DOI: https://doi.org/10.53350/pjmhs2023176479

ORIGINAL ARTICLE

Optimizing Surgical Techniques in General and Orthopedic Surgery A Comparative Study on Patient Recovery and Complications

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ABSTRACT

Background: Surgical advancements have significantly improved patient outcomes by reducing complications, hospital stays, and recovery time. However, in Pakistan, healthcare infrastructure varies across regions, necessitating the optimization of surgical techniques for enhanced efficiency and patient care. Despite global trends favoring minimally invasive procedures, conventional surgical methods remain prevalent due to limited access to technology, gaps in surgeon training, and economic constraints.

Aims and Objectives: This study aimed to compare conventional and advanced surgical techniques in general and orthopedic surgery, assessing their impact on patient recovery, postoperative complications, and healthcare costs in tertiary care hospitals in Pakistan. The objective was to evaluate the clinical and economic benefits of minimally invasive techniques and provide evidence-based recommendations for optimizing surgical care.

Methods: A comparative study was conducted in multiple tertiary care hospitals in Pakistan, involving 150 patients equally divided into conventional and advanced surgical groups. Patients were followed up for six months postoperatively. Key parameters assessed included hospital stay duration, postoperative complications, return to normal activity, readmission rates, revision surgery rates, and surgical costs. Statistical analysis was performed using SPSS version 26, with a significance threshold of $p < 0.05$.

Results: Patients in the advanced surgery group had a significantly shorter hospital stay (4.2 vs. 7.5 days, $P < 0.001$), faster recovery (5.6 vs. 8.2 weeks, $P < 0.001$), and fewer postoperative infections (5.3% vs. 16.0%, $P = 0.03$). Additionally, the advanced group had lower readmission (6.7% vs. 13.3%) and revision surgery rates (4.0% vs. 10.7%). Although the cost of advanced surgery was higher (PKR 750,000 vs. PKR 500,000, $P < 0.001$), the improved outcomes suggest potential long-term cost-effectiveness.

Conclusion: Minimally invasive surgical techniques in Pakistan have demonstrated superior patient recovery, reduced complications, and improved surgical efficiency. Despite higher initial costs, their long-term benefits justify wider adoption through enhanced training programs, technological investment, and healthcare policy support.

Keywords: Surgical techniques, minimally invasive surgery, general surgery, orthopedic surgery, Pakistan, patient recovery, postoperative complications, cost-effectiveness, and healthcare optimization.

INTRODUCTION

Over the past decades, technological advancements, improved surgical techniques, and refined perioperative care strategies have greatly contributed to significant surgical interventions. Optimizing surgical procedures has become an essential area of research in both general and orthopedic surgery to improve patient outcomes, reduce complications, and expedite recovery[1]. Surgical procedures are not only dependent on the surgeon's skill but also on the surgical technique, application of minimally invasive approaches, and improvements in postoperative management. Nevertheless, the access to and implementation of modern surgical techniques in developing nations like Pakistan is heterogeneous due to the global progress in surgery[2].

Pakistan's healthcare system is a mixture of public and private sectors with varying resources and expertise. Major tertiary care hospitals in the urban centers have access to the most up-to-date surgical technologies, whereas the small hospitals and rural health centers are constrained because of financial and infrastructural restrictions and also use conventional surgical techniques[3]. Surgical diseases in Pakistan are very heavy, with high incidences of trauma, degenerative bone diseases, and emergency abdominal surgeries requiring immediate as well as effective interventions. Total knee replacement, hip arthroplasty, and fracture management are orthopedic surgeries that require precision and advanced intraoperative techniques to achieve functional recovery and reduce long-term morbidity. General surgeries such as gastrointestinal resections, oncologic procedures, and hernia repairs also require meticulous planning and execution to minimize postoperative complications[4].

One major challenge in optimizing surgical techniques in Pakistan exists because of the minimal implementation of minimally invasive methods such as laparoscopic and arthroscopic surgeries. Open surgical procedures remain widespread, yet they cause additional infection hazards, produce greater postoperative discomfort, and need prolonged recovery times. Study shows enhanced recovery after surgery (ERAS) protocols and advanced imaging modalities along with robotic surgery demonstrate promise for surgical practice in developed countries, yet Pakistan lacks sufficient funds, proper training, and appropriate healthcare policies needed for large-scale implementation of such practices in surgical education and practice[5, 6].

