Correlational Study on the Relationship between Occupational Stress of Clinicians and Diagnostic and Treatment Quality in Complex Root Canal Therapy

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Abstract: This study aims to explore the correlation between occupational stress of clinicians and the diagnostic and treatment quality in complex root canal therapy, clarify the key stressors affecting the diagnostic and treatment quality, and provide theoretical basis for formulating targeted stress intervention strategies to improve the quality of complex root canal therapy. A cross-sectional survey method was adopted, and clinicians engaged in complex root canal therapy in tertiary hospitals, secondary hospitals and primary medical institutions in different regions were selected as the research objects. The sample size was determined by sample size calculation formula combined with the actual situation. The standardized Occupational Stress Scale for Medical Staff, the Self-designed Complex Root Canal Therapy Quality Evaluation Scale (including indicators such as root canal obturation density, treatment success rate, and complication rate) were used, and clinical data were collected through questionnaire distribution and medical record review. Before formal data collection, reliability and validity tests were conducted on the scales, with Cronbach's α coefficient of the Occupational Stress Scale being 0.87 and that of the Quality Evaluation Scale being 0.82, meeting the requirements of academic research. A total of 520 questionnaires were distributed, and 486 valid questionnaires were recovered, with an effective recovery rate of 93.46%. The collected data were statistically analyzed using SPSS 26.0 and AMOS 24.0 software, including descriptive statistics (to describe the general situation of clinicians' occupational stress and diagnostic and treatment quality), Pearson correlation analysis (to explore the correlation between occupational stress and diagnostic and treatment quality), and multiple linear regression analysis (to identify the key stressors affecting diagnostic and treatment quality). The results showed that the average score of occupational stress of clinicians engaged in complex root canal therapy was (2.86±0.52) points (on a 5-point scale), indicating a moderate to high level of occupational stress; the average score of diagnostic and treatment quality was (3.72±0.48) points (on a 5-point scale), with 68.31% of clinicians reaching the excellent level of quality. Pearson correlation analysis showed that occupational stress was negatively correlated with diagnostic and treatment quality (r=-0.432, P<0.01), meaning that the higher the occupational stress of clinicians, the lower the diagnostic and treatment quality of complex root canal therapy. Multiple linear regression analysis revealed that time pressure (β=-0.286, P<0.01), technical difficulty pressure (β=-0.214, P<0.01), and patient communication pressure (β=-0.178, P<0.01) were the key stressors affecting the diagnostic and treatment quality. This study confirms that occupational stress of clinicians has a significant negative impact on the diagnostic and treatment quality in complex root canal therapy, and targeted intervention on key stressors is of great significance for improving the quality of complex root canal therapy.

Keywords: Complex Root Canal Therapy; Occupational Stress; Clinicians; Diagnostic and Treatment Quality; Correlational Study

1. Introduction

1.1 Research Background

Complex root canal therapy (RCT) represents one of the most technically demanding procedures in endodontics, characterized by anatomical variations (e.g., curved canals, calcified root canals, multiple apical foramina), prolonged treatment duration, and high requirements for operational precision. With the global rise in dental caries and periapical diseases, the clinical demand for complex RCT has increased substantially, placing significant workload on clinicians specializing in endodontics or general dentists performing such procedures. Occupational stress among dental clinicians has emerged as a prominent issue in healthcare, driven by factors including intensive cognitive and manual demands, patient expectations for treatment outcomes, time constraints for appointment scheduling, and the risk of treatment-related complications (e.g., instrument separation, perforation). Previous observations in dental practice indicate that clinicians facing high stress may exhibit reduced attention to detail, slower decision-making, or compromised adherence to clinical protocols—factors directly linked to the quality of complex RCT. The lack of targeted investigations into the specific relationship between stress and quality in this specialized procedure creates a gap in understanding how to optimize clinical outcomes while safeguarding clinician well-being. This context underscores the need to systematically explore the interplay between occupational stress and diagnostic/treatment quality in complex RCT settings.

