Pelvic Ring Injuries

Subjects: Orthopedics

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Pelvic ring injuries have an estimated annual incidence of 14–37 per 100,000 inhabitants each year. Treatment can be either non-operative or operative, depending on the injury as well as patient characteristics. The operative treatment of pelvic ring injuries remains a challenging task for surgeons due to the complex three-dimensional (3D) shape of the pelvis, morphological variations, limited access to fracture sites, and narrow bone corridors for screw placement. The goal of operative treatment is to restore pelvic symmetry and achieve stable fracture fixation, which allows for early mobilization and good functional outcome at the long-term.

Keywords: pelvic ring injury ; sacroiliac screw ; three-dimensional ; 3D virtual surgical planning ; 3D printing ; navigation

1. Introduction

Progress in 3D imaging technologies has resulted in an exponential increase in the usage of these techniques—that is both industry- as well as surgeon-driven- for preoperative planning and for translation of the plan to the operative procedure [1]. In essence, 3D-assisted surgery encompasses a wide spectrum of modalities including 3D virtual preoperative planning, 3D-printed models for pre-contouring of osteosynthesis plates and 3D navigational tools. Some coin these 3D (printing) techniques the “second industrial revolution” in Orthopaedic Trauma Surgery . Nevertheless, the additional clinical value of 3D techniques in pelvic surgery has yet to be elucidated, both practically as well as scientifically.

Conventional X-rays and two-dimensional (2D) computed tomography (CT) images are to date widely used to assess fracture characteristics, reduction quality and positions of osteosynthesis materials in pelvic ring injury treatment [2]. However, 3D virtual models may allow the surgeon to gain more insight in the fracture pattern, surgical approach, and positions of osteosynthesis materials. It has been reported that pre-operative virtual simulation and 3D printing-assisted pre-contoured plate fixation of pelvic ring injuries resulted in precise pre-operative planning and accurate execution of the operative procedures [2]. Moreover, 3D-assisted surgery for percutaneous screw placement may lower the risk of complications and decrease the need for revision surgery due to a lower rate of screw malposition [3]. However, there is a lack of studies with sufficient statistical power to provide evidence on superiority of the available 3D technologies compared to conventional (2D) techniques in different types of pelvic ring injuries.

2. Does 3D-Assisted Operative Treatment of Pelvic Ring Injuries Improve Patient Outcome?

No overview exists on the currently available 3D technologies and to what extent they contribute to the operative treatment of pelvic ring injuries.

Our first question concerned the effects of 3D-assisted surgery on intra-operative outcomes including operation time, blood loss, fluoroscopy time, dose and frequency as well as screw malposition. The results reveal some potential intra-operative advantages by using 3D-assisted surgery. Overall, operative time can be reduced by using 3D printed models. This is in line with a meta-analysis performed by Zhang et al. [4]. Additionally, operation time per screw is shown to be decreased using 3D navigation in percutaneous sacroiliac screw placement. One case-control study showed that blood loss might be reduced by using 3D printing assisted contoured template compared to conventional surgery [2]. Fluoroscopy time can be effectively reduced by using 3D techniques as shown by three case-control studies [5][6][7]. Moreover, fluoroscopy dose and frequency might be reduced, although more studies are needed to actually draw conclusions with regard to these outcome measures. The majority of the articles (13 out of 18) reported on use of 3D navigation for percutaneous screw placement. Based on these results, we may cautiously conclude that 3D navigation tends towards a decrease in screw malposition, although larger comparative studies are needed. This is in line with the systematic review and meta-analysis by Zwingmann et al. [8]. All identified 3D-assisted surgery techniques are shown in **Figure 1**.

Our second question concerned the effects of 3D-assisted surgery on post-operative outcomes including fracture reduction and functional outcome. According to the reduction score by Tornetta and Matta, no difference could be found by using 3D-assisted surgery in comparison with conventional surgery. However, to date reduction measurements in pelvic radiographs have not been validated and interobserver reliability has shown to be poor [9]. Moreover, no evidence for improved functional outcome was found using 3D-assisted surgery for pelvic ring injuries. Nonetheless, only a limited number of studies with different methodological quality reported on these outcome measures after iliosacral screw fixation. Hence, future high-quality comparative studies on all five 3D techniques are needed to clarify whether post-operative reduction and functional outcome may benefit from 3D-assisted surgery.

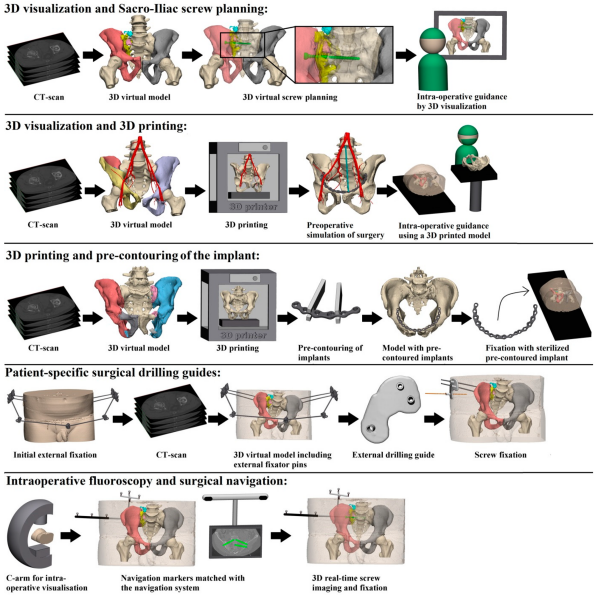

Figure 1. Presentation of the five identified 3D-assisted surgery techniques.

3. Conclusions

Overall, five different techniques of 3D-assisted surgery were identified and are currently in use for pelvic ring injury treatment. These included ‘3D virtual fracture visualization and preoperative planning’, ‘3D printed model assisted surgery’, ‘pre-contouring of osteosynthesis material’, ‘3D printed surgical guides’, and ‘intra-operative 3D imaging’. These 3D-based techniques offer additional tools to improve intra-operative efficiency in terms of operation time, blood loss, fluoroscopy dose, time and frequency as well as accuracy of screw placement. However, improved anatomical reduction or functional outcome following 3D-assisted surgery has not been established so far.

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