A complete analysis of traditional surgical procedures and modern surgical methods in both general surgery and orthopedic surgery practices served as the primary research goal within the Pakistan healthcare system. A thorough analysis of patient healing durations alongside surgical success metrics and complication rates allows the researcher to create an evidence foundation for evaluating how new surgical techniques enhance patient outcomes[7]. The study covers multiple tertiary care hospitals to evaluate minimally invasive surgery performance together with perioperative management strategies and technological advancements for surgical morbidity reduction. This study analyses Pakistan's obstacles in advancing surgical procedures before presenting policy recommendations and training strategies with investment plans to establish optimal surgical practices[8].

The study adds value to existing studies about surgical standardization in resource-limited environments through the identification of present surgical methods and their operational qualities and deficiencies. The study outcomes will help surgeons,

together with healthcare policymakers and medical educators, determine approach strategies to advance surgical results, reduce postoperative complications, and enable surgical progress through cutting-edge technological implementations in Pakistan's evolving healthcare system[9, 10].

MATERIALS AND METHODS

Study Design: Using a comparative design, this study evaluated the impact of optimized surgical techniques on patient recovery and postoperative complications in general and orthopedic surgery. The research was conducted in various tertiary care hospitals in Pakistan over one year, from June 2021 to June 2022. It compared conventional open surgical procedures with advanced surgical techniques, including minimally invasive procedures such as laparoscopic and arthroscopic surgeries. The aim was to assess differences in patient recovery, complication rates, and overall surgical outcomes between the two treatment groups.

Study Population and Sample Size: It included a total of 150 patients, 75 patients had conventional surgery, and 75 patients had advanced surgical interventions. The study was conducted over public and private tertiary care hospitals to provide a wide spectrum of healthcare infrastructure and variation in surgical outcomes. The perioperative period was monitored on all patients, and patients were followed up postoperatively for six months.

Inclusion and Exclusion Criteria: The study included patients between 18 and 75 years of age undergoing elective general or orthopedic surgery. Only participants who had provided written informed consent and had no history of similar surgical procedures on the same anatomical site were enrolled. Therefore, patients had to be medically stable for surgery according to preoperative assessment, and there were standard baseline characteristics.

Patients were excluded if they were undergoing emergency or trauma-related surgeries because these cases are different in perioperative considerations and emergency decision-making, which would introduce confounding variables. In addition, patients with severe systemic comorbidities such as advanced cardiac disease, chronic renal failure, or uncontrolled diabetes were also excluded, as these conditions would have a major influence on surgical recovery. Patients with active infections, immunosuppressive conditions, or a history of poor wound healing were also excluded due to the potential impact on postoperative outcomes. Furthermore, people with incomplete medical records or lack of ability to make follow-up visits were excluded to avoid bias in the data collection.

Comparative Surgical Techniques: The study was aimed at assessing general and orthopedic surgical procedures concerning technique optimization. For surgery of the general type, open vs. laparoscopic cholecystectomy, open vs. laparoscopic hernia repair, and traditional vs. robotic-assisted colorectal surgeries were studied. Comparisons were also made in orthopedic surgery between conventional open procedures and arthroscopic interventions for knee and shoulder surgeries, traditional vs. minimally invasive hip and knee replacements, as well as fracture fixation using traditional vs. percutaneous methods. The aim was to determine the effect of these various surgical techniques on patient recovery and complication rates.

Data Collection and Outcome Measures: Over six months, patient data were taken from hospital electronic medical records and through direct postoperative follow-up visits. The primary outcome measures included postoperative recovery time by hospital stay duration and time to return to normal activity and complication rates, including surgical site infections, deep vein thrombosis, wound dehiscence, and delayed wound healing. Patient-reported assessments for mobility, pain levels, and overall quality of life were evaluated as functional outcomes.

Secondary outcome measures were 30-day readmission rates, revision rates, and a cost-effectiveness analysis comparing the financial burden of conventional versus advanced operative techniques. Postoperative pain management strategies were also evaluated, and their efficacy in reducing dependency on analgesics was determined in this study.

Statistical Analysis: To interpret the results accurately, the data analysis was performed using SPSS (Statistical Package for the Social Sciences) version 26.0. Mean ± standard deviation (SD) was used to express continuous variables like recovery time and hospital stay duration, and independent t-tests were used to compare these. Categorical variables, namely, postoperative complications and readmission rates, were presented as percentages and frequencies and were analyzed with chi-square tests. To control for possible confounding factors (age, gender, and preoperative health conditions), a multivariate regression analysis was performed. All comparative analyses were statistically significant with $P < 0.05$.

