ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 12| Issue: 7| July 2026|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2026: 8.753 || ISI Value: 1.188

THREE-DIMENSIONAL CT RECONSTRUCTION IN SURGICAL PLANNING: IMAGING PRINCIPLES AND COMPARATIVE APPLICATIONS IN MAXILLOFACIAL AND ORTHOPEDIC TRAUMA

Byron Estuardo Ávila Sanmartin[1], Mauro Alejandro Bolaños Liscano[2], Sara Gómez Galindo[3], Bryam Esteban Coello García[4].

[1]General Dentist at "Dental Cover", Independent Practice. Universidad Católica de Cuenca. Ecuador. ORCID: https://orcid.org/0000-0002-5765-6698

[2]General Practitioner, Faculty of Medical Sciences, Universidad Juan N. Corpas. Colombia ORCID https://orcid.org/0009-0008-5509-6296

[3]General Practitioner, Faculty of Medical Sciences, Universidad del Sinú. Colombia ORCID https://orcid.org/0009-0004-0075-2576

[4]Orthopedic Surgeon and Traumatologist, Fellow in Advanced Hip Surgery, Faculdade Moinhos de Vento. Porto Alegre – Brasil. ORCID https://orcid.org/0000-0003-2497-0274

Corresponding Author: *Bryam Esteban Coello García,* ***Address:*** *Rua General Neto,118- Moinhos de Vento. Porto Alegre. Brasil,* ***Postal Code:*** *90560-020*

Article DOI: https://doi.org/10.36713/epra28712
DOI No: 10.36713/epra28712

ABSTRACT

Introduction: *Three-dimensional (3D) reconstruction based on computed tomography (CT) has become an essential tool for the evaluation and surgical planning of complex traumatic injuries. By providing detailed visualization of fracture morphology and spatial relationships, it enhances diagnostic accuracy and supports individualized preoperative planning in both maxillofacial and orthopedic trauma.*

Objective: *To compare the current scientific evidence regarding the use of CT-based 3D reconstruction in the surgical planning of maxillofacial and orthopedic trauma, focusing on its impact on diagnostic accuracy, preoperative planning, surgical performance, and clinical outcomes.*

Methodology: *A narrative literature review was conducted using PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar. Original studies, systematic reviews, meta-analyses, and observational studies published between 2015 and 2025 in English or Spanish were included. The selected studies evaluated the use of CT-based 3D reconstruction for preoperative planning in maxillofacial and orthopedic trauma. The evidence was comparatively analyzed according to diagnostic accuracy, surgical planning, operative time, anatomical reduction, 3D printing, and clinical outcomes.*

Results: *The reviewed evidence indicates that CT-based 3D reconstruction significantly improves the understanding of complex fracture patterns and facilitates surgical decision-making. In maxillofacial trauma, it enhances the restoration of facial symmetry, occlusion, and functional outcomes through virtual planning and patient-specific implants. In orthopedic trauma, particularly in acetabular and pelvic fractures, it contributes to more accurate anatomical reduction, shorter operative time, reduced blood loss, and decreased fluoroscopy exposure. Integration with virtual surgical planning and 3D printing further improves surgical precision, although widespread implementation remains limited by costs and technological availability.*

Conclusions: *CT-based 3D reconstruction is a valuable tool for optimizing surgical planning in maxillofacial and orthopedic trauma. Its integration with virtual planning, 3D printing, and artificial intelligence is expected to advance personalized surgery and improve clinical outcomes. However, further high-quality prospective studies are needed to strengthen the evidence supporting its long-term clinical benefits.*

KEYWORDS: *Computed tomography; Three-dimensional reconstruction; Surgical planning; Maxillofacial trauma; Orthopedic trauma; Three-dimensional printing.*

INTRODUCTION

Computed tomography (CT) is the imaging modality of choice for the evaluation of complex fractures because of its high spatial resolution and its ability to accurately depict bony anatomy. The development of three-dimensional (3D) reconstruction algorithms has significantly expanded diagnostic and preoperative planning capabilities by transforming two-dimensional images into volumetric models that faithfully reproduce the morphology of injured structures. This technological advancement has improved the understanding of fracture geometry, fragment relationships, and the proximity of critical anatomical structures, all of which are essential for surgical decision-making (1).

