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# Trends in the Adoption of Minimally Invasive Surgery in a Resource-Limited Setting: An Eight-Year Retrospective Analysis from a Tertiary Care Hospital in Pakistan

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## Abstract

**Introduction:** Minimally invasive surgery (MIS) has gained global recognition for its superior outcomes, including reduced postoperative pain, shorter recovery times, and improved cosmetic results compared to open surgery. However, its adoption in resource-limited settings remains a challenge due to high equipment costs, limited training opportunities, and patient perceptions. This study aimed to evaluate the trends in the adoption of MIS versus open surgery over eight years in a public sector hospital in Pakistan.

**Methods:** A retrospective review was conducted of all elective abdominothoracic surgeries performed from January 1, 2015, to December 1, 2022, at the Department of General Surgery, a tertiary care hospital in Rawalpindi, Pakistan. Data were extracted from electronic surgical records, including the number and type of surgeries performed. Cases were categorised as open or minimally invasive, and annual trends were analysed. Conversion rates from MIS to open surgery were recorded. Statistical significance of trends was assessed using the chi-square test, with a p-value < 0.05 considered significant.

**Results:** A total of 4,119 elective surgeries were included, averaging 514 cases annually. In 2015, 79.5% of procedures were open surgery, with only 20.4% performed via MIS. By 2022, the trend had reversed, with 42.6% open surgeries and 57.3% MIS, a statistically significant change ($p < 0.001$). Conversion from MIS to open occurred in 17 cases.

**Conclusion:** The study highlights a significant shift toward MIS in a public hospital setting, demonstrating its feasibility in resource-limited environments. Continued efforts to reduce costs and enhance training are essential to sustain this trend and align with global surgical standards.

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## Introduction

Laparoscopic surgery is technically defined as a surgical procedure employing a minimal access approach, utilising specialised instruments to minimise tissue trauma associated with larger surgical incisions[1]. Once regarded as an advanced skill, minimal access surgery has, in recent years, evolved into a universal standard-of-care technique and is increasingly replacing the open approach in both elective and emergency settings.

This transition is driven by the well-documented advantages of laparoscopic surgery. Intraoperatively, these benefits include reduced blood loss, shorter operative times, and less tissue injury[2]. Postoperatively, laparoscopic procedures are associated with lower infection rates, reduced postoperative pain, shorter hospital stays, and superior cosmetic outcomes when compared to laparotomy[2,3].

Despite these clear advantages, the higher costs associated with laparoscopic equipment and its maintenance, alongside a steeper learning curve and substantial training expenses, have limited its adoption in developing countries and resource-limited settings. The cost-effectiveness of laparoscopic surgery in such contexts remains a subject of ongoing debate. Although recent studies suggest it may be cost-effective in the long term[4,5], the initial financial burden continues to pose significant challenges. Consequently, many healthcare centres in these regions still favour open surgery.

A growing body of literature from middle- and low-income countries has demonstrated that minimal access surgery is feasible, cost-effective, and safe in these settings[6,7]. However, most of these studies focus on short-term data, and the availability of laparoscopic facilities remains insufficient to form a definitive consensus. Ensuring the availability and utilisation of laparoscopic services has become a priority, particularly in public sector healthcare systems in low-income countries.

The objective of this study was to examine the availability and practice of minimally invasive surgical procedures in a tertiary care hospital within a middle-income country, and then to describe the outcomes of laparoscopic procedures performed over an eight-year period. Through this analysis, we aimed to demonstrate whether the shift towards minimal access surgery is not only feasible but essential for improving healthcare standards and aligning with global surgical practices in resource-constrained regions.

## Methods

### *Study Design and Setting*

A retrospective review was conducted of laparoscopic procedures performed in the Department of General Surgery at a public hospital in Pakistan. The study covered the period from 1st January 2015 to 1st December 2022. The department is a 52-bedded unit offering a wide range of general surgery services, including gastrointestinal, abdominal, and thoracic surgeries. It manages both elective cases admitted through the outpatient department and emergency cases from the Accident and Emergency Department.

