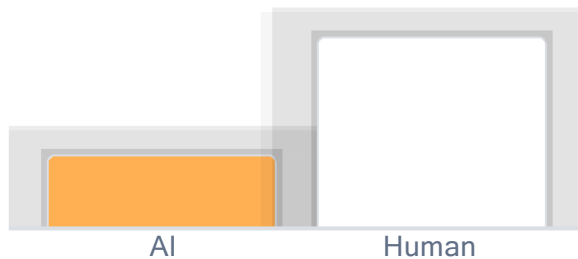




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Patient Factors and Clinical Pathway Implementation in Post-Odontectomy Complications: A Partial Least Squares Structural Equation Modelling Study

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Abstract

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

INTRODUCTION

Impacted teeth refer to teeth that do not erupt completely into the oral cavity because they remain partially or fully embedded within the jawbone. This condition most frequently involves the third molars. When not properly managed, impacted teeth can interfere with normal chewing function and may lead to various clinical complications (Chaudhary et al., 2024). The prevalence of impacted third molars differs widely across populations worldwide, with reported rates ranging from 9.5% to 68%. These variations are influenced by multiple factors, including genetic predisposition, patterns of jaw development, and specific population characteristics (Passi et al., 2019);(Patel et al., 2024). Such broad variability highlights that third molar impaction remains a common and significant issue in dental practice globally. In Indonesia, dental and oral health problems remain a significant public health issue. According to data from the 2018 Basic Health Research (Riskesdas), 57.6% of Indonesians were reported to have dental and oral health problems. The most common problems include dental caries, periodontal disease, malocclusion, and third molar impaction (Kemenkes, 2023);(Ginanjar et al., 2022). These data indicate that the burden of dental and oral diseases in Indonesia is still relatively high and requires more serious attention. 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 indicate that impacted wisdom teeth

remain a significant and persistent oral health problem in Indonesia, highlighting the need for more standardised and effective management strategies. Impacted wisdom teeth most commonly occur during late adolescence to young adulthood, a period when jaw growth has ceased and available space within the dental arch becomes limited (Alwan & Zaki, 2024). The primary underlying cause is insufficient space for tooth eruption. However, several additional factors may contribute, including genetic predisposition, variations in jaw development, and poor oral habits such as mouth breathing (Cinthura et al., 2020); (Trakinienė et al., 2021). In many cases, definitive management requires surgical removal through an odontectomy procedure. Odontectomy is a surgical intervention aimed at extracting impacted or partially erupted teeth, and is generally performed by an Oral and Maxillofacial Surgeon. This procedure requires a thorough preoperative evaluation, as well as careful intraoperative and postoperative management, to reduce the risk of complications (Saleh et al., 2016). However, post-operative complications are still relatively 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-compliance with clinical pathways has been associated with delays in therapy administration and an increased risk of adverse outcomes, including post-operative infections (Lestari et al., 2020). This indicates that deviations from standardised clinical pathways can have a direct impact on patient safety and the effectiveness of healthcare services. A number of previous studies have consistently shown that adherence to clinical pathways contributes to improved service quality, improved clinical outcomes, and cost efficiency of care. A study conducted by Arwiana azisah, (2019) reported a decrease in length of stay and improvement in patient condition in cases of infectious diseases after the implementation of clinical pathways. In addition, research by Mutiarasari et al., (2017) found a significant relationship between the implementation of clinical pathways and improved quality of care for patients with acute ischaemic stroke. These findings reinforce the importance of consistent implementation of clinical pathways in clinical practice to achieve optimal service outcomes. However, evidence regarding the application of clinical pathways in odontectomy procedures, particularly in relation to postoperative complications, remains limited. The importance of this research is reinforced by the consistently high number of odontectomy procedures performed in dental and oral health services. Based on medical records, 59 patients underwent odontectomy in 2023, followed by 56 patients in 2024, and

6 patients in the early months of 2025. Although the annual figures show some variation, odontectomy remains one of the most frequently performed minor surgical procedures in clinical dental practice. 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. Given these aspects, it is important to conduct a comprehensive evaluation of how the implementation of clinical pathways affects the incidence of post-extraction complications. This study is designed to produce empirical evidence on the effectiveness of clinical pathways in improving clinical outcomes, while contributing to ongoing quality improvement efforts, particularly in optimising patient management during the post-extraction care period.

