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Response to "Letter Regarding: Intraoperative Effect of 2D vs 3D Fluoroscopy on Quality of Reduction and Patient-Related Outcome in Calcaneal Fracture Surgery"

Dear Editor,

We thank Dr. Richter for taking an interest in our paper, which is the first randomized controlled trial of its kind, and recounting his *expert opinion* on the matter at hand.[7]

The hypothesis when initiating the EF3X trial was that the use of intraoperative 3-dimensional (3D) imaging would improve radiological results as well as patient-reported outcomes after operative treatment of calcaneal fractures.[4] As Dr. Richter appropriately remarked, more corrections were performed after the use of 3D imaging, which corresponds to our own findings and the current literature.[2,3]

While it may feel great for the operating surgeon to intraoperatively correct flaws detected on 3D imaging there is no scientific evidence that the number of intraoperative corrections benefit our patients. In the study of Kendoff et al,[8] postoperative CT scans were performed after using intra-operative 3D imaging; however, these scans were not systematically evaluated by a panel. Additionally, 5 patients (out of 129) underwent a revision surgery nonetheless. In our trial, we performed a systematical and blinded evaluation of postoperative CT scans of all our randomized patients. The overall radiological outcomes of reduction were comparable to those found in the literature.[1,5,6] In addition, we also described the quality of fixation resulting in quite a number of required revisions. However, between the 2 randomized groups no differences could be found in terms of postoperative complications, quality of life, functional outcome, or posttraumatic osteoarthritis.

Our randomized clinical trial was conducted after 2 years of prior experience with intraoperative 3D imaging by surgeons with extensive experience in calcaneal fracture surgery. Therefore, we believe a learning curve did not bias our results. In our study, patients were allocated to a 2-dimensional (2D) or 3D group. When patients were allocated to the 2D group, an intraoperative 3D scan was performed at the end of the procedure, but the operating surgeon was not allowed to see this 3D scan. In Figure 1 of our paper, a 3D scan of a patient allocated to the 2D group was shown. This patient required revision surgery, which might have been prevented had this patient been allocated to the 3D group. And even though this was a prime example to demonstrate the possible benefit of intraoperative 3D imaging, it was the only case in the 2D group requiring revision surgery because of inadequate reduction.

We transparently described our unexpected study results showing that intraoperative 3D fluoroscopy prolonged the procedure without improving the quality of reduction and fixation and had to reject our hypothesis. Still, with high percentages of intraoperative corrections, mainly implant related, it is likely that 3D fluoroscopy has some form of advantage. Future studies should elucidate such and report these advantages by (time-consuming) transparent and systematic evaluation of the operative results (and patient-reported outcome) rather than mere expert opinion. New techniques require critical (preferably randomized) evaluation to determine actual patient benefit. This may, however, prevent "tech" from being used as "toys for boys" if results fail to pass muster.

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Declaration of Conflicting Interests

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