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Patient Factors and Clinical Pathway Implementation in Post-Odontectomy Complications: A Partial Least Squares Structural Equation Modelling Study

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Track Record Article Accepted: Published:	Abstract 10 Purpose - This study aims to analyse the effect of Clinical Pathway implementation on post-odontectomy complications and to examine the influence of patient-related factors on postoperative outcomes at the Dental and Oral Hospital of Universitas Airlangga. Design/methodology/approach - A quantitative cross-sectional study was conducted using a survey method. The sample comprised 97 patients who underwent odontectomy and 10 healthcare professionals directly involved in the procedure, selected through purposive sampling. Data were collected from clinical pathway documentation, medical records, and structured questionnaires. The relationships among variables were analysed using Partial Least Squares-Structural Equation Modelling (PLS-SEM) with SmartPLS version 4. Findings - The results show that patient factors have a significant positive effect on post-odontectomy complications ($\beta = 0.855$; $p < 0.001$), indicating that individual characteristics such as age, comorbidities, and adherence to postoperative instructions are the primary determinants of complications. Conversely, Clinical Pathway implementation does not demonstrate a significant direct effect on post-odontectomy complications ($\beta = -0.012$; $p = 0.406$), nor does it significantly moderate the relationship between patient factors and postoperative complications ($\beta = -0.028$; $p = 0.296$). The structural model exhibits strong explanatory power, with an R-square value of 0.731. Conclusion - Patient-related factors play a dominant role in the occurrence of post-odontectomy complications, while Clinical Pathway implementation alone is insufficient to reduce complication rates. Strengthening patient-centred risk assessment and personalised postoperative management is therefore essential to improve clinical outcomes. Keyword: Clinical Pathway, Odontectomy, Postoperative Complications, Patient Factors, Healthcare Quality
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INTRODUCTION

Impacted teeth are defined as teeth that fail to erupt fully into the oral cavity due to being embedded within the jawbone, with the condition most commonly affecting third molars. This condition may lead to impaired masticatory function and a range of clinical complications not appropriately managed (Chaudhary et al., 2024). Globally, the prevalence of impacted third molars varies considerably, ranging from 9.5% to 68%, influenced by genetic factors, jaw growth patterns, and population characteristics (Passi et al., 2019)(Patel et al., 2024). This wide

variation indicates that third molar impaction remains a significant concern in dental practice worldwide.

In Indonesia, oral and dental health problems continue to pose a major public health challenge. Data from the 2018 National Basic Health Research (Riskesdas) reported that 57.6% of the Indonesian population experienced oral and dental health problems, including dental caries, periodontal disease, malocclusion, and impacted third molars (Kemenkes, 2023)(Ginanjar et al., 2022). Regional studies further support the high prevalence of impacted teeth, with research conducted in Malang reporting a prevalence of 60.6% (Septina et al., 2021) and a study in Semarang indicating an even higher prevalence of 94.6% (Faridha et al., 2019). These findings demonstrate that third molar impaction represents a substantial and persistent oral health problem in Indonesia that requires standardised and effective management.

Third molar impaction most commonly occurs during late adolescence and early adulthood, coinciding with the cessation of jaw growth and limited space within the dental arch (Alwan & Zaki, 2024). Insufficient eruption space is recognised as the primary cause of impaction, with contributing factors including genetic predisposition, variations in jaw development, and unfavourable oral habits such as mouth breathing (Cinthura et al., 2020)(Trakinienė et al., 2021). In many cases, surgical intervention in the form of odontectomy is required as definitive treatment.

Odontectomy is a surgical procedure performed to remove impacted or partially erupted teeth and is typically carried out by an Oral and Maxillofacial Surgeon. This procedure requires comprehensive preoperative assessment as well as appropriate intraoperative and postoperative management to minimise the risk of complications (Saleh et al., 2016). Despite these precautions, postoperative complications following odontectomy remain common and may include dry socket, infection, osteomyelitis, cellulitis, trismus, paraesthesia, and swelling (Goswami et al., 2020)(Mundiya & Sun, 2023). Among these, postoperative swelling is reported as the most frequent complication, with an incidence rate of up to 27% (Shaban et al., 2014).

The implementation of clinical pathways has been widely recognised as an effective strategy to improve healthcare quality and patient safety. A clinical pathway is a structured, diagnosis-based care plan designed to optimise clinical outcomes, reduce unwarranted variations in practice, and minimise the risk of complications (Siswanto & Chalidyanto, 2020). In addition to serving as a clinical guideline, clinical pathways facilitate systematic monitoring of care processes and evaluation of patient outcomes (Anggara et al., 2021). Non-adherence to clinical

pathways has been associated with delays in treatment and an increased risk of adverse outcomes, including postoperative infections (Lestari et al., 2020).