### *Data Collection*

Data were extracted from the unit's electronic record register as part of an interdepartmental audit, with the approval of the department head. Depersonalised data regarding the type of surgery and mode of access (open or minimally invasive) were collected and summarised. As the study was retrospective and did not involve identifiable patient data, institutional review board (IRB) approval was not required.

### *Inclusion and Exclusion Criteria*

The study included all patients who underwent elective thoraco-abdominal surgery (either minimally invasive or open) during bi-weekly elective surgical lists. Emergency surgeries were excluded to minimise confounding factors, as these cases often involve greater complexity and time-sensitive decision-making that may not reflect standard elective surgical practices.

### *Data Analysis*

The total number of surgeries performed during the study period was calculated and categorised by type of procedure (open or minimally invasive). Annual trends were analysed, and comparisons were made between open and minimally invasive surgeries within each category. The results were visually represented using bar charts and line diagrams. Statistical significance was determined using the chi-square test, with a p-value of $< 0.05$ considered significant.

## Results

### *Overview of Surgical Procedures*

Data retrieved from electronic records revealed that a total of 4,119 patients underwent elective abdominothoracic surgeries over the eight-year study period (2015–2022), as detailed in supplemental table 1. Among these, 2,468 patients (59.9%) underwent open surgical procedures, while 1,651 patients (40.1%) were treated with laparoscopic (minimal access) techniques. On average, 514 elective thoraco-abdominal procedures were performed annually during this period. Figures 1 and 2 illustrate the annual breakdown of these cases.

### *Trends in Surgical Approaches*

Figure 2 presents the percentage distribution of open

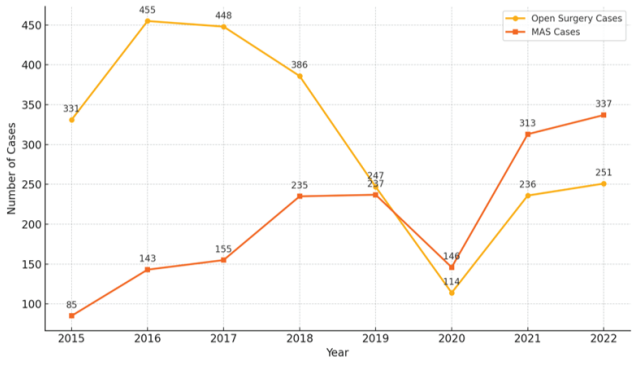


**Figure 1:** Open versus minimally invasive thoracoabdominal surgeries from 2015-2022

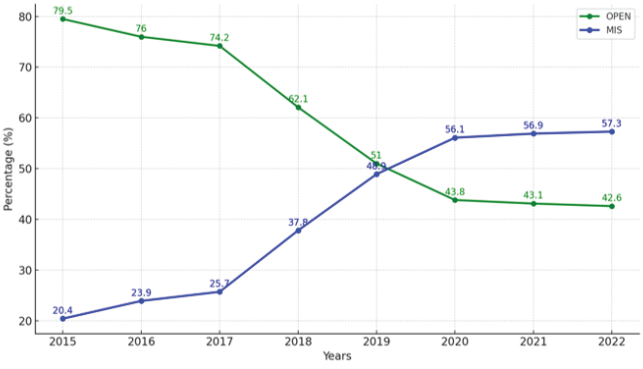


**Figure 2.** Line graph showing percentage distribution of open versus minimally invasive thoracoabdominal surgeries per year.

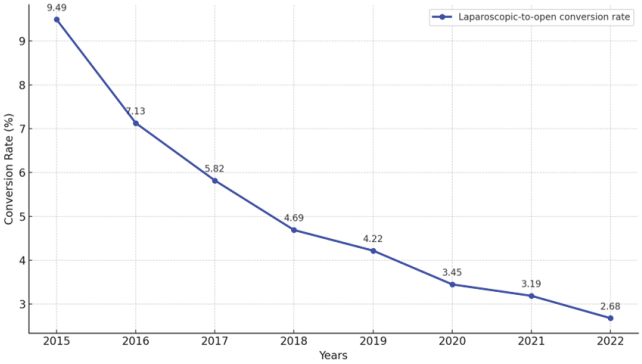


**Figure 3.** Conversion rate from laparoscopic to open surgery

versus minimal access surgeries over the eight years. In 2015, 331 (79.5%) of the thoraco-abdominal surgeries were performed using the open approach, while 85 (20.4%) were conducted via a minimally invasive technique. By 2022, this trend had reversed, with 251 (42.6%) surgeries performed via the open approach and 337 (57.3%) utilising minimally invasive methods. This shift towards increased adoption of minimal access surgery was statistically significant ($p<0.001$).