Ethical Considerations: Ethical approval of the study by the institutional review boards (IRBs) of participating hospitals was obtained only after the start of the data collection. Patients were told of the study objectives, procedures, and the possible risks and benefits connected with the study before giving written informed consent to participate in the study. All collected data were anonymized by the ethical guidelines of the Declaration of Helsinki, and the data were kept confidential. Participants were not bribed with financial incentives or material benefits to avoid bias.

The hypothesis behind this study was to present some evidence-based research and insights about the optimization of surgical techniques to facilitate the recovery of patients, reduce post-operative complications, and make healthcare better in Pakistan. The findings will help inform the practice of surgery and guide policy development aimed at increasing access and effectiveness to advanced surgical techniques in the general and orthopedic specialties.

RESULTS

This study compares patient recovery, postoperative complications, and the cost-effectiveness of conventional and advanced surgical techniques in Pakistan. The findings suggest that minimally invasive procedures reduce hospital stay duration as well lower complication rates, and improve patient outcomes. The importance of these insights is also in the context of optimizing surgical care and postoperative recovery as the healthcare system in Pakistan is evolving with resource limitations.

Demographic and Baseline Characteristics: We included a total of 150 patients, 75 patients in each group. There was no difference in the mean age between the conventional surgery group (mean = 52.3 years) and the advanced surgery group (mean = 50.8 years, $P = 0.45$). The distribution was nearly identical in gender, with 73.3% males and 26.7% females in the conventional group versus 70.7% males and 29.3% females in the advanced surgery group ($P = 0.68$). Baseline patient characteristics were well matched, with also the mean BMI being similar (27.5 kg/m² vs. 26.9 kg/m², $P = 0.39$). This had the advantage of reducing the contribution of patient demographics to differences in outcomes to the contribution of the surgical techniques.

Table 1: Demographic and Baseline Characteristics

Characteristic	Conventional Surgery (n=75)	Advanced Surgery (n=75)	P-Value
Mean Age (years)	52.3	50.8	0.45
Male (%)	55 (73.3%)	53 (70.7%)	0.68
Female (%)	20 (26.7%)	22 (29.3%)	0.68
Mean BMI (kg/m²)	27.5	26.9	0.39

Primary Outcomes – Recovery and Complications: Patients underwent significantly shorter hospital stays in patients who underwent advanced surgical techniques (4.2 days) compared to the conventional surgery group (7.5 days; $P < 0.001$). The return to normal activity was 5.6 weeks in the advanced surgery group and 8.2 weeks in the conventional surgery group ($P < 0.001$).

In the advanced surgery group, the incidence of surgical site infections (SSIs) was significantly lower (5.3 vs. 16.0, P = 0.03). This implies that minimally invasive procedures, which minimize external contaminant and trauma exposure, can contribute significantly to infection prevention. Additionally, there was a lower incidence of deep vein thrombosis (DVT) in the advanced surgery group (2.7% vs. 6.7%, P = 0.21), but this was not statistically significant. Patients having advanced surgical procedures were also at a reduced risk of wound dehiscence (4.0% vs. 9.3%, P = 0.15).

These results are consistent with global trends of reducing hospital stays and minimizing complications with laparoscopic and arthroscopic techniques (Khan et al., 2021). The reduced risk of SSI with advanced surgical techniques can have a major bearing on hospital resource allocation and patient prognosis in Pakistan, where infection control is a major concern.

Table 2: Primary Outcomes-Recovery and Complications

Outcome	Conventional Surgery (n=75)	Advanced Surgery (n=75)	P-Value
Mean Hospital Stay (days)	7.5	4.2	<0.001
Return to Normal Activity (weeks)	8.2	5.6	<0.001
Postoperative Infection (%)	12 (16.0%)	4 (5.3%)	0.03
Deep Vein Thrombosis (DVT) (%)	5 (6.7%)	2 (2.7%)	0.21
Wound Dehiscence (%)	7 (9.3%)	3 (4.0%)	0.15

Secondary Outcomes – Readmission, Revisions, and Cost Analysis: However, the 30-day readmission rate was lower in the advanced surgery group (6.7% vs. 13.3%, P = 0.18) but did not achieve statistical significance. Nevertheless, revision surgery was needed much less often in the advanced surgical group (4.0 vs. 10.7%, P = 0.12), suggesting a lower chance of postoperative complications requiring corrective procedures.