Previous studies have consistently demonstrated that adherence to clinical pathways is associated with improved quality of care, better clinical outcomes, and enhanced cost efficiency. A study by (Arwiana azisah, 2019), reported reduced length of hospital stay and improved patient outcomes in cases of infectious diseases, while research by (Mutiarasari et al., 2017) identified a significant association between clinical pathway implementation and improved service quality in patients with acute ischaemic stroke. However, evidence regarding the application of clinical pathways in odontectomy procedures, particularly in relation to postoperative complications, remains limited.

The urgency of this study is further emphasised by the high number of odontectomy procedures performed in dental and oral health services. Medical record data indicate that 59 patients underwent odontectomy in 2023, 56 patients in 2024, and 6 patients in early 2025. Although the number of procedures fluctuated annually, odontectomy remains one of the most frequently performed minor surgical interventions. Third molar impaction fulfils the criteria of high volume and high risk, which are key considerations in selecting topics suitable for clinical pathway implementation implementation (Bakel et al., 2024). Although a clinical pathway for odontectomy has been implemented since 2022, its execution has not been optimal, primarily due to limited staff engagement and the perception that the pathway increases clinical workload.

Based on these considerations, an evaluation of the impact of clinical pathway implementation on post-odontectomy complications is warranted. This study aims to provide empirical evidence regarding the effectiveness of clinical pathways in improving clinical outcomes and to support quality improvement initiatives, particularly in the management of post-odontectomy care.

METHODS

Study Design

This study employed a quantitative approach using a survey method with a cross-sectional design. The quantitative design was selected to objectively examine the relationships between variables and to generate findings that are generalisable to a defined population. The cross-sectional approach allows the independent and dependent variables to be measured

simultaneously within a single time frame, making it appropriate for assessing the effect of clinical pathway implementation on postoperative complications following odontectomy. A structured survey was used to collect primary data through systematically developed questionnaires, enabling a comprehensive assessment of clinical pathway adherence and associated clinical outcomes.

Study Participants

Participants consisted of oral and maxillofacial surgeons, residents enrolled in the oral and maxillofacial surgery training programme (PPDGS), and nurses who were directly involved in odontectomy procedures. Participants were selected using purposive sampling based on their direct involvement in odontectomy procedures and their familiarity with the implementation of the odontectomy clinical pathway.

Research Procedure

The research was conducted in three main stages. The preparation stage involved preliminary observations at the study site, a comprehensive literature review, identification of the research problem, and development of the research proposal. During this phase, eligibility criteria were also established to determine appropriate study participants.

The implementation stage involved data collection through the review of completed odontectomy clinical pathway forms and postoperative medical records. In addition, structured interviews were conducted with selected participants to support and clarify quantitative findings.

The final stage comprised data analysis and formulation of follow-up recommendations. All collected data from clinical pathway documentation, medical records, and participant interviews were compiled and analysed to evaluate the relationship between clinical pathway implementation and postoperative complications. The results of the analysis were subsequently synthesised into recommendations for stakeholders to support quality improvement initiatives.

Data Analysis

Quantitative data analysis was performed using SmartPLS (version 4). Partial Least Squares Structural Equation Modelling (PLS-SEM) was applied to assess the relationships between clinical pathway implementation, postoperative complications, and patient-related factors. The analysis included evaluation of the measurement model through indicators of validity and reliability, followed by assessment of the structural model to examine path coefficients and significance of hypothesised relationships. This approach was selected due to its suitability for complex models and its robustness when applied to relatively small sample sizes.

RESULTS

Presents the empirical findings obtained from the application of Partial Least Squares-Structural Equation Modelling (PLS-SEM) to examine the relationships between Patient Factors, Clinical Pathway Implementation, and Post-Odontectomy Complications. The discussion is structured systematically, beginning with an evaluation of the measurement model to ensure the validity and reliability of the constructs, followed by an assessment of the structural model to determine the strength of the relationships among variables and the explanatory power of the model. Each quantitative finding is not only interpreted based on statistical outcomes but is also critically contextualised within clinical practice and compared with relevant evidence from previous studies. This approach aims to provide a comprehensive understanding of the factors influencing post-odontectomy complications, while also evaluating the extent to which the implementation of clinical pathways contributes to improving clinical outcomes in dental and oral healthcare settings.