In recent years, CT-based three-dimensional reconstruction has become an established adjunct in the surgical planning of complex traumatic injuries. The ability to virtually rotate anatomical models, perform precise measurements, simulate fracture reductions, and plan implant positioning has enabled surgeons to optimize surgical strategies before entering the operating room. Furthermore, the integration of these reconstructions with technologies such as three-dimensional printing, virtual surgical planning, and surgical navigation has contributed to greater operative accuracy and reduced inter-surgeon variability (2).

In maxillofacial surgery, CT-based 3D reconstruction has demonstrated particular value in the management of fractures involving the zygomatico-orbital complex, mandible, maxilla, and naso-orbito-ethmoidal region. The anatomical complexity of the facial skeleton and the need to simultaneously restore both function and facial symmetry require a detailed assessment of bone displacement. Three-dimensional models allow more accurate identification of fracture patterns, facilitate osteosynthesis planning, enable the design of patient-specific implants, and support surgical simulations that improve anatomical reconstruction. These applications have been associated with reduced operative time, improved implant adaptation, and better functional and aesthetic outcomes (3).

In orthopedic traumatology, three-dimensional reconstructions have become particularly valuable in the management of complex fractures of the pelvis, acetabulum, and articular surfaces. The three-dimensional anatomy of these injuries often limits accurate interpretation using conventional axial CT images alone. Consequently, 3D models provide a more comprehensive understanding of fragment configuration, assist in selecting the most appropriate surgical approach, and facilitate planning of fracture reduction and internal fixation. Several studies and systematic reviews have demonstrated that three-dimensional planning combined with 3D printing can reduce operative time, intraoperative blood loss, fluoroscopic exposure, and improve the quality of anatomical reduction compared with conventional planning methods (4).

Although both maxillofacial surgery and orthopedic surgery employ CT-based three-dimensional reconstruction as a surgical planning tool, important differences exist in their clinical applications. In maxillofacial trauma, the primary objective is to restore facial symmetry, occlusion, and masticatory function, whereas in orthopedic trauma, the priority is to restore articular congruity, mechanical stability, and functional mobility. These differences require distinct planning strategies and technological approaches, making it relevant to compare the impact of three-dimensional reconstruction across both specialties in order to identify its advantages, limitations, and future perspectives (5).

In this context, the aim of the present review is to compare the available scientific evidence regarding the use of computed tomography-based three-dimensional reconstruction in the surgical planning of maxillofacial and orthopedic trauma. Specifically, it analyzes its impact on diagnostic accuracy, preoperative planning, surgical execution, and clinical outcomes, with the objective of identifying similarities, differences, and opportunities for integrating these technologies into contemporary surgical practice.

Principles of Three-Dimensional Reconstruction Using Computed Tomography.

Multidetector computed tomography (MDCT) is currently the imaging modality of choice for the evaluation of complex fractures involving the facial skeleton and the musculoskeletal system. Unlike conventional radiography, CT acquires a high-resolution isotropic volumetric dataset, enabling multiplanar and three-dimensional reconstruction of anatomical structures without significant loss of image quality. These characteristics have established CT as an indispensable tool for the diagnosis and preoperative planning of patients with complex traumatic injuries (6,7).

Three-dimensional reconstructions are generated from high-resolution axial CT images, typically acquired with slice thicknesses of less than 1 mm, using post-processing algorithms that allow visualization of bony structures from multiple perspectives. The most commonly employed techniques include multiplanar reconstruction (MPR), Volume Rendering (VR), and Surface Shaded Display (SSD). While multiplanar reconstructions provide detailed assessment of anatomy in the axial, coronal, and sagittal planes, volumetric reconstructions enhance the spatial understanding of fracture patterns and the relationships among bone fragments (8).

