ORIGINAL RESEARCH

Prospective Evaluation of Postoperative Recovery and Pain Management in Minimally Invasive vs. Open Abdominal Surgery

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ABSTRACT

Aim: This prospective study aimed to evaluate postoperative recovery and pain management outcomes in patients undergoing minimally invasive surgery (MIS) versus open abdominal surgery. **Materials and Methods**: A total of 120 patients were enrolled and divided into two groups: 60 underwent MIS, and 60 underwent open surgery. Patients were assessed preoperatively for baseline characteristics, and postoperative recovery metrics including pain scores, time to first ambulation, hospital stay, complications, and return to normal activities were measured. Pain levels were assessed using a numerical rating scale (NRS) during the first 48 hours post-surgery. Follow-up assessments were made at 1 week, 1 month, and 3 months post-surgery. **Results**: The MIS group reported significantly lower pain scores at all postoperative time points (6, 12, 24, and 48 hours) compared to the open surgery group ($p < 0.01$). Additionally, patients in the MIS group had quicker recovery, with earlier ambulation (10.2 ± 3.4 hours vs. 14.7 ± 5.2 hours) and shorter hospital stays (3.4 ± 1.1 days vs. 6.2 ± 2.3 days). Complication rates were lower in the MIS group, with fewer surgical site infections (1.7% vs. 8.3%) and less bleeding (3.3% vs. 10.0%). At 1 and 3 months post-surgery, the MIS group also reported better quality of life and functionality. **Conclusion**: This study highlights the superior outcomes of minimally invasive surgery in terms of reduced pain, quicker recovery, fewer complications, and better long-term functional outcomes compared to open surgery. These findings suggest that MIS is a beneficial approach for abdominal surgeries, improving both short- and long-term patient recovery.

Keywords: Minimally invasive surgery, open surgery, postoperative recovery, pain management, quality of life.

INTRODUCTION

In recent years, there has been a paradigm shift in the field of surgery with the widespread adoption of minimally invasive techniques. Traditionally, abdominal surgeries were performed through large incisions, which required extensive recovery times, increased risk of complications, and longer hospital stays. However, the advent of minimally invasive surgery (MIS), including laparoscopic and robotic-assisted procedures, has significantly changed the landscape of abdominal surgery. These techniques, which involve smaller incisions, enhanced visualization, and more precise surgical interventions, promise to offer benefits both to the patient and the healthcare provider. One of the primary advantages touted by proponents of minimally invasive surgery is the potential for faster recovery and reduced postoperative pain.[1]

The comparison between minimally invasive surgery and traditional open abdominal surgery regarding postoperative recovery and pain management is a topic of increasing interest in the medical community. Open abdominal surgery, while effective and reliable in many cases, is associated with significant postoperative discomfort and prolonged recovery periods. On the other hand, minimally invasive approaches have been shown to result in less postoperative pain, shorter hospital stays, and quicker returns to normal activities. However, there are important nuances in these findings, and the extent to which these advantages are realized can vary based on the patient's condition, the complexity of the surgery,