Measurement Model: Validity and Reliability Assessment

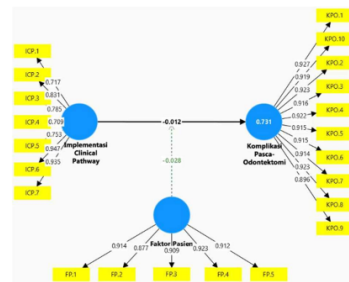


Figure 1. Validated Research Model

The structural equation model estimated using Partial Least Squares Structural Equation Modelling (PLS-SEM) is illustrated in Figure 1. The model depicts the relationships between the latent constructs of Clinical Pathway Implementation, Patient Factors, and Post-Odontectomy Complications, along with their respective indicators. Evaluation of measurement model demonstrated that all indicators achieved factor loading values above 0.70, confirming adequate convergent validity (Sarstedt et al., 2021). The highest loadings were

observed for indicators FP.4 and POC.3, while the lowest loading values remained within acceptable thresholds.

Table 1. Convergent Validity Test

Variable / Construct	Indicator	Loading Factor	Cronbach's Alpha	AVE	Remarks
Clinical					
Pathway Implementation	ICP.1	0.801	0.939	0.666	Valid
	ICP.2	0.717			Valid
	ICP.3	0.831			Valid
	ICP.4	0.785			Valid
	ICP.5	0.709			Valid
	ICP.6	0.935			Valid
	ICP.7	0.753			Valid
Patient Factors	FP.1	0.914	0.946	0.823	Valid
	FP.2	0.877			Valid
	FP.3	0.909			Valid
	FP.4	0.923			Valid
	FP.5	0.912			Valid
Post-					
Odontectomy Complications	KPO.1	0.927	0.979	0.841	Valid
	KPO.2	0.919			Valid
	KPO.3	0.923			Valid
	KPO.4	0.923			Valid
	KPO.5	0.915			Valid
	KPO.6	0.915			Valid
	KPO.7	0.914			Valid
	KPO.8	0.896			Valid
	KPO.9	0.914			Valid
	KPO.10	0.910			Valid

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Reliability testing was conducted to assess the internal consistency of each latent construct.

Construct reliability was evaluated using four main parameters, namely Cronbach's Alpha,

Composite Reliability (ρ_a dan ρ_c), and Average Variance Extracted (AVE). The following table presents the results of the reliability assessment for the three constructs examined in this study:

Table 2. Data Reliability Construct (n = 107)

Construct	Cronbach's Alpha	Composite Reliability (ρ_{hoa})	Composite Reliability (ρ_{hoc})	Average Variance Extracted (AVE)	Remarks
Patient Factors	0.946	0.946	0.959	0.823	Reliable
Clinical Pathway Implementation	0.939	0.891	0.932	0.666	Reliable
Post-Odontectomy Complications	0.979	0.979	0.981	0.841	Reliable

Based on Table 4, all constructs in the model exhibit Cronbach's Alpha and Composite Reliability values exceeding the recommended threshold of 0.70, indicating a high level of internal consistency among the indicators within each construct. In addition, all Average Variance Extracted (AVE) values are above the minimum criterion of 0.50, suggesting that the constructs demonstrate adequate convergent validity (Sarstedt et al., 2021). Accordingly, all constructs in this study can be classified as reliable, both in terms of inter-item consistency and their ability to explain the variance of their respective indicators.

Structural Model Evaluation (R-Square)

Table 3. R-Square and Adjusted R-Square Values of Post-Odontectomy Complication

Variables		
Dependent Construct	R-square (R^2)	Adjusted R-square
Post-Odontectomy Complications	0.731	0.723

Assessment of the structural model revealed an R-square value of 0.731 for the Post-Odontectomy Complications variable, as shown in Table 5. This indicates that 73.1% of the variance in post-odontectomy complications can be explained by Patient Factors and Clinical Pathway Implementation, including their interaction effects. According to the criteria proposed by Hair et al. (2021), this R-square value is considered substantial, suggesting that the model

demonstrates strong explanatory power. The adjusted R-square value of 0.723 further supports the robustness of the model after accounting for the number of predictors included.

DISCUSSION

Hypothesis Testing and Discussion

Table 4. Inner Model Testing

H	Hypothesis	Path Coefficient (O)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	p-value	Decision
H1	Patient Factors → Post-Odontectomy Complications	0.855	0.068	12.493	0.000	Supported
H2	Clinical Pathway Implementation → Post-Odontectomy Complications	-0.012	0.050	0.238	0.406	Not Supported
H3	Patient Factors × Clinical Pathway Implementation → Post-Odontectomy Complications	-0.028	0.052	0.537	0.296	Not Supported

The results of hypothesis testing obtained through the inner model analysis of PLS-SEM are presented in Table 6. Three primary hypotheses were tested to examine the effects of Patient Factors, Clinical Pathway Implementation, and their interaction on Post-Odontectomy Complications.