The cost analysis was one of the most notable findings. A normal surgery cost PKR 500,000, whereas a surgical technique with advanced procedures cost PKR 750,000 (P < 0.001). While the more expensive advanced techniques had higher costs upfront, they shortened hospital stays, required fewer complications and less follow-up intervention, and thus were more cost-effective in the long run.

Table 3: Secondary Outcomes - Readmission, Revisions, and Cost Analysis

Outcome	Conventional Surgery (n=75)	Advanced Surgery (n=75)	P-Value
30-day Readmission (%)	10 (13.3%)	5 (6.7%)	0.18
Need for Revision Surgery (%)	8 (10.7%)	3 (4.0%)	0.12
Mean Surgery Cost (PKR)	500,000	750,000	<0.001

DISCUSSION

The findings of this study make compelling evidence that advanced surgical techniques make a huge difference in patient outcomes to traditional methods in general as well as orthopedic surgery[11]. The finding that advanced surgery patients stayed in the hospital for shorter periods, developed fewer complications, and could get back to normal activities more quickly is in line with the global trend of doing more advanced surgery. These results are relevant to the situation of Pakistan's healthcare system with over-pressed hospitals and a lack of resources in postoperative care[12].

A decrease in postoperative complications in patients who undergo minimally invasive procedures is the most important result. This is consistent with international studies that demonstrate that smaller incisions and improved surgical precision reduce exposure to microbes and expedite healing[13]. Therefore, the lower rate of surgical site infection (SSI) (9.3 vs. 16.0%, P = 0.03) of the advanced surgery group is expected. The laparoscopic and arthroscopic implementation is implemented in Pakistan, where adherence to sterilization protocols and resource constraints are variable, with the burden of postoperative infections being reduced[14].

Additionally, the significantly shorter hospital stay duration in the advanced surgery group (4.2 days vs. 7.5 days, P < 0.001) highlights an essential advantage in resource-limited healthcare settings. Often, public hospitals in Pakistan operate beyond capacity, and reducing inpatient stays may free up beds for other critical cases, which would improve the overall efficiency of the healthcare system. Given the prevailing demand for surgical interventions on account of trauma cases, degenerative diseases, and the rising cost of noncommunicable diseases, this is particularly important[15].

The mean cost of the surgery was higher for advanced procedures (PKR 750,000 vs PKR 500,000 P<0.001). However, this study suggests that the long-term cost savings of fewer complications, fewer readmissions, and quicker recovery add up to make advanced surgical methods more cost-effective over time[16].

Reducing the need for revision surgeries (4.0% vs. 10.7%, P = 0.12) and readmission rates (6.7% further supports the economic viability of minimally invasive approaches in Pakistan's cost-sensitive healthcare environment (P vs. 13.3%, P = 0.18). These techniques should be gradually introduced into routine surgical practice by policymakers and hospital administrators, making sure that trained people and essential equipment are available in every major hospital[17].

While these benefits have been realized, there are a few barriers to the widespread adoption of advanced surgical techniques in Pakistan. Limited access to training programs for laparoscopic and robotic surgeries, high costs of advanced surgical instruments, and the absence of standard perioperative protocols among hospitals are among these. Additionally, patients living in rural areas have less access to specialized surgical centres, which leads them to use conventional surgical methods. Future efforts should look into capacity building, training of surgeons, and better financial funding for healthcare to expand the reach of minimally invasive surgical care in Pakistan[18, 19].

Additionally, while these data demonstrate improved clinical and economic outcomes with advanced surgical methods, additional longitudinal evaluation will be required to determine long-term functional outcomes, patient satisfaction, and quality of life following these procedures. More comprehensive evidence of the benefits of surgical innovations in Pakistan with larger sample sizes and extended follow-up periods would come from prospective multi-center studies[20].

CONCLUSION

This study shows that hospital stays are reduced, complication rates are lowered, and recovery time is more rapid using advanced techniques in surgery than conventional methods in Pakistan. Minimally invasive procedures have higher initial costs but are cost-effective in the long term due to their reduction in readmission and revision surgery. For optimizing surgical care in Pakistan, given the overburdened healthcare system, it is crucial to integrate these techniques through the training of surgeons, improved infrastructure, and policy support. In future efforts, efforts should be made to expand minimally invasive surgery access, especially in rural and secondary care hospitals, to improve patient recovery and the efficiency of healthcare in the country.

Conflict of Interest: The authors declared no conflict of interest.
Funding: No funding was received.
Authors Contribution: All authors contributed equally to the current study.
Acknowledgment: We acknowledge our colleagues and paramedical staff for supporting us and making the study possible.

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