and individual factors such as age and comorbidities.[2] Postoperative recovery is a multifaceted process that encompasses not only the alleviation of pain but also the restoration of function and the avoidance of complications such as infection, bleeding, and adhesions. In traditional open surgery, large incisions are required to access the abdominal cavity, which can disrupt normal tissue and muscle structure, leading to significant postoperative pain. The pain is often managed through a combination of medications, including opioids, nonsteroidal anti-inflammatory drugs (NSAIDs), and local anesthetics. However, the use of opioids in particular has raised concerns about dependency and side effects, prompting a push towards multimodal analgesia and the exploration of alternative pain management strategies.[3]Minimally invasive surgery, with its smaller incisions and less disruption of tissue, has the potential to reduce the severity of postoperative pain. Because the surgical trauma is less extensive, the pain experienced by patients following surgery is typically less intense, and the need for opioid medications may be reduced. Studies have demonstrated that patients who undergo minimally invasive procedures tend to report lower pain scores during the recovery period, experience fewer complications, and are able to mobilize more quickly than their counterparts who undergo open surgery. These advantages contribute to improved patient satisfaction and a more efficient use of healthcare resources, as shorter recovery times translate to shorter hospital stays and quicker returns to work and daily activities.[4]One of the key factors contributing to differences in postoperative pain and recovery between minimally invasive and open abdominal surgery is the technique's impact on tissue healing. The smaller incisions used in minimally invasive surgery result in less disruption of the abdominal muscles, fascia, and other soft tissues. This less invasive approach leads to a reduction in inflammatory responses and may promote faster healing. Moreover, the use of advanced technologies, such as robotic surgery, allows for more precise dissection and suturing, further minimizing tissue damage. As a result, patients are able to recover more quickly, with less pain and fewer complications.[5]Despite these advantages, there are also challenges and limitations associated with minimally invasive surgery. In some cases, the complexity of the procedure may limit the ability to perform surgery with minimal incisions. For example, some conditions or anatomical variations may require open surgery to achieve optimal results. Furthermore, while minimally invasive surgery is associated with less pain and faster recovery in the majority of cases, it is not a one-size-fits-all solution. Patients with certain comorbidities or those undergoing more complex procedures may still experience significant postoperative pain and prolonged recovery times, regardless of the surgical approach used.[6]In addition to the physical aspects of recovery, pain management is a critical component of the postoperative experience. Effective pain management strategies are essential for minimizing discomfort, promoting healing, and preventing complications. The use of opioids, while common, poses challenges due to the risk of dependence and adverse effects, leading to a growing emphasis on multimodal pain management approaches. Multimodal analgesia involves combining different classes of medications and techniques to target pain through various mechanisms, thereby reducing the reliance on opioids and enhancing overall pain control. Non-opioid medications, regional anesthesia techniques, and physical therapy are all components of this approach and can be particularly effective in the context of minimally invasive surgery, where the surgical insult is reduced.Despite the growing body of evidence supporting the benefits of minimally invasive surgery, it is important to note that there is still some variability in patient outcomes. Factors such as surgeon expertise, institutional resources, and patient selection can all play a role in determining the success of a minimally invasive approach. Furthermore, while the promise of reduced pain and faster recovery is compelling, the long-term outcomes of these surgeries, particularly in terms of recurrence rates and the need for additional interventions, remain areas of ongoing research.[7]This prospective evaluation of postoperative recovery and pain management aims to explore the comparative advantages and challenges of minimally invasive versus open abdominal surgery. By examining patient outcomes, pain scores, recovery times, and complications, this study seeks to provide valuable insights into how these two surgical approaches impact the postoperative experience. As the field of surgery continues to evolve, understanding the nuances of postoperative recovery and pain management will be essential for optimizing patient care and ensuring the best possible outcomes.

MATERIALS AND METHODS

This prospective study aimed to evaluate postoperative recovery and pain management outcomes in patients undergoing minimally invasive versus open abdominal surgery. A total of 120 patients, who were scheduled for abdominal surgery, were enrolled and divided into two groups based on the surgical technique: 60 patients underwent minimally invasive surgery (MIS), while the remaining 60 patients underwent open surgery. Inclusion criteria included adults aged 18 to 75 years, with no significant comorbidities that would interfere with the postoperative recovery process, and patients who provided informed consent to participate in the study. Exclusion criteria included patients with previous abdominal surgeries, major gastrointestinal disorders, or those with chronic pain conditions requiring long-term opioid use.

All procedures were performed by experienced surgeons, and the types of surgeries included

colectomy, hernia repair, and cholecystectomy. Preoperative assessment involved routine laboratory tests, imaging, and patient history to ensure optimal surgical planning. Postoperatively, pain management was standardized: both groups received multimodal analgesia, including intravenous opioids, nonsteroidal anti-inflammatory drugs (NSAIDs), and local anesthetic blocks as indicated. Pain levels were assessed using a numerical rating scale (NRS) at rest and with movement at set intervals during the first 48 hours following surgery.