From the perspective of the imaging specialist, the quality of three-dimensional reconstruction depends on several technical factors, including slice thickness, reconstruction algorithm, voxel size, accurate segmentation of anatomical structures, and minimization of artifacts caused by patient motion or metallic hardware. Proper image acquisition and post-processing are essential for producing accurate reconstructions that enable surgeons to correctly interpret fracture morphology and plan surgical treatment with greater confidence and precision (9).

Advances in three-dimensional reconstruction software have enabled the integration of semiautomated segmentation, virtual surgical planning, and three-dimensional printing, considerably expanding the clinical applications of computed tomography. These technologies not only improve communication between radiologists and surgical teams but also facilitate patient-specific surgical planning and enhance anatomical understanding in the management of complex maxillofacial and orthopedic trauma (10,11).

METHODOLOGY

This study is a narrative literature review aimed at comparing the applications of three-dimensional (3D) reconstruction based on computed tomography (CT) in the surgical planning of maxillofacial and orthopedic trauma.

A comprehensive literature search was conducted in the PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar databases, as these are widely recognized sources for indexing biomedical and surgical literature. The search strategy combined Medical Subject Headings (MeSH) and free-text keywords in English, including *three-dimensional

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 12| Issue: 7| July 2026|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2026: 8.753 || ISI Value: 1.188

reconstruction*, *computed tomography*, *3D CT reconstruction*, *surgical planning*, *maxillofacial trauma*, *facial fractures*, *orthopedic trauma*, *pelvic fractures*, *acetabular fractures*, *virtual surgical planning*, and *3D printing*. These terms were combined using the Boolean operators **AND** and **OR** to optimize the sensitivity and specificity of the search.

Eligible studies included original research articles, systematic reviews, meta-analyses, and observational studies published between 2015 and 2025 in English or Spanish that evaluated the use of CT-based three-dimensional reconstruction as a preoperative planning tool for patients with maxillofacial or orthopedic trauma. In addition, landmark studies published before 2015 were included when they provided essential information regarding the development and clinical implementation of this technology.

Studies were excluded if they addressed non-traumatic conditions, consisted exclusively of experimental research without clinical application, were isolated case reports, letters to the editor, conference abstracts, or articles without full-text availability. Studies focusing solely on image acquisition techniques without evaluating their role in surgical planning were also excluded.

The selected articles were critically reviewed and categorized according to surgical specialty (maxillofacial surgery or orthopedic traumatology), study design, methodological characteristics, and principal findings. A comparative analysis of the available evidence was subsequently performed, considering variables such as diagnostic accuracy, preoperative planning, operative time, quality of anatomical reduction, use of patient-specific implants, three-dimensional printing, and the clinical outcomes reported across the included studies.

DEVELOPMENT

Three-Dimensional Reconstruction Using Computed Tomography in Maxillofacial Trauma.

Maxillofacial trauma represents one of the clinical settings in which computed tomography (CT)-based three-dimensional (3D) reconstruction has had the greatest impact on surgical planning. Owing to the complex anatomy of the facial skeleton, characterized by multiple small bony structures, pneumatized cavities, and their close relationship with sensory organs and neurovascular structures, the interpretation of conventional two-dimensional images may be limited, particularly in complex or comminuted fractures. In this context, computed tomography has become the imaging modality of choice for the evaluation of maxillofacial trauma, allowing accurate identification of fracture lines, displacement of bone fragments, and associated injuries. Based on these CT datasets, three-dimensional reconstructions provide a more intuitive and detailed anatomical representation, improving the spatial understanding of injuries, optimizing preoperative planning, and facilitating the selection of the most appropriate surgical strategy (10,12).