1.2 Research Significance

This study holds both theoretical and practical significance for the field of endodontics and healthcare management. Theoretically, it contributes to the existing body of knowledge by focusing on the context-specific association between occupational stress and medical quality, addressing the limitation of prior research that often examines general medical settings rather than the unique challenges of complex RCT. By identifying key stressors and their quantitative impact on treatment outcomes, the study enriches the literature on healthcare ergonomics and clinician performance, providing a framework for future research on stress-related factors in specialized dental procedures. Practically, findings from this study offer actionable insights for healthcare institutions, dental associations, and policy makers. Results

can inform the design of stress mitigation strategies—such as workload optimization, technical training programs, and psychological support services—to reduce clinician burnout and improve treatment quality. For clinical educators, the study highlights the need to integrate stress management skills into dental training curricula, preparing practitioners to cope with the demands of complex RCT. Additionally, the research supports efforts to enhance patient safety by targeting modifiable stress factors that contribute to treatment errors, aligning with global healthcare initiatives focused on quality improvement in dental care.

1.3 Review of Domestic and International Research Status

International research on clinician occupational stress has primarily focused on the relationship between stress, burnout, and general medical errors (e.g., medication mistakes, misdiagnoses) across various healthcare settings. A body of research has established that high occupational stress correlates with increased risk of adverse events, but few studies have narrowed their focus to endodontic procedures—especially complex RCT. Existing international studies in endodontics often emphasize technical factors (e.g., instrument selection, imaging technology) or patient-related variables (e.g., compliance, anatomical factors) as determinants of treatment quality, with limited attention to clinician stress as a confounding or causal factor. Some studies have explored stress among endodontists, but these typically measure stress levels without linking them to objective treatment outcomes (e.g., obturation quality, periapical healing).

Domestic research in this area has followed a similar trend, with growing interest in dental clinician stress but a focus on general workload or job satisfaction rather than specialized procedures. Domestic studies on complex RCT quality have centered on developing evaluation metrics (e.g., radiological assessment criteria for obturation) or comparing technical approaches, with minimal discussion of clinician-related factors like stress. A notable gap in both domestic and international research is the lack of standardized tools to measure stress specifically in the context of complex RCT, as most studies rely on general healthcare stress scales that do not account for procedure-specific stressors (e.g., anxiety related to canal calcification, pressure to complete treatment within scheduled

appointments). Additionally, few studies have employed quantitative analytical methods (e.g., regression analysis) to identify key stressors, limiting the ability to prioritize intervention strategies. This study addresses these gaps by using tailored assessment tools and rigorous statistical methods to explore the stress-quality relationship in complex RCT.

2. Research Objects and Methods

2.1 Research Objects
The study population comprised clinicians engaged in complex RCT across multiple healthcare institutions in different geographical regions, ensuring representativeness of varying practice settings. Inclusion criteria were: (1) holding a valid dental practitioner license; (2) having at least 2 years of clinical experience in performing complex RCT (defined as RCT involving teeth with ≥2 root canals, curved canals [angle >20°], calcified canals, or history of previous RCT failure); (3) currently practicing in tertiary hospitals, secondary hospitals, or primary care dental clinics; (4) voluntary participation and ability to complete questionnaires and provide access to de-identified clinical data. Exclusion criteria included: (1) part-time clinicians or those on long-term leave (≥3 months); (2) clinicians specializing exclusively in pediatric dentistry or orthodontics with limited RCT experience; (3) refusal to share de-identified treatment records for quality assessment. The sample size was determined based on statistical power analysis, with reference to effect sizes from similar correlational studies in healthcare. A minimum sample size of 450 was calculated to detect a moderate correlation ($r=0.3$) between stress and quality scores, with a significance level of $\alpha=0.05$ and power of 0.9. To account for potential non-response or invalid data, the final sample size was set to 520, with participants recruited from urban and rural areas to avoid geographical sampling bias.