*Conversion Rates*

The conversion rate from laparoscopic to open surgery was also analysed over the eight-year period. A total of 17 laparoscopic procedures were converted to open surgeries due to technical challenges or complications such as intraoperative bleeding. The details of these conversions are summarised in Figure 3.

## Discussion

This study analysed the practice of minimally invasive surgical procedures in a tertiary care hospital in a developing country over an eight-year period. The results demonstrate a significant shift from open surgery to minimal access surgery, a trend that was statistically significant. Additionally, a progressive decrease in conversion rates from laparoscopic to open surgery was observed, reflecting improved surgical outcomes and expertise.

These findings highlight the sustained efforts of the hospital administration and faculty to adopt modern surgical techniques and provide cost-effective, state-of-the-art care to patients. While the increased costs associated with laparoscopic surgery often limit its feasibility in low-income countries, our experience has been positive, consistent with other studies in the region demonstrating comparable outcomes[6].

Over the eight-year period, several challenges were encountered. The first was the cost of acquiring and maintaining laparoscopic equipment. This was addressed through fundraising initiatives, including charitable contributions (zakat) and voluntary donations from residents and consultants. These funds, combined with the administrative budget, enabled the provision of basic laparoscopic equipment.

Innovative cost-reduction strategies were also implemented. Single-use instruments were sterilised and reused where permitted by international and national regulations[8,9,10]. For patients unable to afford equipment, costs were covered by charitable funds. Metal trocars, electrocautery instruments, and reusable gowns and drapes were employed. Makeshift solutions, such as using surgical gloves as specimen retrieval bags[11], and suture fixation for mesh in hernia repairs instead of more expensive tacks[12,13], further reduced expenses.

A second challenge was the limited availability of laparoscopic training opportunities, compounded by the steep learning curve associated with this technique[5]. To address this, a dedicated training programme was developed, including seminars, workshops, and a simulation laboratory with low-cost box trainers. Studies support the effectiveness of such trainers, showing them to be comparable to more expensive virtual reality simulators[15,16]. These initiatives enabled a significant increase in laparoscopic procedures while maintaining the annual departmental budget.

Another barrier was the perception among patients that

open surgery was superior to laparoscopic techniques. Many patients required counselling to address fears regarding complications and scarring associated with minimally invasive surgery. A study conducted in Pakistan in 2018 revealed that 73% of patients were apprehensive about laparoscopic surgery compared to 13.3% for open surgery[17]. However, with increased awareness, patient attitudes have shifted favourably towards minimal access techniques.

This study has several limitations. Firstly, it provides a statistical analysis of data without comparing long-term outcomes of open versus minimally invasive procedures. Secondly, the focus was limited to elective surgeries; emergency procedures, which often necessitate open techniques, were excluded[18,19]. Thirdly, the COVID-19 pandemic led to a significant reduction in elective surgeries in 2020, a trend observed globally[20].

Based on our findings, we recommend active engagement of policymakers and hospital administrations to develop systems that promote safe and cost-effective laparoscopic surgery. Addressing barriers to care and leveraging available resources at different income levels will be essential. Public hospital policies should be redefined to prioritise quality, safety, access, and economic considerations in scaling up laparoscopic services. Such measures are critical for aligning surgical care in developing regions with global standards.

**GAIT statement[21] for Generative AI use:** Generative AI was used for language editing in this manuscript. No content generation, data analysis, or substantive rewriting was performed. The authors take full responsibility for the accuracy and integrity of the work.

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