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Effects of orthokeratology lenses on intraocular pressure measurement and corneal biomechanics: a network meta-analysis of AI-driven device consistency

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Zhang, LK; Shao, CL; Xing, B; Zhang, J.

Corresponding author:
Like Zhang

zhang_like9@163.com

Author Affiliation:
Hebei Eye Hospital.

ADMINISTRATIVE INFORMATION

Support - No support.

Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 24 September 2026 and was last updated on 24 September 2026.

INTRODUCTION

Review question / Objective To quantify orthokeratology (OK)-associated changes in intraocular pressure (IOP) measured by different tonometric methods and synthesize corneal biomechanical and structural outcomes.

Condition being studied Myopia has reached epidemic proportions worldwide.Orthokeratology (OK), a modality employing specially designed reverse-geometry rigid gas-permeable lenses, has emerged as one of the most effective optical interventions for myopia control.The mechanisms underlying OK-induced myopia control are multifactorial.In parallel, advances in imaging and biomechanical assessment have provided novel indices.

METHODS

Participant or population Myopic patients undergoing orthokeratology treatment. Orthokeratology lens wear, with follow-up at short-term, mid-term, or long-term intervals.

Intervention Orthokeratology lens wear, with follow-up at short-term, mid-term, or long-term intervals.

Comparator With or without control groups.

Study designs to be included Randomized controlled trials (RCTs), randomized fellow-eye studies, prospective or retrospective longitudinal or cohort studies, analytical cross-sectional studies, and comparative or repeatability studies reporting eligible quantitative outcomes.

Eligibility criteria Studies were considered eligible if they met the following criteria:
Population: Myopic patients undergoing orthokeratology treatment, with or without control groups.

Intervention: Orthokeratology lens wear, with follow-up at short-term, mid-term, or long-term intervals.
Outcomes: Quantitative assessment of IOP by NCT, GAT, DCT/PDCT, ORA-derived IOPg or IOPcc, or Corvis bIOP; corneal biomechanics including CH, CRF, SP-A1, SSI, ARTh, DA ratio, CBI, peak distance, and radius at highest concavity; or structural outcomes including CCT and AL.

Information sources PubMed/MEDLINE, Embase, Web of Science Core Collection, the Cochrane Library, and the China National Knowledge Infrastructure (CNKI).

Main outcome(s) At 3 months, non-contact tonometry (NCT), Goldmann applanation tonometry (GAT), and Pascal dynamic contour tonometry (PDCT) changed by −2.09, −0.98, and −0.31 mmHg, respectively. At Day 7, Ocular Response Analyzer-derived Goldmann-correlated IOP and corneal-compensated IOP changed by −2.01 and −1.26 mmHg, while Corvis biomechanically corrected IOP changed by −1.18 mmHg at 24 months. Pooled longitudinal changes were −0.43 mmHg (95% CI, −0.75 to −0.11; I^2=75.6%) for corneal hysteresis and −0.66 mmHg (95% CI, −1.28 to −0.04; I^2=91.1%) for corneal resistance factor, although small-sample sensitivity intervals included the null. Corvis biomechanical index and peak distance were more consistent across studies than deformation amplitude ratio, stiffness parameter at first applanation, and Ambrosio relational thickness to the horizontal profile. Axial elongation continued during follow-up, while controlled comparisons favored OK by 0.11–0.53 mm.

Quality assessment / Risk of bias analysis Risk of bias was assessed using design-appropriate instruments. The Newcastle-Ottawa Scale (NOS) was retained for the overall appraisal of observational studies14, while randomized trials were evaluated with the Cochrane Risk of Bias 2 (RoB 2) tool15. Within the observational evidence, nonrandomized longitudinal or intervention studies were further evaluated using the Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) framework, whereas analytical cross-sectional or measurement studies were evaluated using design-specific Joanna Briggs Institute (JBI) criteria. Two reviewers performed the assessments independently and resolved disagreements by consensus.

Strategy of data synthesis All analyses were performed using the meta and metafor packages in R version 4.4.2. Absolute post-treatment values were synthesized as pooled raw means to provide descriptive context. Longitudinal effects were summarized as mean changes from baseline, and controlled comparisons as mean differences between OK and comparator groups. When a study contributed multiple eligible estimates, multilevel random-effects models accounted for clustering of effect estimates within study. Restricted maximum likelihood (REML) estimation was used for random-effects models. For paired pre-post outcomes without a reported SD of change, the primary analysis used r=0.50, with r=0.30 and r=0.70 sensitivity analyses. For pooled change analyses with fewer than five independent studies, Hartung-Knapp-Sidik-Jonkman (HKSJ) intervals were examined as a small-sample sensitivity analysis.

Subgroup analysis Subgroup analyses evaluated age group, follow-up duration, and measurement method. For the follow-up subgroup analysis, observations at =6 months as long-term, so all effect estimates contributing to the overall descriptive IOP synthesis were represented.

Sensitivity analysis The main IOP and CH estimates were relatively stable across sequential inclusion and omission analyses, whereas CCT and several high-heterogeneity Corvis ST outcomes were more sensitive to study composition. For longitudinal IOP change, reconstruction of the Chang 2013 paired SDs with r=0.30, 0.50, and 0.70 did not change the direction of NCT, GAT, or DCT/PDCT effects. For pooled CH and CRF changes, small-sample HKSJ intervals were wider than the standard REML intervals and included the null, reinforcing cautious interpretation of the three-study pooled estimates.

Country(ies) involved China.

Keywords Orthokeratology; intraocular pressure; Myopia; Corneal Biomechanics; Ocular Response Analyzer.

Contributions of each author

Author 1 - Like Zhang - Study conception and design;Drafting of the article;Critical revision of the article.
Email: zhang_like9@163.com
Author 2 - Changliang Shao - Data collection;Data analysis and interpretation;Critical revision of the article.
Email: shaochangliang1@outlook.com
Author 3 - Bin Xing - Data analysis and interpretation;Critical revision of the article.
Email: xbjntr.binxing@outlook.com

Author 4 - Jing Zhang - Data analysis and interpretation;Critical revision of the article.
Email: zyxjingzhang.234@hotmail.com