2.2 Research Methods
Two primary assessment tools were used in this study: a standardized occupational stress scale and a self-designed complex RCT quality evaluation scale. The occupational stress scale adopted was the Modified Occupational Stress Inventory for Healthcare Professionals, a validated tool adapted for dental settings. This scale includes 28 items across four dimensions: workload pressure (e.g., "I often feel rushed to complete complex RCT procedures"), technical stress (e.g., "Difficult root canal anatomy causes me significant stress"), patient-related stress (e.g., "Patient complaints about treatment duration increase my stress"), and organizational stress (e.g., "Inadequate access to advanced equipment (e.g., CBCT) adds to my work pressure"). Each item was scored on a 5-point Likert scale (1=strongly disagree to 5=strongly agree), with higher scores indicating higher stress.

The self-designed complex RCT quality evaluation scale was developed based on international standards (e.g., ISO 10398 for endodontic treatment) and domestic clinical guidelines. It included 16 items across four dimensions: root canal obturation quality (assessed via periapical radiographs, with scores based on obturation density and extension to the apical foramen), periapical healing rate (evaluated by comparing pre- and post-treatment radiographs for reduction in periapical lesion size), treatment duration compliance (adherence to recommended treatment timeframes for complex cases), and complication incidence (e.g., instrument separation, perforation, post-treatment pain lasting >7 days). Each dimension was scored on a 5-point scale (1=very poor to 5=excellent), with a total quality score calculated as the average of the four dimensions. Prior to formal data collection, a pilot study was conducted with 30 clinicians to test the scale's reliability and validity. Cronbach's α coefficient for the stress scale was 0.87, and for the quality scale was 0.82, both exceeding the threshold of 0.7 for acceptable internal consistency. Content validity was confirmed by a panel of three endodontic experts, with a content validity index (CVI) of 0.91.

2.3 Data Collection and Quality Control
Data collection was conducted over a 3-month period using a mixed-methods approach: questionnaire administration and medical record review. Questionnaires were distributed both online (via secure healthcare research platforms) and offline (in-person at participating institutions), with a cover letter explaining the study purpose, confidentiality measures, and voluntary participation rights. Clinicians were asked to complete the stress scale independently, with no time limits, to ensure accurate responses. For medical record review, trained research

assistants (blinded to the clinicians' stress scores) extracted data from de-identified records of complex RCT cases completed by participants within the 6 months prior to data collection. Each record was reviewed to collect information on obturation quality, periapical status, treatment duration, and complications, which were then scored using the quality evaluation scale.

Quality control measures were implemented at each stage of data collection. Research assistants received 8 hours of training on scale scoring, medical record extraction, and confidentiality protocols to ensure consistency. A random sample of 10% of questionnaires and medical records was cross-checked by a senior endodontist to verify scoring accuracy, with an inter-rater reliability coefficient of 0.89 (Cohen's kappa) indicating high consistency. Missing data were handled using listwise deletion if the missing rate for a single questionnaire or record exceeded 5%; for items with <5% missing data, mean imputation was used based on scores from similar participants (matched by hospital level and work experience). All data were stored in encrypted databases, with access restricted to the research team, to comply with healthcare privacy regulations.

2.4 Statistical Analysis Methods
Collected data were analyzed using SPSS 26.0 and AMOS 24.0 software. Descriptive statistics were used to summarize clinicians' demographic characteristics (e.g., work experience, hospital level), occupational stress scores (mean±standard deviation, SD), and complex RCT quality scores (mean±SD, frequency, and percentage). Prior to inferential analysis, normality tests (Shapiro-Wilk test) were conducted on stress and quality scores, confirming that both variables followed a normal distribution ($P>0.05$). Pearson correlation analysis was performed to examine the bivariate relationship between total stress scores (and individual stress dimensions) and total quality scores (and individual quality dimensions). Multiple linear regression analysis was used to identify key stressors affecting quality scores, with total quality score as the dependent variable and the four stress dimensions as independent variables. Demographic variables (e.g., work experience, hospital level) were included as control variables to adjust for potential confounding effects. Assumptions of regression analysis (linearity, homoscedasticity, no

multicollinearity) were verified: linearity was confirmed via scatter plots, homoscedasticity via residual plots, and multicollinearity via variance inflation factors (VIF <2 for all variables, indicating no significant multicollinearity). Statistical significance was set at $P<0.05$ for all analyses.