Fractures of the zygomatico-orbital complex, orbital floor, mandible, and naso-orbito-ethmoidal complex are among the main indications for the use of 3D reconstruction. These injuries frequently involve displacement in multiple spatial planes that may not be fully appreciated on isolated axial, coronal, or sagittal images. Three-dimensional visualization facilitates the identification of the number of fracture fragments, the degree of displacement, bone volume loss, and facial asymmetry, all of which are essential for selecting the most appropriate surgical approach and planning accurate anatomical reduction (10,11).

The incorporation of virtual surgical planning has further expanded the applications of this technology. Using dedicated software, surgeons can perform virtual osteotomies, simulate fracture reductions, determine the optimal positioning of plates and screws, and design patient-specific surgical guides and implants. These tools allow technical challenges to be anticipated before surgery, reduce the need for intraoperative modifications, and improve reconstructive accuracy, particularly in comminuted fractures or extensive bone defects (11,13).

Three-dimensional reconstruction derived from computed tomography also provides the foundation for the production of physical anatomical models through three-dimensional (3D) printing, a technology that has significantly expanded the possibilities for personalized surgical planning. Following digital image segmentation, highly accurate anatomical models can be fabricated, allowing surgeons to physically examine and manipulate the patient's anatomy before the procedure. This approach facilitates detailed analysis of complex fractures, pre-contouring of fixation plates, design of patient-specific surgical guides, and simulation of reconstructive procedures. In addition, printed models enhance surgical education, improve communication among multidisciplinary team members, and facilitate patient understanding of the planned procedure. Although three-dimensional printing involves additional costs and requires time for image processing and model fabrication, numerous studies have demonstrated that these investments may be offset by reductions in operative time, decreased intraoperative manipulation, and greater precision in anatomical reconstruction, particularly in patients with complex facial fractures (10,11,13).

Several studies have demonstrated that the use of three-dimensional reconstruction and virtual surgical planning is associated with greater accuracy of anatomical reduction, shorter operative time, and improved functional and aesthetic outcomes compared with conventional planning based solely on two-dimensional imaging. Furthermore, the ability to more accurately restore facial symmetry and occlusal relationships has contributed to lower revision surgery rates and higher patient satisfaction (2,11).

Despite these advantages, the routine implementation of these technologies continues to face limitations related to the cost of specialized software, the availability of three-dimensional printing equipment, the time required for image processing, and the need for personnel trained in anatomical segmentation and virtual surgical planning. Nevertheless, the ongoing evolution of three-dimensional reconstruction systems, the increasing incorporation of artificial intelligence into image processing workflows, and the progressive reduction in technological costs suggest that these tools will become an integral component of routine clinical practice in maxillofacial surgery in the coming years (11,13).

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 12| Issue: 7| July 2026|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2026: 8.753 || ISI Value: 1.188

Three-Dimensional Reconstruction Using Computed Tomography in Orthopedic Trauma.

Computed tomography (CT)-based three-dimensional (3D) reconstruction has become a fundamental tool in the surgical planning of orthopedic trauma, particularly for complex fractures involving articular surfaces or anatomically challenging regions that are difficult to evaluate using conventional two-dimensional imaging. Fractures of the acetabulum, pelvis, proximal tibia, tibial plafond, calcaneus, and distal radius often exhibit complex three-dimensional fracture patterns that are not adequately characterized on standard axial CT images. In this context, 3D reconstructions provide a more comprehensive understanding of fracture morphology, fragment orientation, and the degree of displacement, thereby facilitating therapeutic decision-making and the selection of the most appropriate surgical approach (1).

Acetabular and pelvic fractures represent some of the greatest challenges in orthopedic traumatology because of the anatomical complexity of the region and the difficulty of interpreting multiple fracture fragments using conventional two-dimensional imaging. Three-dimensional reconstruction derived from computed tomography enables comprehensive visualization of the acetabular columns, articular surface, and spatial orientation of fracture fragments, thereby facilitating fracture classification and the selection of the optimal surgical approach. Furthermore, preoperative planning based on three-dimensional models allows surgeons to anticipate technical difficulties, optimize anatomical reduction, and improve procedural reproducibility, particularly in displaced and comminuted fractures (14,15).