Postoperative recovery was monitored through a range of outcomes, including time to first ambulation, length of hospital stay, incidence of postoperative complications (e.g., infection, bleeding), and return to normal activities. Follow-up assessments were conducted at 1 week, 1 month, and 3 months post-surgery to evaluate pain levels, functionality, and quality of life. Data were analyzed using appropriate statistical methods to compare postoperative recovery trajectories and pain management efficacy between the two surgical groups, with a significance threshold set at $p < 0.05$.

RESULTS

Table 1: Demographics and Baseline Characteristics of Study Participants The demographic data revealed that the two groups, minimally invasive surgery (MIS) and open surgery, were well-matched in terms of age, gender, and American Society of Anesthesiologists (ASA) scores. The average age of the MIS group was 48 years, while the open surgery group had an average age of 50 years, with no significant difference ($p=0.45$). The gender distribution was also balanced, with equal numbers of male and female participants in both groups ($p=0.72$). The ASA score, which is a classification of a patient's physical status before surgery, showed no significant differences between the groups ($p=0.61$), with most patients classified as ASA 2 (60% of the MIS group and 53.3% of the open surgery group). The types of surgeries performed, which included colectomy, hernia repair, and cholecystectomy, were comparable across both groups, with no significant differences in the distribution (p-values ranging from 0.54 to 0.76), suggesting that the surgeries were evenly distributed across the two groups.

Table 2: Postoperative Pain Scores at Various Time Points Pain scores were assessed at four postoperative time points (6, 12, 24, and 48 hours), and the results showed significant differences between the two groups at all intervals. The MIS group reported lower pain levels compared to the open surgery group. At 6 hours post-surgery, the MIS group had an average pain score of 4.2 ± 1.3, while the open surgery group reported a higher average of 6.1 ± 1.8 ($p < 0.01$). The difference remained significant at 12 hours (MIS: 3.5 ± 1.1 vs. open surgery: 5.8 ± 1.7, $p < 0.01$), 24 hours (MIS: 2.8 ± 1.0 vs. open surgery: 5.2 ± 1.6, $p < 0.01$), and 48 hours (MIS: 2.0 ± 0.9 vs. open surgery: 4.6 ± 1.5, $p < 0.01$). These findings suggest that patients undergoing MIS experienced less postoperative pain throughout the initial 48 hours following surgery, which is a key advantage of the minimally invasive approach in pain management.

Table 3: Postoperative Recovery Metrics Recovery metrics further demonstrated the advantages of minimally invasive surgery. The MIS group was able to ambulate earlier, with an average time to first ambulation of 10.2 ± 3.4 hours, compared to 14.7 ± 5.2 hours in the open surgery group ($p < 0.01$). Additionally, the length of hospital stay was significantly shorter for the MIS group (3.4 ± 1.1 days) compared to the open surgery group (6.2 ± 2.3 days) ($p < 0.01$), indicating a quicker recovery and discharge. Moreover, the time to return to normal activities was also faster for the MIS group (4.1 ± 1.3 weeks), compared to the open surgery group (6.8 ± 2.0 weeks) ($p < 0.01$). These results highlight the quicker recovery trajectory associated with minimally invasive techniques.

Table 4: Postoperative Complications The incidence of postoperative complications was generally low in both groups, though the open surgery group exhibited higher complication rates. The rate of surgical site infections (SSIs) was higher in the open surgery group (8.3%) compared to the MIS group (1.7%), but this difference did not reach statistical significance ($p=0.12$). Bleeding occurred in 3.3% of the MIS group and 10.0% of the open surgery group, with no significant difference ($p=0.22$). The incidence of anastomotic leaks was rare, occurring in only 1 patient in the open surgery group (1.7%). Other complications, including issues like wound dehiscence, were also more frequent in the open surgery group (11.7%) compared to the MIS group (5.0%), although these differences were not statistically significant ($p=0.18$). Overall, while the complications were few, the open surgery group experienced more, though this did not always achieve statistical significance.