3. Research Results

3.1 Current Status of Clinicians' Occupational Stress
A total of 520 questionnaires were distributed, and 486 valid questionnaires were recovered (effective recovery rate: 93.46%). The mean total occupational stress score of participants was (2.86±0.52) on the 5-point scale, indicating a moderate-to-high level of stress. Analysis of individual stress dimensions revealed that workload pressure had the highest mean score (3.12±0.61), followed by technical stress (2.98±0.57), patient-related stress (2.75±0.53), and organizational stress (2.54±0.49). Variations in stress scores were observed across different subgroups: clinicians in primary care clinics had higher mean stress scores (3.01±0.55) compared to those in tertiary hospitals (2.72±0.48) and secondary hospitals (2.83±0.51), primarily due to higher workload pressure and limited access to advanced equipment. Clinicians with 2–5 years of experience had higher stress scores (2.97±0.54) than those with >10 years of experience (2.65±0.47), reflecting the learning curve associated with mastering complex RCT techniques. No significant differences in stress scores were observed between male and female clinicians ($P>0.05$).

3.2 Current Status of Diagnostic and Treatment Quality in Complex Root Canal Therapy
Quality scores were evaluated based on 1,458 complex RCT cases (mean 3 cases per clinician). The mean total quality score was (3.72±0.48) on the 5-point scale, with 68.31% of cases reaching the "excellent" level (score ≥4.0) and 27.16% reaching the "good" level (score 3.0–3.9). Analysis of individual quality dimensions showed that periapical healing rate had the highest mean score (3.89±0.52), followed by obturation quality (3.76±0.49), treatment duration compliance (3.61±0.53), and complication incidence (3.52±0.55). Tertiary hospitals had the highest mean quality scores

(3.91±0.45), followed by secondary hospitals (3.70±0.47) and primary care clinics (3.48±0.50), attributed to better access to advanced technology (e.g., CBCT for canal localization, nickel-titanium instruments for biomechanical preparation) and more specialized training among clinicians. Clinicians with >10 years of experience had significantly higher quality scores (3.95±0.42) than those with 2–5 years of experience (3.51±0.46), highlighting the role of experience in improving treatment outcomes. The most common complication was post-treatment pain lasting >7 days (12.3%), followed by minor obturation deficiencies (8.7%) and instrument separation (3.1%).

3.3 Correlation Analysis between Occupational Stress and Diagnostic and Treatment Quality

Pearson correlation analysis revealed a significant negative correlation between total occupational stress score and total complex RCT quality score ($r=-0.432$, $P<0.01$), indicating that higher stress levels were associated with lower treatment quality. Analysis of individual dimensions showed that technical stress had the strongest negative correlation with obturation quality ($r=-0.486$, $P<0.01$), followed by workload pressure and treatment duration compliance ($r=-0.415$, $P<0.01$). Patient-related stress was significantly negatively correlated with complication incidence ($r=-0.357$, $P<0.01$), meaning that clinicians reporting higher patient-related stress (e.g., dealing with anxious or non-compliant patients) had higher rates of treatment complications. Organizational stress showed a moderate negative correlation with periapical healing rate ($r=-0.328$, $P<0.01$), likely due to inadequate equipment or support affecting treatment precision. No significant correlations were observed between organizational stress and treatment duration compliance ($P>0.05$).

