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Accuracy of Dental Implant Robot: A Systematic Review and Meta-Analysis of Clinical and In Vitro Studies

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Zhou, LB; Wang, YM; Teng, WW; SU, YC.

Corresponding author:
Yucheng Su

yuzzsu@163.com

Author Affiliation:
School of Stomatology, Jiamusi University.

ADMINISTRATIVE INFORMATION

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 06 April 2024 and was last updated on 06 April 2024.

INTRODUCTION

Review question / Objective As an emerging surgical treatment technology, the dental implant robot has demonstrated high precision in in vitro and clinical studies, meeting the basic standards of clinical needs.The objective of this meta-analysis was to systematic review the accuracy of implant placement using the dental implant robot.In vitro and clinical studies were performed a meta-analysis, separately, with the primary outcome measures focusing on deviation in three-dimensional directions of implant placement, including global coronal, global apical andangulardeviation.Dental implant robots have undeniable advantages in implant surgery, but the key issues such as safety, privacy, ethics, and patient satisfaction should also be considered. Dental implant robots are an emerging surgical treatment technology with great potential, but their comprehensiveness and maturity in application still need to be supplemented and confirmed in the futureresearch.

Condition being studied With the continuous advancement of technology and the continuous development of oral medicine, the research of dental implant robots also needs continuous innovation to meet the changing clinical needs.Robotic systems have emerged in dental implant surgery due to their accuracy.The dental implant robot may offer unprecedented advantages over conventional alternatives. The research of dental implant robot need to be based on advanced robotics, mechanics, biomedical engineering and stomatology. The robot should have a high-precision and high-stability motion control system to achieve minimally invasive and accurate implantation surgery. A large amount of experimental data needs to be collected during the

research process, which needs to be deeply analyzed and processed to evaluate the performance of the robot and the direction of improvement. Our team is dedicated to the clinical and preclinical research of dental implant robots.

METHODS

Search strategy Computer search: Four databases including PubMed, Embase, Cochrane Library, Web of Science were searched by two researchers independently from the inception to December 2023. The search term of English databases including "dental implant/surgical dental prostheses/robot surgery/surgial procedure/ assisted/robot". In order to obtain more relevant studies, the reference tracking method were employe.

Participant or population The clinical population (in vivo) consisted of patients with complete or partial edentulism requiring implant-supported restorations. The in vitro population (in vitro) consisted of models simulating complete or partial edentulous arches.

Intervention Interventions: Implant placement using the dental implantrobot.

Comparator The comparison was made between the results from clinical and in vitro studies.

Study designs to be included Clinical and vitro study.

Eligibility criteria This research included studies on implantation accuracy of dental implant robot in vitro and clinical studies.

Information sources PubMed, Embase, Cochrane Library, Web of Science.

Main outcome(s) With the outcome measures focusing on deviation in three-dimensional directions of implant placement, including global coronal, apical and angular deviation.

Quality assessment / Risk of bias analysis The quality of the included studies was independently assessed by two reviewers. The quality of the clinical studies was assessed using the Cochrane bias risk assessment tool, including random sequence generation, allocation concealment, blinding of participants and personal, blinding of outcome assessment, incomplete outcome data, selective reporting and other bias. If the above six criteria were met, it was considered as low risk of bias. If partially met, it was considered as unclear risk of bias. Otherwise it was considered as high risk of bias Additionally, the NOS scale was employed to evaluate the quality of the in vitro studies, includign three dimensions: selection criteria for research subjects, comparability between groups, measurement of outcomes, mainly focusing on whether the exposed and non-exposed groups were adequately represented, whether the selection of outcome indicators of exposure was reasonable, and whether the comparison between inter-groups and the evaluation of result were complete. If the NOS scale score > 6 points, it was regarded as high-quality articles, < 4 points was regarded as low quality articles.

Strategy of data synthesis Meta-analysis was performed using Stata 15.1 software and RevMan 5.3 software. The effect size for the global coronal , global apical and angular deviation. were expressed as weighted mean difference with 95% confidence intervals (95% CI). Heterogeneity was assessed using the Cochran's Q test and I2 statistics was applied to appraise the heterogeneity across researches (p 50% indicating heterogeneity). If $p \geq 0.05$ and $I2 \leq 50\%$, indicating the homogeneity of the studies were good, and a fixed-effect model was employed for meta-analysis. Conversely, the between-study heterogeneity was statistically when p 50%, and a random-effects model was used for meta-anlaysis. Galbraith plots and subgroup analyses were employed to investigate potential sources of heterogeneity, while the sensitivity analysis was conducted to assess the robustness of the results. Egger's test was utilized to evaluate publication bias, with $P > 0.05$ indicating no significant publication bias, and $P < 0.05$ indicating publication bias. If there was publication bias, the trim-and-fill method was employed to evaluate the impact of publication bias on the meta-analysis results.

Subgroup analysis According to the study subjects, using robots for cavity preparation or implantation. Unfortunately, due to limited available data, subgroup analysis was not carried out for different robotic system, missing teeth and jawbone position.

Sensitivity analysis Galbraith plots were used to analyze possible sources of heterogeneity in in vitro studies. Sensitivity analysis were also conducted both in in vitro and clinical studies to assess the stability of the meta-analysis.

Country(ies) involved China.

Keywords dental implant; dental implant robot; implant surgery robot; robot; computer-assisted surgery; accuracy.

Contributions of each author

Author 1 - Libo Zhou.
Email: zhoulibo0219@gmail.com
Author 2 - Yiming Wang.
Email: 949508806@qq.com
Author 3 - Weiwei Teng.
Email: tengweiwei1993@163.com