MAYO CLINIC

THA-NET is a next-generation total hip arthroplasty (THA) AI-based templating tool that can generate synthetic radiographs graded higher on ultimate surgical execution than real radiographs.

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THA-Net: A Deep Learning Solution for Next Generation Templating and Patient-Specific Surgical Execution

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INTRODUCTION

- This study introduces THA-Net, a deep learning (DL) inpainting algorithm for simulating postoperative total hip arthroplasty (THA) radiographs from a single preoperative pelvis radiograph input while being able to generate predictions either unconditionally (algorithm chooses implants) or conditionally (surgeon chooses implants).
- THA-Net was intended to be a next-generation THA templating tool with no to minimum inputs required from the operating surgeons.

METHODS

THA-Net is a denoising diffusion probabilistic model (DDPM), which receives an input preoperative radiograph, and subsequently inpaints the target hip joint with THA implants to generate a synthetic yet realistic postoperative radiograph. We trained THA-Net on 356,305 pairs of radiographs from 14,357 patients from a single institution's total joint registry and evaluated the validity (quality of surgical execution) and realism (ability to differentiate real and synthetic radiographs) of its outputs against both human-based and software-based criteria.

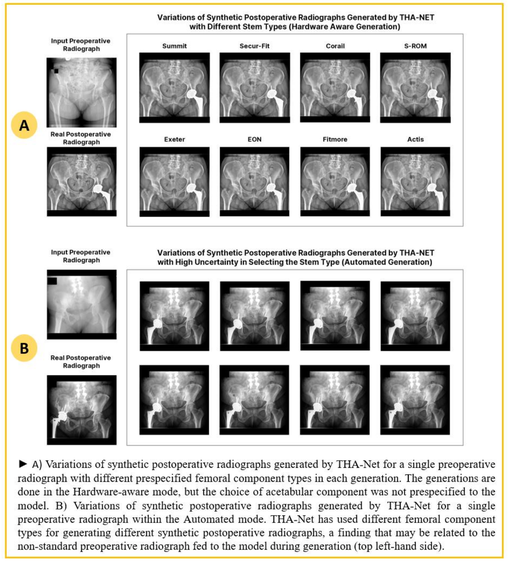
RESULTS

- The surgical validity of synthetic postoperative radiographs was significantly higher than their real counterparts (mean difference: 0.8 and 1.1 points on a 10-point Likert scale for automated and hardware-aware generations, respectively; p< 0.001).
- Real and synthetic radiographs were not able to be differentiated in terms of realism in blinded expert review.
- On average, reviewers rated the synthetic radiographs as realistic in 95% of hardware-aware generations and in 98% of automated generations.
- Synthetic images showed excellent validity and realism when analyzed with already-validated software.

CONCLUSION

- We developed a THA next-generation templating tool that can generate synthetic radiographs graded higher on ultimate surgical execution than real radiographs from training data.
- Further refinement of this tool may potentiate patient-specific surgical planning and enable technologies such as robotics, navigation, and augmented reality.

FIGURE



► A) Variations of synthetic postoperative radiographs generated by THA-Net for a single preoperative radiograph with different prespecified femoral component types in each generation. The generations are done in the Hardware-aware mode, but the choice of acetabular component was not prespecified to the model. B) Variations of synthetic postoperative radiographs generated by THA-Net for a single preoperative radiograph within the Automated mode. THA-Net has used different femoral component types for generating different synthetic postoperative radiographs, a finding that may be related to the non-standard preoperative radiograph fed to the model during generation (top left-hand side).

CONTACT

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