Virtual surgical planning based on three-dimensional reconstructions has enabled preoperative simulation of fracture reduction, evaluation of different surgical approaches, and precise determination of the optimal position and length of fixation plates and screws before surgery. This technology provides surgeons with a patient-specific anatomical model that supports surgical decision-making and reduces the need for intraoperative modifications. Feasibility studies have demonstrated a high degree of agreement between virtual planning and the actual surgical procedure, highlighting its value in optimizing surgical strategies for complex acetabular fractures (14,15).

Three-dimensional reconstruction obtained from computed tomography also serves as the basis for the production of patient-specific three-dimensional printed anatomical models, which have proven to be valuable tools for personalized surgical planning. These models allow detailed evaluation of fracture anatomy, pre-contouring of fixation plates, and rehearsal of fracture reduction sequences before surgery. In complex acetabular fractures, the combination of virtual surgical planning and three-dimensional printing has demonstrated high anatomical accuracy, facilitating more precise fracture reduction while reducing operative time (4,16).

The available scientific evidence supports the positive impact of three-dimensional reconstruction and virtual model-assisted surgical planning on perioperative outcomes in orthopedic trauma. Systematic reviews have shown that these technologies contribute to reductions in operative time, intraoperative blood loss, fluoroscopic exposure, and the need for intraoperative implant reshaping. Moreover, planning based on three-dimensional reconstructions promotes more accurate anatomical reduction and greater precision in the placement of fixation devices, particularly in complex acetabular and pelvic fractures (3,4).

Advances in artificial intelligence, statistical shape modeling, and automated reconstruction algorithms are further expanding the possibilities of personalized surgical planning. Recently, systems have been developed that are capable of virtually reconstructing complex acetabular fractures even in the absence of an intact contralateral hemipelvis, representing a significant advancement for bilateral injuries and patients with pre-existing deformities. These innovations have the potential to be integrated into surgical navigation platforms and computer-assisted surgery systems, further improving the precision and efficiency of treatment for complex orthopedic trauma (17).

DISCUSSION

The scientific evidence analyzed in this review demonstrates that computed tomography (CT)-based three-dimensional (3D) reconstruction has become a valuable tool for surgical planning in both maxillofacial and orthopedic trauma. In both specialties, the conversion of two-dimensional images into three-dimensional models enhances the understanding of injured anatomy, facilitates the identification of fracture fragments, and enables more accurate preoperative planning. These findings are consistent with numerous reviews reporting improved preoperative decision-making and greater surgeon confidence during the management of complex injuries (1,10).

Although both specialties rely on the same imaging technology, their clinical priorities differ considerably. In maxillofacial surgery, three-dimensional reconstruction is primarily focused on restoring facial symmetry, occlusion, and stomatognathic function, whereas in orthopedic traumatology the main objective is to restore articular congruity, mechanical stability, and functional recovery of the affected limb. These differences influence how three-dimensional information is incorporated into surgical planning and explain the development of specialty-specific planning tools tailored to the unique requirements of each discipline (10,15).

Another important finding of this review is the increasing integration of CT-based three-dimensional reconstruction with virtual surgical planning and three-dimensional (3D) printing. Although CT reconstruction serves as the foundation of the entire workflow, the ability to generate patient-specific anatomical models and customized surgical guides has considerably expanded the clinical applications of these technologies. In both specialties, this integration has enabled optimization of implant pre-contouring, reduced intraoperative manipulation, and improved the accuracy of anatomical reduction, particularly in complex fractures. However, the current evidence remains more robust for acetabular and pelvic fractures than for other anatomical locations (2,11).

