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Surgical outcomes of minimally invasive hallux valgus correction using 3D-printed patient-specific instrumentation: A prospective case series

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Introduction: Fourth-generation minimally invasive surgery (MIS) for hallux valgus (HV) provides recognized advantages over open techniques but remains technically demanding, with a steep learning curve and dependence on fluoroscopy. Three-dimensional (3D) printing enables the development of patient-specific guides that translate CT-based preoperative planning into the operating room, potentially improving surgical accuracy and efficiency.

Methods: This prospective single-center case series follows a predefined protocol (planned sample size 20; 3-month follow-up). An interim analysis was performed on the first eight consecutive patients (14 feet; six bilateral) undergoing primary fourth-generation metaphyseal extra-articular transverse and Akin osteotomy (META) using a CT-based 3D-printed guide. Preoperative DICOM data were segmented to generate 3D models, and osteotomy level, metatarsal translation, and screw trajectories were digitally planned. Guides were produced in biocompatible resin using stereolithography and sterilized prior to surgery. Operative time, fluoroscopy use, radiographic correction (HV angle [HVA], intermetatarsal angle [IMA]), and clinical outcomes (VAS pain, AOFAS score) were recorded.

Results: Eight patients (mean age 45.6 ± 14.8 years) comprising 14 operated feet were analyzed. Mean operative time was 32.2 ± 3.8 minutes per foot. Mean fluoroscopy shots were 68.6 ± 8.4, with a mean radiation dose of 1.64 ± 0.30 mGy. HVA improved from 26.8° ± 6.3° to 6.3° ± 5.0°, and IMA from 10.4° ± 2.8° to 4.4° ± 2.7° at three months. VAS pain decreased from 7.1 ± 0.9 to 0.2 ± 0.6, and AOFAS score increased from 67.4 ± 8.9 to 98.6 ± 3.6.

Conclusion: In this interim prospective series, fourth-generation MIS HV correction using CT-based 3D-printed patient-specific guides demonstrated acceptable operative times, low radiation exposure, substantial radiographic correction, and marked early improvements in pain and function.

Keywords: Minimally invasive surgical procedures; Printing, three-dimensional; Hallux valgus.

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