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

This study was conducted in three main stages. The preparatory stage began with preliminary observations at the research site to obtain an initial overview of the conditions in the field. This was followed by a comprehensive literature review to strengthen the theoretical basis, followed by the formulation of research questions and the preparation of a research proposal. At this stage,

inclusion and exclusion criteria were also established as a basis for determining participants who were suitable for the research objectives. The implementation stage involved data collection through the review of completed odontectomy clinical pathway forms and patient medical records during the postoperative period.. 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 used to analyse the relationship between clinical pathway implementation, postoperative complications, and patient-related factors. The analysis was conducted in two main stages, namely evaluation of the measurement model by assessing the validity and reliability of the indicators, followed by testing of the structural model to determine the magnitude of the path coefficients and the significance of the hypothesized relationships between variables. This method was chosen because it is capable of handling complex models and still provides stable results even when used on a relatively limited sample size.

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. This discussion is organised systematically. It begins with an analysis of the measurement model to ensure that each construct meets the necessary standards of validity and reliability. Once this foundation has been established, the analysis proceeds to the structural model to evaluate the magnitude and direction of relationships between variables, as well as to assess the explanatory capacity of the model. Furthermore, quantitative results are not interpreted solely on the basis of statistical significance. Each finding is critically analysed based on clinical practice and compared with evidence reported in previous studies, without ignoring existing citations. Through this integrated approach, the discussion aims to provide a more comprehensive understanding of the determinants of post-extraction complications. At the same time, the discussion evaluates the extent to which the implementation of clinical pathways contributes to improving clinical outcomes in dental and oral health services.

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. This model illustrates the relationships between latent constructs, including Clinical Pathway Implementation, Patient Factors, and Post-Odontectomy Complications, along with their constituent indicators. The evaluation of the measurement model shows that all indicators have factor loadings above 0.70, indicating that the convergent validity criteria recommended by Sarstedt et al., (2021) are met. The highest loading values were found in indicators FP.4 and POC.3, while the indicators with the lowest loading values were still within acceptable limits, so that overall the measurement model can be considered adequate. 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

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 (rho_a dan rho_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 (rhoa)

Composite Reliability (rhoc)

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 exceeded the recommended threshold of 0.50, indicating that each construct met the convergent validity requirements (Sarstedt et al., 2021). These results indicate that the indicators are able to represent their respective latent constructs well. Therefore, the constructs analysed in this study can be considered reliable, both in terms of internal consistency between items and their ability to capture and explain the variance of the related indicators.

Structural Model Evaluation (R-Square)

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

Dependent Construct

R-square (R²)

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. These findings are consistent with previous studies showing that age, the presence of comorbidities, and certain clinical conditions play a significant role in increasing the risk of complications after oral surgery (Shigeishi et al., 2015); (Hwang et al., 2016); (Cramer et al., 2016). In the Indonesian context, (Puspitasari et al., 2019), also found that the most common complications after odontectomy were pain and swelling, which were greatly influenced by 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. These results are in line with the findings of Güner, (2020) and Heymans et al., (2022), which confirm that the effectiveness of Clinical Pathways is highly dependent on consistent implementation and the active involvement of multidisciplinary teams. In other words, the success of implementation is not only determined by the existence of written guidelines, but also by the commitment and coordination between professions in carrying them out. However, several other studies show different results. Studies by (Karunakaran et al., 2021); (Huang et al., 2024), report that comprehensively implemented Clinical Pathways can significantly reduce post-operative complications. These differing findings indicate that contextual factors and the quality of implementation play an important role in determining the real impact of Clinical Pathways in various healthcare settings. 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 risk 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 shows that patient factors have a significant effect on the occurrence of complications after odontectomy. This means that individual patient characteristics—such as age, comorbidities,

and level of compliance with medical instructions—are the main determinants of postoperative complications, including wound infection, trismus, and dry socket. In other words, the patient's condition and behaviour before and after the procedure have a greater contribution to clinical outcomes than procedural factors alone. Conversely, the implementation of the Clinical Pathway was not found to have a significant effect on reducing the complication rate. These findings indicate that standardised procedures have not been fully implemented in daily clinical practice. Therefore, further evaluation is needed regarding the level of compliance among healthcare professionals, consistency of implementation, and the quality of the pathway's implementation so that its benefits can be maximised. Furthermore, the interaction between Patient Factors and Clinical Pathway implementation also did not show a significant moderating effect. This further emphasises that individual patient characteristics remain the dominant factor in determining clinical outcomes, even when system-based interventions have been implemented. Overall, the results of this study emphasise the importance of a more personalised, preventive, and risk-based approach to post-odontectomy patient management. The integration of systemic interventions and individual risk assessment is key to minimising complications and improving the quality of post-operative care. 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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