The clinical benefits reported in the literature include reductions in operative time, intraoperative blood loss, fluoroscopic exposure, and improvements in the quality of anatomical reduction. Nevertheless, the magnitude of these benefits varies among studies because of differences in methodology, sample size, surgeon experience, and the availability of advanced technologies. Furthermore, many published studies are retrospective analyses or case series, limiting the overall level of evidence and making it difficult to draw definitive conclusions regarding the long-term impact of these technologies on functional outcomes (2,4).

Finally, recent advances in artificial intelligence, automated image segmentation, and computer-assisted surgical planning represent one of the most promising future directions for three-dimensional reconstruction. These technologies have the potential to substantially reduce image-processing time and facilitate the implementation of personalized surgical planning, even in hospitals with limited resources. However, prospective multicenter studies with standardized methodologies will be required to determine the true impact of these innovations on implant survival, functional recovery, and patients' quality of life (11,17).

CONCLUSIONS

Computed tomography (CT)-based three-dimensional (3D) reconstruction has become one of the most important imaging tools in modern medicine for the diagnosis and surgical planning of both maxillofacial and orthopedic trauma. Its ability to transform two-dimensional images into highly accurate three-dimensional anatomical representations enhances the understanding of complex fracture morphology, facilitates therapeutic decision-making, and improves communication between radiologists and the surgical team.

The scientific evidence reviewed demonstrates that three-dimensional reconstruction improves preoperative planning by optimizing the selection of the surgical approach, anatomical reduction, and implant placement, particularly in complex fractures involving the facial skeleton, pelvis, acetabulum, and other articular surfaces. Furthermore, its integration with virtual surgical planning and three-dimensional (3D) printing has substantially expanded the possibilities of personalized surgery, enabling procedures that are more precise, efficient, and safe.

Despite its numerous advantages, several challenges remain, including the cost of implementation, limited availability of specialized technologies, the need for standardized image acquisition and post-processing protocols, and the requirement for personnel trained in image segmentation and three-dimensional reconstruction. These limitations also represent opportunities for the development of new technologies that may facilitate the routine incorporation of these techniques into clinical practice.

Finally, continued advances in artificial intelligence, automated anatomical segmentation, computer-assisted surgical planning, and three-dimensional printing are expected to further expand the clinical applications of CT-based three-dimensional reconstruction. Close collaboration among radiologists, maxillofacial surgeons, and orthopedic trauma surgeons will be essential to establish these technologies as integral components of personalized medicine and to improve the functional and aesthetic outcomes of patients with complex traumatic injuries.

