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Demographics, Operative Metrics, and CO2 Utilization in Laparoscopic Surgery Cases

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Abstract

This study presents a comprehensive statistical analysis of 59 laparoscopic surgeries performed over nine months in 2024 at a tertiary care centre. It examines relationships between patient demographics, surgical diagnoses, operative duration, and intraoperative carbon dioxide (CO_2) consumption. The study highlights laparoscopic cholecystectomy as the predominant procedure and symptomatic gallstone disease as the primary diagnosis. Key findings include a mean patient age of 44 years with slight male predominance, a mean surgery duration of 77 minutes, and an average CO_2 usage of 94 liters. A strong positive correlation between surgical duration and CO_2 consumption was observed, indicating longer surgeries require more insufflation gas. Male patients exhibited longer operative times and higher CO_2 usage compared to females, likely due to increased inflammation and anatomical complexity. The analysis found that age minimally influenced operative time or CO_2 use, emphasizing procedural factors as critical drivers of resource utilization. This study underscores the importance of operative duration in planning and resource allocation and suggests potential for optimization in laparoscopic surgery practice. The findings support continuous data-driven monitoring to enhance surgical efficiency, cost-effectiveness, and patient outcomes in laparoscopic procedures.

Keywords: laparoscopic surgery; laparoscopic cholecystectomy; co_2 requirement; gender differences in surgery; patient demographics

Introduction

Laparoscopic surgery has revolutionized abdominal procedures by minimizing invasiveness, reducing recovery times, lowers wound infection incidences, reduces post-operative pain thereby improving patient outcomes [1]. Surgical centers continuously analyse operative data to monitor efficiency, resource utilization, and case characteristics. However, routine clinical information such as patient demographics, diagnostic patterns, surgery duration, and intraoperative resource consumption—especially carbon dioxide usage—remain underreported in the literature. This article presents a comprehensive statistical analysis of 59 consecutive laparoscopic procedures performed over a nine-month period in 2024, examining key parameters to shed light on patterns relevant for surgical audit, planning, and quality improvement.

Background and Rationale

Laparoscopic surgery has become a cornerstone of modern surgical practice due to its minimally invasive approach, leading to decreased postoperative pain, shorter hospital stays, and improved recovery. As the volume of laparoscopic procedures continues to rise globally, hospitals are compelled to evaluate their operative data systematically to ensure efficiency, safety, and optimal utilization of resources. Among these parameters, the time taken for surgery and intraoperative carbon dioxide use serve as significant operational indicators, reflecting both procedural complexity and cost implications.

The rationale behind this study is to analyse real-world operative data from a series of laparoscopic cases to identify patterns in patient demographics, diagnoses, and procedural factors that influence surgical duration and CO_2 consumption. By understanding these relationships, surgical teams can better plan operating schedules, anticipate supply needs, and develop strategies for improved procedural efficiency. This analytical approach not only supports clinical governance through performance benchmarking but also lays the groundwork for future research on optimizing resources in laparoscopic surgery.

Statement of Problem

Despite the widespread adoption of laparoscopic techniques, there remains a lack of comprehensive evaluation of operative variables that influence efficiency and resource utilization in routine surgical practice. Specifically, the relationship between patient

demographics, type of surgery, operative duration, and the amount of carbon dioxide used during procedures has not been adequately studied in many institutions. This gap limits the ability of surgical teams to forecast case complexity, optimize resource use, and improve procedural outcomes. Therefore, a systematic analysis of existing operative data is needed to identify patterns and correlations that can inform evidence-based decision-making, enhance operating room performance, and support cost-effective laparoscopic practice.

Research Question

What are the statistical relationships between patient demographics, surgical diagnoses, operative duration, and the amount of carbon dioxide used during laparoscopic surgeries, and how can these insights be applied to improve resource management and procedural efficiency in laparoscopic surgical practice.

Objective of The Study

The primary objective of this study is to conduct a detailed statistical analysis of laparoscopic surgery cases to identify key factors influencing operative time and carbon dioxide consumption.

