**The Value of 3D-Printed Models and Virtual Reality in Understanding Acetabular Fractures**

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**Purpose:** Acetabular fractures are complex and difficult to classify. Although the Judet-Letournel classification is designed to increase the understanding of acetabular fractures, it remains prone to error when using conventional medical imaging. We hypothesize that 3-dimensional (3D) printing and virtual reality (VR), as new diagnostic imaging tools, will lead to an increased understanding and knowledge about the acetabular fracture and surgical approach.

**Methods:** Digital data (DICOM [Digital Imaging and Communications in Medicine]) of 20 acetabular fractures was converted into 3D files (STL [stereolithography] data). These STL files were used to prepare 3D prints of life-size hemi-pelvic models with acetabular fractures and files for a mobile VR headset. Seven senior trauma surgeons specialized in pelvic and acetabular surgery, 5 young fellowship-trained trauma surgeons, 5 senior surgical residents, 5 junior surgical residents, and 5 interns classified 20 acetabular cases using radiographs/2D CT, 3D reconstructions, 3D printing, and VR according to the Judet-Letournel classification. Furthermore, all junior and senior surgeons were instructed to evaluate their surgical approach and positioning of the patient during operation. Time to classify each case was recorded. Calculations were done using Fleiss kappa statistics.

**Results:** Only slight and fair interobserver agreements for senior surgeons ($\kappa = 0.33$) and interns ($\kappa = 0.16$) were found when using radiographs/2D CT. However, 3D printing showed moderate and substantial interobserver agreements for senior surgeons ($\kappa = 0.59$), junior surgeons($\kappa = 0.56$), senior surgical residents ($\kappa = 0.66$), junior surgical residents ($\kappa = 0.51$), and interns ($\kappa = 0.61$), while VR showed a clear decrease in interobserver agreements for senior surgeons ($\kappa = 0.42$). Compared with radiographs/2D CT, the interobserver agreements on the surgical approach for junior surgeons using 3D printed models and VR increased, respectively, $\kappa = 0.04$, $\kappa = 0.23$, and $\kappa = 0.17$. Except for the interns, a significant time difference between radiographs/2D CT and 3D CT - 3D print - VR was found for junior and senior surgical residents and junior and senior surgeons ($P < 0.001$).

**Conclusion:** 3D printing is of added value in understanding, classification, and surgical evaluation of acetabular fractures, whereas VR is of added value for the future generation trauma surgeons. We recommend implementation of 3D printed models and VR into trauma surgery training.



See pages 401 - 442 for financial disclosure information.