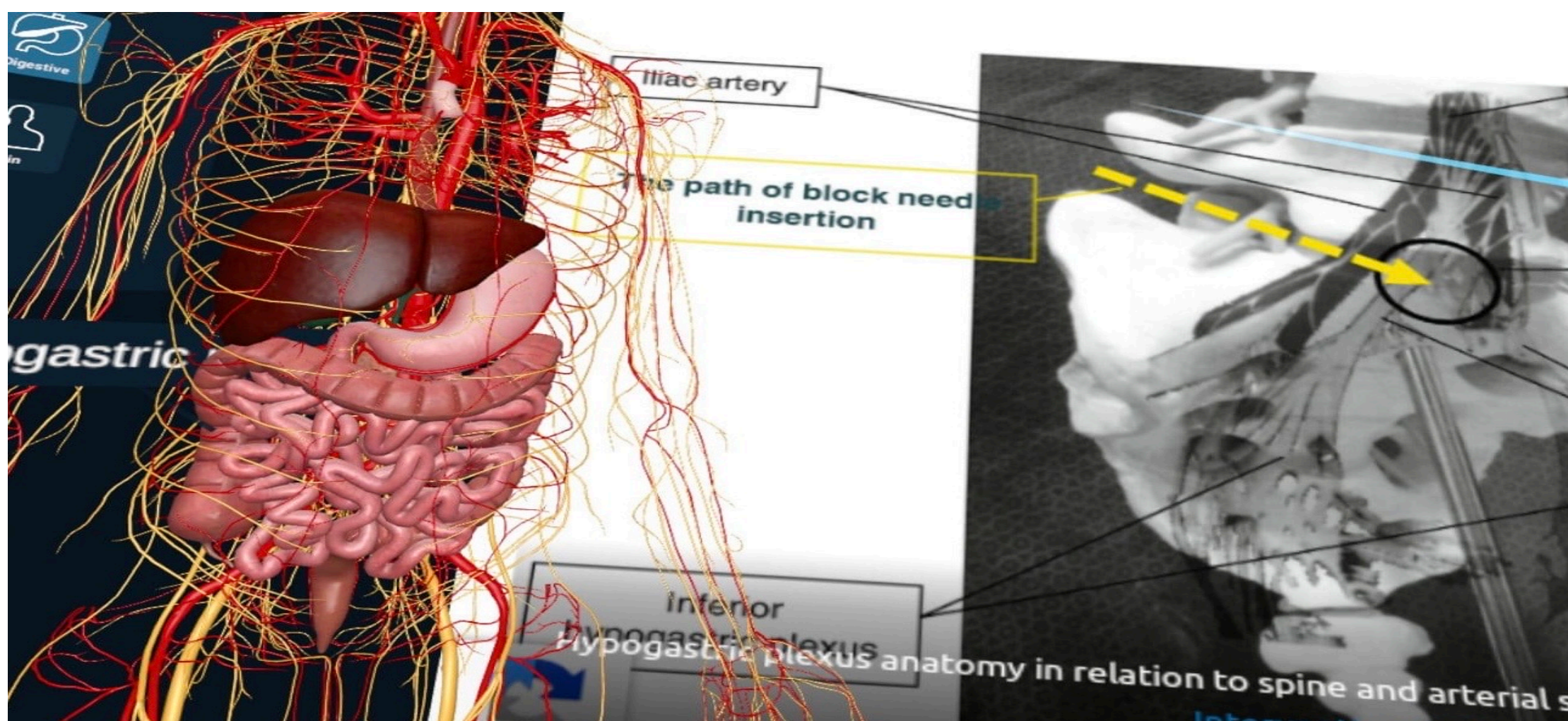


Figure 2. Reviewing the anatomy: SHPB lies anterior to the L5 and S1 vertebra

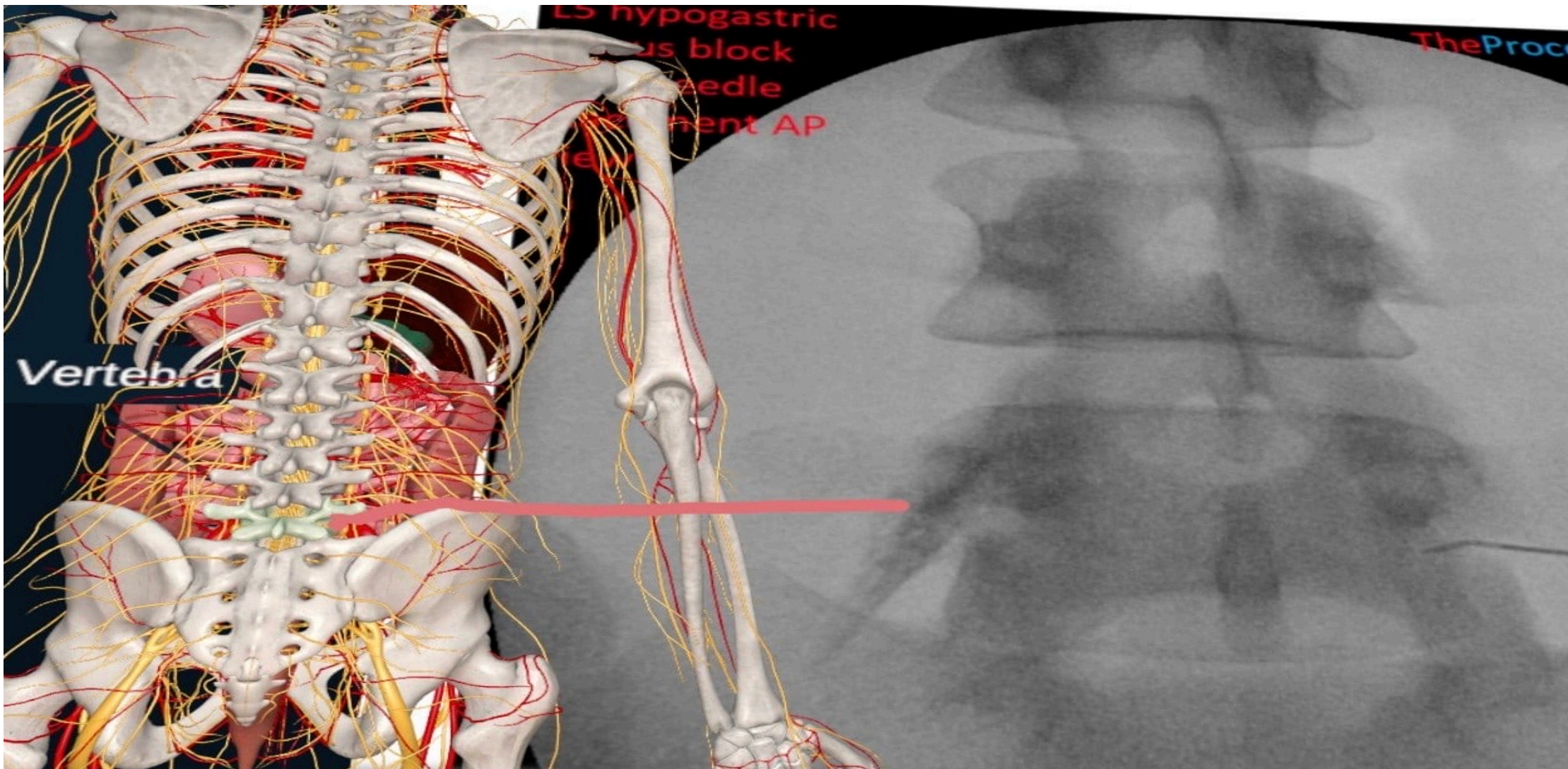


Figure 3. L5 hypogastric block at the AP view

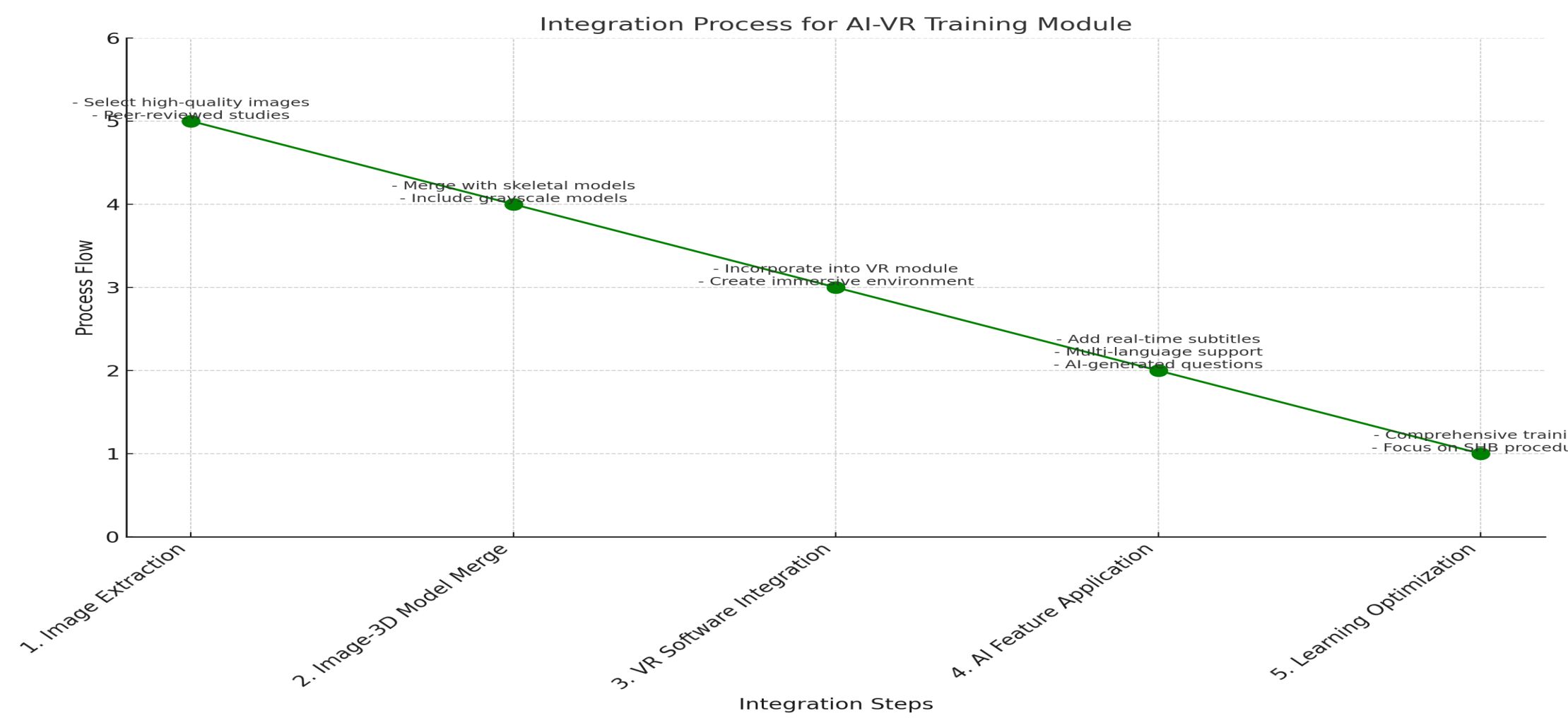


Figure 4. Integration Process for AI / VR Training Module

AI GENERATED QUESTIONS

1. What is the goal of patient positioning for the procedure described?

- a) Needle at the posterior border of L5 on a lateral view
- b) Needle at the anterior border of L5 on a lateral view
- c) Needle at tip at the midline border of L5 on an AP view
- d) Needle at the lateral border of L5 on an AP view

2. Where is the entry point for needle insertion during the procedure?

- a) Medial to inferolateral corner of vertebral body
- b) Lateral to inferolateral corner of vertebral body
- c) Anterior to inferolateral corner of vertebral body
- d) Posterior to inferolateral corner of the vertebral body

CONCLUSION

This proof of concept module highlighted the potential of VR technology synergized with AI in interventional pain education, signaling a possible paradigm shift in physician training. This innovative approach not only bridges the gap between theory and practice but also equips physicians with the confidence and proficiency needed to deliver improved patient care in the field of pain management, ultimately enhancing treatment outcomes and quality of life for patients. While promising, it also has limitations such as potential biases in AI algorithms due to non-representative training data, and the limitations of simulations to fully replicate real-life tactile feedback and complexities. Additionally, high costs may limit accessibility in resource-constrained settings. Future directions should focus on including diverse datasets, conducting randomized controlled trials to evaluate effectiveness, building c arm 3D models, and developing cloud-based VR platforms for broader access. Addressing these aspects will enhance the module's efficacy, accessibility, and impact on physician training and patient care outcomes.

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