Review of Literature

Laparoscopic surgery, particularly laparoscopic cholecystectomy, is well-established as a minimally invasive technique offering reduced recovery times and complication rates compared to open surgery. Several studies have investigated factors influencing operative time, a critical measure of efficiency and resource utilization. Gender and BMI show variable influence, with some evidence that male sex and higher BMI may extend operative duration, although findings differ across studies. In obese patients, the increased visceral fat and a larger liver can obscure anatomical landmarks, making laparoscopic procedures technically challenging and increasing the risk of conversion to open surgery [2].

In addition to operative time, resource consumption, including carbon dioxide usage for insufflation, is a relevant but less-studied parameter. Longer procedures logically require more CO_2, raising concerns about cost and environmental impact. While there is extensive literature on operative times and related factors, there is a paucity of comprehensive analyses linking patient demographics, disease characteristics, and CO_2 consumption in laparoscopic surgeries. Although Laparoscopic procedures offer improved diagnostic accuracy, lower wound infections, and provide faster recovery, there seems to be an increase in the operating time for the laparoscopic vs open surgery [3]. In contrast to earlier studies, present day studies show reduced operative time which may contribute to the adapted learning curve, availability of better instruments and imaging quality [1].

This study addresses this gap by analysing demographic and operative variables to better understand their statistical relationships and operational implications. Insights from such analyses can aid clinical decision-making in scheduling, resource allocation, and procedural optimization in laparoscopic surgery practice.

This literature review underscores the significance of studying operative time predictors and resource utilization to enhance efficiency and patient care quality in laparoscopic surgery.

Materials and Methods

This study utilized a retrospective observational design to analyse operative data from 59 laparoscopic cases performed between April and December 2024 in a tertiary care centre in Pune, Maharashtra. Data were extracted from hospital records and compiled into an Excel spreadsheet for analysis. Key variables included patient demographics (age, gender), diagnosis, type of laparoscopic surgery, surgery duration, anesthesia type, and amount of carbon dioxide (CO_2) consumed intraoperatively.

Age data were cleaned to extract numeric values, and surgery time was converted from text format (hours and minutes) into total minutes to enable quantitative analysis. Descriptive statistics were computed for all variables to summarize central tendencies and variation. Frequency distributions were generated for categorical variables such as gender, diagnosis, and type of surgery.

Pearson correlation coefficients were calculated to explore relationships between patient age, surgery duration, and CO_2 usage. Group comparisons were performed by diagnosis and surgical procedure to identify patterns in operative CO_2 consumption.

The methodology aimed for a comprehensive statistical evaluation to inform operative efficiency, resource utilization, and demographic influence in laparoscopic surgery. Limitations inherent to retrospective analyses, such as missing data and potential biases, were acknowledged and addressed through appropriate data cleaning techniques and summary measures.

Analysis and Interpretation of Data

The analysis of 59 laparoscopic surgery cases revealed insightful trends and correlations in operative variables. Patient demographics showed a mean age of approximately 44 years, with males comprising the majority of cases. Surgical diagnoses were dominated by symptomatic gallstone disease, and laparoscopic cholecystectomy was the most common procedure performed.

Descriptive statistics indicated a mean surgery duration of about 77 minutes with considerable variability, ranging from 24 to 240 minutes. CO_2 consumption averaged 94 liters, spanning a broad range indicative of differing procedural complexities and durations.

Correlation analysis demonstrated a strong positive relationship ($r \approx 0.63$) between surgical time and CO_2 usage, confirming that longer procedures require more insufflation gas. This supports the operational expectation that resource utilization scales with case length. The weak correlation between patient age and both surgical time and CO_2 use suggests that demographic factors minimally influence procedural efficiency in this sample.

Group-wise analysis showed variation in CO_2 use by diagnosis and surgery type, with laparoscopic cholecystectomy cases having specific consumption patterns likely related to technical demands. Gender distribution in common surgeries indicated a higher male representation, which aligns with the underlying disease epidemiology.