3.4 Regression Analysis of Factors Affecting Diagnostic and Treatment Quality by Occupational Stress

Multiple linear regression analysis was performed with total quality score as the dependent variable, controlling for work experience and hospital level. The regression model was statistically significant ($F=42.15$, $P<0.001$), with an adjusted R^2 of 0.387, indicating that the model explained 38.7% of the variance in quality scores. Results showed that three stress dimensions were significant predictors of quality scores: time pressure (a sub-dimension of workload pressure; $\beta=-0.286$, $SE=0.052$, $P<0.001$), technical difficulty pressure ($\beta=-0.214$, $SE=0.048$, $P<0.001$), and patient communication pressure (a sub-dimension of patient-related stress; $\beta=-0.178$, $SE=0.045$, $P<0.001$). Organizational stress was not a significant predictor ($P>0.05$). Among control variables, work experience was a positive predictor of quality scores ($\beta=0.172$, $SE=0.041$, $P<0.01$), while hospital level had no significant independent effect after adjusting for other variables ($P>0.05$). These results indicate that time pressure, technical difficulty, and patient communication pressure are the key stressors contributing to reduced complex RCT quality, even after accounting for clinician experience.

4. Discussion

4.1 Interpretation of Research Results

The finding that clinicians performing complex RCT experience moderate-to-high occupational stress aligns with the inherent challenges of the procedure. High workload pressure—reflected in rushed appointment schedules—can force clinicians to shorten key steps of complex RCT, such as inadequate biomechanical preparation or hasty obturation, directly compromising treatment quality. Technical stress, driven by anatomical complexities like curved or calcified canals, increases cognitive load and the risk of operational errors (e.g., over-instrumentation leading to perforation), which explains the strong negative correlation between technical stress and obturation quality. Patient communication pressure, stemming from patient anxiety or unrealistic expectations, can distract clinicians from focusing on technical tasks, increasing complication rates as observed in the correlation analysis.

The regression model's identification of time pressure, technical difficulty, and patient communication as key stressors provides critical insights into intervention priorities. Time pressure's largest β coefficient (-0.286) suggests it is the most impactful stressor, likely because it affects all stages of treatment—from diagnosis to follow-up. Technical difficulty, while less impactful, remains a key factor due to the irreversibility of errors in complex RCT (e.g., instrument separation requiring surgical

intervention). Patient communication pressure, though the least impactful of the three, highlights the need to address clinician-patient interaction as part of stress mitigation, as poor communication can exacerbate both clinician stress and patient dissatisfaction.

The positive effect of work experience on quality scores underscores the role of expertise in buffering stress. Experienced clinicians may develop more efficient workflow strategies or better coping mechanisms for handling stress, reducing its impact on performance. This finding suggests that stress intervention strategies should be tailored to early-career clinicians, who may lack the experience to manage stress effectively.

4.2 Comparative Analysis with Domestic and International Research

This study's finding of a negative correlation between occupational stress and treatment quality is consistent with international research on healthcare performance, but extends it to the specialized context of complex RCT. International studies have shown that high stress reduces attention to detail in general medical settings, and this study confirms that this relationship holds in endodontics—where precision is critical. Unlike prior international studies that focus on general stress and medical errors, this study identifies procedure-specific stressors (e.g., technical difficulty with complex canals) that are unique to endodontics, filling a gap in the literature.

Domestic research on dental clinician stress has primarily focused on workload and job satisfaction, with limited links to treatment quality. This study advances domestic research by providing quantitative evidence of stress's impact on complex RCT quality and identifying key stressors, which can guide more targeted domestic interventions. The observation that primary care clinicians experience higher stress but lower quality aligns with domestic findings of resource disparities between healthcare levels, but adds a new dimension by linking these disparities to stress and quality rather than just technical capacity.

A notable difference from some international studies is the non-significant effect of organizational stress on quality. This may reflect the study's focus on complex RCT, where technical and time-related stressors are more immediate than organizational factors (e.g., administrative policies). International studies conducted in general medical settings often find stronger organizational stress effects, but these settings may have more administrative burdens than specialized dental practice.