The first hypothesis (H1) indicates that Patient Factors have a significant effect on Post-Odontectomy Complications, with a path coefficient of 0.855, a t-statistic of 12.493, and a p-value < 0.001. This finding suggests that patient-related characteristics are the primary determinants of post-odontectomy complications. This result is consistent with previous studies demonstrating that age, comorbidities, and individual clinical conditions significantly influence the risk of complications following oral surgery (Shigeishi et al., 2015);(Hwang et al., 2016);(Cramer et al., 2016). In the Indonesian context, (Puspitasari et al., 2019) similarly

reported that post-odontectomy complications are predominantly associated with pain and swelling, which are closely linked to individual patient characteristics.

In contrast, the second hypothesis (H2) shows that Clinical Pathway Implementation does not have a significant direct effect on Post-Odontectomy Complications ($\beta = -0.012$; $p = 0.406$).

This finding suggests that the mere existence of a Clinical Pathway is insufficient to directly reduce complication rates. This result aligns with studies by (Güner, 2020) and (Heymans et al., 2022), which emphasise that the effectiveness of Clinical Pathways depends heavily on consistent implementation and multidisciplinary engagement. Nevertheless, other studies have reported contrasting results, demonstrating that comprehensively implemented Clinical Pathways can reduce postoperative complications (Karunakaran et al., 2021)(Huang et al., 2024), indicating that contextual factors and implementation quality play critical roles.

The third hypothesis (H3), which examined the moderating role of Clinical Pathway Implementation on the relationship between Patient Factors and Post-Odontectomy Complications, also yielded non-significant results ($\beta = -0.028$; $p = 0.296$). This suggests that Clinical Pathways did not function as a moderating variable in this model. Supporting this finding, (Luo et al., 2024) and (Blyleven et al., 2024) noted that Clinical Pathways primarily serve as tools for service standardisation and may not sufficiently mitigate the strong influence of biological and behavioural patient factors on clinical complications.

Implications of the Findings

Furthermore, the absence of a significant effect of Clinical Pathway Implementation on post-odontectomy complications may indicate a gap between formal protocol availability and its consistent application in daily clinical practice. Clinical pathways, while designed to standardise care and reduce unwarranted variation, may not fully account for the complexity and heterogeneity of patients undergoing odontectomy, particularly those with systemic conditions or differing levels of postoperative compliance. This finding suggests that the effectiveness of clinical pathways is highly dependent on contextual factors, including staff adherence, clinical judgement, and the flexibility of pathway use in response to individual patient needs.

In addition, the lack of a significant moderating effect implies that clinical pathways alone are insufficient to mitigate the strong influence of patient-related factors on surgical outcomes. This underscores the importance of integrating clinical pathways with comprehensive stratification frameworks, enabling clinicians to tailor perioperative and postoperative care strategies more precisely. Such integration may improve the early identification of high-risk

patients and facilitate timely preventive interventions, thereby reducing the likelihood of adverse outcomes.

Taken together, these findings emphasise that improving post-odontectomy outcomes requires a balanced approach that combines structured clinical governance with patient-centred care.

Future quality improvement initiatives should therefore focus not only on refining clinical pathway design, but also on strengthening implementation strategies, continuous staff training, and systematic monitoring of pathway adherence. By aligning standardised protocols with individual risk profiles, oral and maxillofacial surgical care may achieve more consistent and clinically meaningful improvements in patient outcomes.

CONCLUSIONS

This study concludes that Patient Factors have a significant effect on post-odontectomy complications, indicating that individual characteristics such as age, comorbidities, and adherence to medical instructions are the primary determinants of postoperative complications, including wound infection, trismus, and dry socket. In contrast, the implementation of a Clinical Pathway does not demonstrate a significant effect on reducing complications, suggesting that the presence of standardised procedures has not yet been optimally translated into routine clinical practice and requires further evaluation in terms of compliance and quality of implementation. Furthermore, the interaction between Patient Factors and Clinical Pathway implementation does not exhibit a significant moderating effect, thereby confirming the predominance of individual patient characteristics over pathway-based interventions in determining clinical outcomes. Overall, these findings highlight the importance of a more personalised, preventive, and risk-based approach to post-odontectomy patient management, in which systemic interventions are integrated with individual risk assessment. Nevertheless, the interpretation of the results should consider several limitations, including the cross-sectional study design, the single-centre setting, and the potential for information bias arising from the use of medical records and questionnaire-based data, indicating the need for future longitudinal and multicentre studies to strengthen the robustness of these findings.

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