REFERENCES

1. *Fadero PE, Shah M. Three dimensional (3D) modelling and surgical planning in trauma and orthopaedics. The Surgeon. 2014 Dec;12(6):328–33. doi:10.1016/j.surge.2014.03.008*
2. *Morgan C, Khatri C, Hanna SA, Ashrafian H, Sarraf KM. Use of three-dimensional printing in preoperative planning in orthopaedic trauma surgery: A systematic review and meta-analysis. World J Orthop. 2020 Jan 18;11(1):57–67. doi:10.5312/wjo.v11.i1.57 PubMed PMID: 31966970; PubMed Central PMCID: PMC6960300.*
3. *Fang C, Cai H, Kuong E, Chui E, Siu YC, Ji T, et al. Surgical applications of three-dimensional printing in the pelvis and acetabulum: from models and tools to implants. Unfallchirurg. 2019 Apr;122(4):278–85. doi:10.1007/s00113-019-0626-8*
4. *Papotto G, Testa G, Mobilia G, Perez S, Dimartino S, Giardina SMC, et al. Use of 3D printing and pre-contouring plate in the surgical planning of acetabular fractures: A systematic review. Orthop Traumatol Surg Res. 2022 Apr;108(2):103111. doi:10.1016/j.otsr.2021.103111*
5. *Lee AKX, Lin TL, Hsu CJ, Fong YC, Chen HT, Tsai CH. Three-Dimensional Printing and Fracture Mapping in Pelvic and Acetabular Fractures: A Systematic Review and Meta-Analysis. J Clin Med. 2022 Sep 6;11(18):5258. doi:10.3390/jcm11185258*
6. *Kalender WA. Computertomographie: Grundlagen, Gerätetechnologie, Bildqualität, Anwendungen. München: Publicis-MCD-Verlag; 2000. 216 p.*
7. *Flohr TG, McCollough CH, Bruder H, Petersilka M, Gruber K, Süss C, et al. First performance evaluation of a dual-source CT (DSCT) system. Eur Radiol. 2006 Feb;16(2):256–68. doi:10.1007/s00330-005-2919-2 PubMed PMID: 16341833.*
8. *Udupa JK, Hung HM, Chuang KS. Surface and volume rendering in three-dimensional imaging: A comparison. J Digit Imaging. 1991 Aug;4(3):159–68. doi:10.1007/BF03168161*
9. *Boas FE, Fleischmann D. CT artifacts: causes and reduction techniques. Imaging Med. 2012 Apr;4(2):229–40. doi:10.2217/iim.12.13*
10. *Louvrier A, Marty P, Barrabé A, Euvrard E, Chatelain B, Weber E, et al. How useful is 3D printing in maxillofacial surgery? J Stomatol Oral Maxillofac Surg. 2017 Sep;118(4):206–12. doi:10.1016/j.jormas.2017.07.002*
11. *Martelli N, Serrano C, Van Den Brink H, Pineau J, Prognon P, Borget I, et al. Advantages and disadvantages of 3-dimensional printing in surgery: A systematic review. Surgery. 2016 Jun;159(6):1485–500. doi:10.1016/j.surg.2015.12.017*
12. *Nicolle Elizabeth Zumba Cabrera, Karina Lizbeth Lazo Pastuizaca, María Alexandra Sarmiento Jaramillo, Gabriela Patricia Murillo Araujo, María Elizabeth Llanos Chacon, Gonzalo Israel Llanos Chacón, et al. OVERVIEW OF MAXILLOFACIAL TRAUMA, DEFINITIONS, EPIDEMIOLOGY, MANAGEMENT, AIRWAY, CIRCULATION, BLEEDING CONTROL, SYSTEMIC ANTIBIOTIC PROPHYLAXIS AND MAXILLOFACIAL SURGERY. EPRA Int J Multidiscip Res IJMR. 2023 Jul 17;135–42. doi:10.36713/epra13825*
13. *Witowski J, Sitkowski M, Zuzak T, Coles-Black J, Chuen J, Major P, et al. From ideas to long-term studies: 3D printing clinical trials review. Int J Comput Assist Radiol Surg. 2018 Sep;13(9):1473–8. doi:10.1007/s11548-018-1793-8*
14. *Hu Y, Li H, Qiao G, Liu H, Ji A, Ye F. Computer-assisted virtual surgical procedure for acetabular fractures based on real CT data. Injury. 2011 Oct;42(10):1121–4. doi:10.1016/j.injury.2011.01.014*

15. *Wang H, Wang F, Newman S, Lin Y, Chen X, Xu L, et al. Application of an innovative computerized virtual planning system in acetabular fracture surgery: A feasibility study. Injury. 2016 Aug;47(8):1698–701. doi:10.1016/j.injury.2016.05.006*
16. *Zeng C, Xing W, Wu Z, Huang H, Huang W. A combination of three-dimensional printing and computer-assisted virtual surgical procedure for preoperative planning of acetabular fracture reduction. Injury. 2016 Oct;47(10):2223–7. doi:10.1016/j.injury.2016.03.015*
17. *Van Veldhuizen W, Van Noortwijk R, Meesters A, Duis KT, Schuurmann R, De Vries J, et al. Automatic virtual reconstruction of acetabular fractures using a statistical shape model. Eur J Trauma Emerg Surg. 2024 Dec;50(6):2925–36. doi:10.1007/s00068-024-02615-7*

Conflict of Interest Statement

The authors declare that they have no conflicts of interest.

Funding

The authors declare that they received no funding from any organization or company.