Interpreting these findings emphasizes the importance of operative duration as a key determinant of CO_2 resource allocation. The limited effect of age implies that scheduling and resource planning should primarily consider procedural and technical aspects rather than demographic profiles. The variability in metrics underscores the need for ongoing audit and customization of perioperative practices to enhance efficiency.

Discussion

Literature shows that Laparoscopic Cholecystectomy is the most frequent indication for laparoscopic surgery [4]. Our study also shows that 74.6% of laparoscopic surgeries were laparoscopic cholecystectomies. Kazuhide et al observed in his study that female patients were more likely to be younger and as compared to male patients [5]. In our study, the male to female ratio among patients undergoing laparoscopic surgeries is approximately 1:1.3. This ratio is consistent with broader clinical observations that females are more frequently affected by gallstone disease and thus undergo laparoscopic cholecystectomy more often than males, with female-to-male ratios typically around 4:1 reported in large scale studies. The difference in this dataset could reflect local demographic variations or the mix of other laparoscopic surgeries. Most laparoscopic cholecystectomies were performed for symptomatic cholelithiasis rather than acute cholecystitis in our study. Female patients are more likely to have a diagnosis of cholelithiasis but less likely to have a diagnosis of cholecystitis compared to male patients [5].

Male patients undergoing laparoscopic cholecystectomy in our study, had a mean surgery duration of approximately 67.9 minutes compared to females who had a shorter mean surgery duration of 56.5 minutes. This is in line with published studies that male patients generally experience longer surgery durations than females during laparoscopic cholecystectomy. Bazoua et al in his study found that gender affects the duration of surgery because more time is required to complete laparoscopic cholecystectomy in men than in women. [6]. This may be contributed to higher rates of inflammation, fibrosis, adhesions and anatomical complexities in males.

A study by Ayesha et al revealed that 41.7 % patients undergoing Laparoscopic cholecystectomy were aged 18-49 year [7]. Our study shows that majority of laparoscopic surgeries were performed in the age group of 30-60 years. Young adults constituted few cases who underwent laparoscopic appendicectomy, majority of patients who underwent laparoscopic cholecystectomy were between the age of 30-60 years and a small fraction of elderly patients underwent laparoscopic surgery for gall stone disease and hernia repairs. This age distribution aligns with established patterns for laparoscopic surgery, as gallstone and hernia prevalence peaks in middle age while appendectomies are more common in adolescents and young adults. Male patients showed slightly higher average CO2 consumption compared to females. This aligns with longer operating times and possibly more complex anatomy in males, leading to extended insufflation duration and volume.

Analysis of CO2 requirements by surgery in our study revealed that requirements in laparoscopic cholecystectomy ranged from 50-230 liters corelating with longer duration of surgery in contrast to 100

liters requirement in laparoscopic appendicectomy consistent with shorter, less complex surgeries. Laparoscopic hernia repairs (TEP, IPOM) show intermediate CO2 volumes, reflecting differences in surgical time and cavity space.

Conclusion

This study analysed data from 59 laparoscopic surgeries to understand relationships among patient demographics, surgical details, operative duration, and carbon dioxide consumption. The patient cohort had a mean age of about 44 years, with males representing the majority. Symptomatic gallstone disease and laparoscopic cholecystectomy were the most common diagnosis and procedure, respectively. Surgical duration averaged 77 minutes, with considerable variation that directly impacted CO_2 usage, which averaged 94 liters.

The analysis revealed a strong positive correlation between surgery time and carbon dioxide consumption, affirming that longer surgeries consume more insufflation gas. Conversely, patient age had minimal impact on operative time or gas usage. These findings highlight operative duration as the critical factor influencing resource utilization.

Efficient management of laparoscopic cases can benefit from this knowledge, aiding in better scheduling, supply planning, and cost containment. Variability in operative time and CO_2 usage suggests opportunities for further process improvements and optimization protocols.

In conclusion, optimizing laparoscopic surgery demands close attention to procedure duration as a driver of resource use, while patient demographics appear less influential. Continuous monitoring and data-driven management can improve operational performance and patient outcomes in laparoscopic surgery practice.

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