Table 5: Quality of Life and Functionality at 1 Month and 3 Months Post-Surgery The quality of life and functional recovery of patients were significantly better in the MIS group at both 1 month and 3 months post-surgery. At 1 month, the MIS group reported a significantly lower pain score (1.1 ± 0.7) compared to the open surgery group (3.2 ± 1.2) ($p < 0.01$). Additionally, the functional score at 1 month was higher for the MIS group (80.2 ± 9.3) compared to the open surgery group (70.5 ± 11.8) ($p < 0.01$). At 3 months post-surgery, the MIS group continued to report lower pain levels (0.5 ± 0.6 vs. 1.8 ± 1.0 for open surgery, $p < 0.01$) and a higher functional score

(90.1 ± 8.0 vs. 80.0 ± 10.5 for open surgery, $p < 0.01$). These results reflect not only a faster recovery but also better long-term outcomes in terms of pain management and functional recovery for patients undergoing minimally invasive surgery.

Table 1: Demographics and Baseline Characteristics of Study Participants

Characteristic	MIS Group (n=60)	Open Surgery Group (n=60)	p-value
Age (years)	48 ± 12	50 ± 11	0.45
Gender (M/F)	30/30	32/28	0.72
ASA Score (1/2/3)	20/30/10	18/32/10	0.61
Type of Surgery			
Colectomy	20	22	0.76
Hernia Repair	18	20	0.75
Cholecystectomy	22	18	0.54

Table 2: Postoperative Pain Scores at Various Time Points

Time Post-Surgery (hours)	MIS Group (n=60)	Open Surgery Group (n=60)	p-value
6 hours	4.2 ± 1.3	6.1 ± 1.8	<0.01
12 hours	3.5 ± 1.1	5.8 ± 1.7	<0.01
24 hours	2.8 ± 1.0	5.2 ± 1.6	<0.01
48 hours	2.0 ± 0.9	4.6 ± 1.5	<0.01

Table 3: Postoperative Recovery Metrics

Metric	MIS Group (n=60)	Open Surgery Group (n=60)	p-value
Time to First Ambulation (hrs)	10.2 ± 3.4	14.7 ± 5.2	<0.01
Length of Hospital Stay (days)	3.4 ± 1.1	6.2 ± 2.3	<0.01
Time to Return to Normal Activity (weeks)	4.1 ± 1.3	6.8 ± 2.0	<0.01

Table 4: Postoperative Complications

Complication	MIS Group (n=60)	Open Surgery Group (n=60)	p-value
Surgical Site Infection	1 (1.7%)	5 (8.3%)	0.12
Bleeding	2 (3.3%)	6 (10.0%)	0.22
Anastomotic Leak	0 (0.0%)	1 (1.7%)	0.32
Other Complications	3 (5.0%)	7 (11.7%)	0.18

Table 5: Quality of Life and Functionality at 1 Month and 3 Months Post-Surgery

Time Point	MIS Group (n=60)	Open Surgery Group (n=60)	p-value
1 Month Pain Score (NRS)	1.1 ± 0.7	3.2 ± 1.2	<0.01
1 Month Functional Score	80.2 ± 9.3	70.5 ± 11.8	<0.01
3 Month Pain Score (NRS)	0.5 ± 0.6	1.8 ± 1.0	<0.01
3 Month Functional Score	90.1 ± 8.0	80.0 ± 10.5	<0.01

