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Review Stage at time of this submission: **Data analysis.**

Conflicts of interest:
None.

The Use of 3D Visualization Techniques for Prostate Procedures

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Review question / Objective: **In this review, we aim to present the development and current application of 3D printing, virtual reality (VR), and augmented reality (AR) techniques for prostate procedures, specifically prostate biopsy (Bx) and radical prostatectomy (RP).**
Condition being studied: **Three-dimensional (3D) visualization has been reported as early as 20 years ago but is only recently applied so extensively in the medical field, due to price reduction and the rapid development of imaging reconstruction techniques. Virtual reality (VR) and augmented reality (AR) techniques, developed based on the 3D reconstruction of imaging data, can further enhance the impact of real-time imaging guidance during surgery with more realistic and accurate anatomic insights and tumor localization. In this review, we aim to present the development and current application of 3D printing, VR, and AR technologies for the management of prostate cancer.**

INPLASY registration number: This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 16 April 2020 and was last updated on 16 April 2020 (registration number INPLASY202040096).

INTRODUCTION

Review question / Objective: **In this review, we aim to present the development and current application of 3D printing, virtual reality (VR), and augmented reality (AR) techniques for prostate procedures, specifically prostate biopsy (Bx) and radical prostatectomy (RP).**

Rationale: **A systematic review of the literature was performed following the guideline from the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).**

Condition being studied: **Three-dimensional (3D) visualization has been**

reported as early as 20 years ago but is only recently applied so extensively in the medical field, due to price reduction and the rapid development of imaging reconstruction techniques. Virtual reality (VR) and augmented reality (AR) techniques, developed based on the 3D reconstruction of imaging data, can further enhance the impact of real-time imaging guidance during surgery with more realistic and accurate anatomic insights and tumor localization. In this review, we aim to present the development and current application of 3D printing, VR, and AR technologies for the management of prostate cancer.

METHODS

Search strategy: PubMed, Scopus, and Embase were screened for studies on the use of 3D printing, VR, and AR techniques in prostate Bx and RP, using the search query (3D printing OR virtual reality OR augmented reality) AND (prostate biopsy OR prostatectomy).

Participant or population: All studies focusing on the use of 3D visualization techniques (3D printing, VR, and AR) in prostate procedures (prostate biopsy and radical prostatectomy) are included. Meeting abstracts, commentaries, editorials, reviews, and book chapters are excluded.

Intervention: None.

Comparator: None.

Study designs to be included: All studies focusing on the use of 3D visualization techniques (3D printing, VR, and AR) in prostate procedures (prostate biopsy and radical prostatec.

Eligibility criteria: All studies focusing on the use of 3D visualization techniques (3D printing, VR, and AR) in prostate procedures (prostate biopsy and radical prostatectomy) are included. Meeting abstracts, commentaries, editorials, reviews, and book chapters are excluded.

Information sources: PubMed, Scopus, and Embase. Possible supplements from the references.

Main outcome(s): The main outcome is to evaluate how the 3D visualization techniques have been developed in the field of prostate cancer procedure, especially prostate biopsy and radical prostatectomy, and affected the outcomes of the procedures.

Additional outcome(s): The distribution of use of 3D, VR, and AR in different procedures such as prostate biopsy and radical prostatectomy.

Data management: Title and abstracts from the search were screened independently by two reviewers to identify qualified studies according to the inclusion and exclusion criteria. Full accesses of the eligible studies were retrieved and then evaluated independently by the two reviewers. any disagreements on eligibility were resolved by discussion between the two investigators until consensus was reached. Extracted data included: Author; Publication Year; Journal; 3D imaging acquisition; Type of technique (3D, VR, or AR); Simulator/ patient; Procedure (Laparoscopic or Robotic assisted); Application (Education/Training Surgical planning, or Intra-op guidance). Two reviewers independently extracted the data onto a pre-made excel sheet.

Quality assessment / Risk of bias analysis: The Newcastle–Ottawa Quality Assessment Scale (NOS) is used to assess the risk of bias. A total score of 5 or less is considered low quality, 6–7 intermediate quality, and 8–9 high quality.

Strategy of data synthesis: We will provide a narrative synthesis of the evidences from the included studies, and evaluated as 3D, VR, and AR, in terms of education/training, surgical planning, and intraoperative guidance.

Subgroup analysis: The subgroup analysis will depend on the data availability.

Sensibility analysis: None.

Country(ies) involved: USA.

Keywords: Prostate Biopsy; Prostatectomy; 3D Printing; Virtual Reality; Augmented Reality.

Contributions of each author:

Author 1 - Acquisition of data; Analysis and interpretation of data; Drafting of the manuscript; Statistical analysis.
Author 2 - Acquisition of data; Analysis and interpretation of data; Critical revision of the manuscript for important intellectual content; Statistical analysis.
Author 3 - Analysis and interpretation of data; Critical revision of the manuscript for important intellectual content.
Author 4 - Analysis and interpretation of data; Critical revision of the manuscript for important intellectual content.
Author 5 - Critical revision of the manuscript for important intellectual content.
Author 6 - Study concept and design; Critical revision of the manuscript for important intellectual content; Supervision.
Author 7 - Study concept and design; Critical revision of the manuscript for important intellectual content; Supervision.
Author 8 - Study concept and design; Critical revision of the manuscript for important intellectual content; Supervision.
Author 9 - Study concept and design; Critical revision of the manuscript for important intellectual content; Supervision.
Author 10 - Study concept and design; Critical revision of the manuscript for important intellectual content; Administrative, technical, or material support; Supervision.