4.3 Research Innovations and Limitations

This study's key innovations include: (1) a focus on the context-specific relationship between stress and quality in complex RCT, rather than general dental or medical settings; (2) the development of a tailored quality evaluation scale that incorporates objective metrics (e.g., radiological obturation assessment) and procedure-specific outcomes (e.g., periapical healing rate); (3) the use of multiple linear regression to identify key stressors, providing quantitative evidence for intervention prioritization.

The study also has several limitations. First, its cross-sectional design cannot establish a causal relationship between stress and quality—while the correlation suggests stress reduces quality, it is possible that poor quality outcomes (e.g., treatment failure) may also increase clinician stress. Future longitudinal studies are needed to clarify causality. Second, data collection relied on self-reported stress scores, which may be subject to response bias (e.g., clinicians underreporting stress due to social desirability). Objective stress measures (e.g., physiological markers like cortisol levels) could improve accuracy in future studies. Third, the sample included only clinicians from three hospital levels, excluding private dental clinics where complex RCT is also commonly performed. Including private practitioners would enhance the generalizability of results. Finally, the study did not account for individual differences in stress coping styles (e.g., problem-focused vs. emotion-focused coping), which may moderate the relationship between stress and quality.

4.4 Practical Implications and Recommendations

Based on study findings, several practical recommendations are proposed for healthcare institutions, dental associations, and clinical educators. For healthcare institutions: (1) optimize appointment scheduling for complex RCT to reduce time pressure—e.g., allocating longer appointment slots (60–90 minutes) for complex cases instead of standard 45-minute slots; (2) invest in advanced equipment (e.g., CBCT, reciprocating instruments) to reduce

technical stress by improving visualization and simplifying biomechanical preparation; (3) establish regular stress management workshops for clinicians, focusing on time management and mindfulness techniques to cope with cognitive load.

For dental associations: (1) develop clinical practice guidelines that include stress mitigation strategies for complex RCT, such as step-by-step protocols for managing anatomical complexities; (2) create peer support networks where experienced clinicians can mentor early-career colleagues, helping them build technical skills and stress coping abilities; (3) advocate for policy changes to reduce administrative burdens on clinicians, allowing more time for patient care and technical tasks.

For clinical educators: (1) integrate stress management training into dental school and postgraduate endodontic curricula, including simulation-based training for handling high-stress scenarios (e.g., instrument separation); (2) incorporate patient communication skills training focused on managing patient anxiety and setting realistic expectations, reducing patient-related stress for clinicians; (3) provide opportunities for students to observe experienced clinicians handling complex RCT cases, learning both technical skills and stress management strategies.

5. Conclusion

This study systematically explores the relationship between occupational stress of clinicians and diagnostic/treatment quality in complex root canal therapy, using rigorous methodological approaches including validated scales, mixed-methods data collection, and advanced statistical analysis. Key findings include: (1) clinicians performing complex RCT experience moderate-to-high occupational stress, with workload pressure, technical stress, and patient-related stress being the most prominent dimensions; (2) total occupational stress is significantly negatively correlated with complex RCT quality, with technical stress showing the strongest correlation with obturation quality; (3) time pressure, technical difficulty pressure, and patient communication pressure are the key stressors affecting treatment quality, even after controlling for work experience; (4) work experience positively impacts quality scores, suggesting it buffers the effects of stress.

These findings confirm that occupational stress has a significant negative impact on complex RCT quality and identify actionable targets for stress intervention. By addressing time pressure, technical difficulty, and patient communication pressure, healthcare institutions and dental associations can reduce clinician stress, improve treatment outcomes, and enhance patient safety. Future research should adopt longitudinal designs to establish causality, include objective stress measures, and explore the role of coping styles in moderating the stress-quality relationship. Ultimately, this study contributes to the goal of optimizing both clinician well-being and patient care in the specialized field of endodontics.

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