DISCUSSION

This prospective study demonstrated the advantages of minimally invasive surgery (MIS) in terms of postoperative recovery and pain management, with significantly improved outcomes compared to open surgery. The demographics and baseline characteristics of the study participants showed no significant differences between the two groups in terms of age, gender, ASA score, and the type of surgery performed (colectomy, hernia repair, or cholecystectomy). These findings are consistent with those of a similar study by Lee et al. (2009), which also found no significant demographic differences between MIS and open surgery groups, ensuring that the observed differences in recovery could be attributed to the surgical approach rather than baseline factors. Furthermore, the balanced distribution of surgeries in both groups minimizes the impact of different procedures on the outcomes.[7]

In terms of pain management, our study found that patients who underwent MIS reported significantly lower pain scores at all postoperative time points (6, 12, 24, and 48 hours) compared to those who underwent open surgery. This result is supported by the findings of Tjandra et al. (2009), who reported that MIS patients generally experience less postoperative pain and require fewer analgesics than those undergoing open surgery. In their study, the average pain score in the first 24 hours post-surgery was also significantly lower in the MIS group, with the open surgery group experiencing higher pain levels similar to those found in our study.[8]The lower pain levels in the MIS group in this study (MIS: 4.2 at 6 hours, 3.5 at 12 hours, 2.8 at 24 hours, and 2.0 at 48 hours)

further corroborate the significant reduction in postoperative discomfort typically seen in minimally invasive approaches.

The faster recovery observed in the MIS group was another key finding of our study. The MIS group was able to ambulate earlier (10.2 hours vs. 14.7 hours for open surgery) and had a shorter length of hospital stay (3.4 days vs. 6.2 days for open surgery). These results align with those of Järvinen et al. (2010), who also reported quicker recovery and earlier ambulation in MIS patients following abdominal surgery. In their study, the median time to first ambulation was significantly shorter in the MIS group (8 hours) compared to the open surgery group (14 hours), reinforcing the advantage of MIS in facilitating early recovery and discharge.[9] Moreover, our study's finding that the time to return to normal activities was faster in the MIS group (4.1 weeks vs. 6.8 weeks for open surgery) is consistent with other studies, such as that of Patel et al. (2011), which showed that patients undergoing MIS returned to their daily activities significantly sooner than those who had open surgery.[10]

Although the incidence of postoperative complications was low in both groups, the open surgery group did experience a higher rate of surgical site infections (SSIs) and other complications. These findings are in line with the work of Harris et al. (2011), who found that patients who underwent open surgery had higher rates of SSIs and other complications, including wound dehiscence, compared to those who underwent minimally invasive procedures. In their study, the SSI rate for open surgery patients was 10%, compared to 2% for MIS patients, similar to our findings.[11] While the differences in complications in our study were not statistically significant, the trends toward fewer complications in the MIS group suggest that this approach is associated with a lower risk of postoperative issues, as noted in previous literature.

In terms of quality of life and functionality, the MIS group showed significantly better outcomes at both 1 month and 3 months post-surgery. At 1 month, the MIS group reported a lower pain score (1.1 vs. 3.2 for open surgery) and a higher functional score (80.2 vs. 70.5 for open surgery), which was maintained at 3 months. This is consistent with the findings of Mullen et al. (2007), who observed that patients who underwent MIS experienced superior functional recovery and lower pain scores at 3 months post-surgery compared to those who had open surgery. In their study, the MIS group had an average pain score of 1.3 at 1 month and a functional score of 85, demonstrating similar trends of faster recovery and better long-term outcomes in terms of both pain and functionality .[12] Our study adds to this body of evidence by further confirming that the benefits of MIS in reducing pain and enhancing functional recovery persist well into the postoperative period.

CONCLUSION

In conclusion, this study demonstrates that minimally invasive surgery (MIS) offers significant advantages over open surgery in terms of postoperative recovery, pain management, and long-term outcomes. Patients undergoing MIS experienced lower pain scores, quicker ambulation, shorter hospital stays, and faster return to normal activities compared to those who underwent open surgery. Furthermore, while both groups had low complication rates, the MIS group tended to have fewer complications.

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