Chelonian Conservation And Biology

Vol. 17No.2 (2022) | https://www.acgpublishing.com/ | ISSN - 1071-8443

DOI:doi.org/10.18011/2022.04(1) .3467-3475

IMPACT OF PRE-OPERATIVE REHABILITATION ON POSTSURGICAL COMPLICATIONS AND RECOVERY

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Abstract

Pre-operative rehabilitation, or prehabilitation, has emerged as a promising strategy to improve post-surgical outcomes and reduce complications. This study aimed to investigate the impact of prehabilitation on postsurgical complications and recovery among patients undergoing various surgical procedures. A systematic review and meta-analysis were conducted, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Randomized controlled trials (RCTs) comparing prehabilitation with standard care were included. The primary outcomes were postsurgical complications and length of hospital stay (LOS). Secondary outcomes included functional capacity, quality of life (QoL), and pain. Random-effects meta-analyses were performed to calculate pooled effect sizes. Twenty-eight RCTs, involving 3,542 patients, were included. Prehabilitation significantly reduced the risk of postsurgical complications (risk ratio [RR] = 0.68, 95% confidence interval [CI]: 0.57-0.81, $p < 0.001$) and LOS (mean difference [MD] = -1.82 days, 95% CI: -2.41 to -1.23, $p < 0.001$) compared to standard care. Prehabilitation also improved functional capacity (standardized mean difference [SMD] = 0.45, 95% CI: 0.26-0.64, $p < 0.001$), QoL (SMD = 0.29, 95% CI: 0.14-0.44, $p < 0.001$), and pain (MD = -0.79, 95% CI: -1.14 to -0.44, $p < 0.001$) after surgery. The findings suggest that prehabilitation is an effective strategy to reduce postsurgical complications, shorten hospital stay, and improve functional outcomes and QoL in patients undergoing surgery.

Keywords: prehabilitation, pre-operative rehabilitation, postsurgical complications, recovery, systematic review, meta-analysis

Introduction

Surgical procedures are associated with various postsurgical complications, prolonged hospital stays, and reduced functional capacity and quality of life (QoL) (Ljungqvist et al., 2017). Pre-operative rehabilitation, or prehabilitation, has emerged as a promising strategy to mitigate these adverse outcomes and improve post-surgical recovery (Carli & Scheede-Bergdahl, 2015). Prehabilitation is defined as a multimodal approach that includes exercise, nutritional optimization, and psychological support in the pre-operative period to enhance patients' functional capacity and physiological reserve (Silver & Baima, 2013).

Numerous studies have investigated the impact of prehabilitation on postsurgical outcomes across various surgical specialties, including orthopedics, abdominal surgery, and cardiothoracic surgery (Barberan-Garcia et al., 2018; Bousquet-Dion et al., 2018; Moran et al., 2016). These studies have demonstrated that prehabilitation can improve functional capacity, reduce postsurgical complications, and shorten hospital stay (Barberan-Garcia et al., 2018; Bousquet-Dion et al., 2018; Moran et al., 2016). However, the overall effect of prehabilitation on postsurgical outcomes remains unclear due to the heterogeneity of interventions, patient populations, and surgical procedures across studies.

Previous systematic reviews and meta-analyses have examined the impact of prehabilitation on postsurgical outcomes, but they focused on specific surgical specialties or patient populations (Hughes et al., 2019; Marmelo et al., 2018). A comprehensive synthesis of the evidence across surgical specialties is needed to guide clinical decision-making and inform future research. Therefore, this study aimed to conduct a systematic review and meta-analysis of randomized controlled trials (RCTs) to investigate the impact of prehabilitation on postsurgical complications and recovery among patients undergoing various surgical procedures.

Objectives

The primary objectives of this systematic review and meta-analysis were:

1. To determine the effect of prehabilitation on postsurgical complications compared to standard care in patients undergoing surgery.
2. To evaluate the impact of prehabilitation on length of hospital stay (LOS) compared to standard care in patients undergoing surgery.

The secondary objectives were:

1. To assess the effect of prehabilitation on functional capacity, QoL, and pain after surgery compared to standard care.
2. To explore the influence of prehabilitation on other postsurgical outcomes, such as readmission rates and healthcare costs.

Methods

Protocol and Registration

This systematic review and meta-analysis were conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009).

Eligibility Criteria

Studies were eligible for inclusion if they met the following criteria:

1. Study design: RCTs comparing prehabilitation with standard care or no intervention.
2. Participants: Adult patients (≥18 years) undergoing any surgical procedure.
3. Intervention: Prehabilitation programs that included exercise, nutritional optimization, and/or psychological support in the pre-operative period.
4. Comparator: Standard care or no intervention.
5. Outcomes: Studies reporting at least one of the following outcomes: postsurgical complications, LOS, functional capacity, QoL, or pain.
6. Language: Studies published in English.

Studies were excluded if they were non-randomized trials, observational studies, case reports, or conference abstracts.

Information Sources and Search Strategy

A comprehensive literature search was conducted in the following electronic databases from inception to December 2022: PubMed, Embase, Cochrane Central Register of Controlled Trials (CENTRAL), and Physiotherapy Evidence Database (PEDro). The search strategy included a combination of Medical Subject Headings (MeSH) terms and keywords related to prehabilitation, surgery, and postsurgical outcomes. The complete search strategy for each database is provided in the supplementary material.

Study Selection

Two reviewers independently screened the titles and abstracts of the retrieved studies for eligibility. Full-text articles of potentially eligible studies were obtained and independently assessed by the same reviewers. Disagreements were resolved through discussion or by consulting a third reviewer.

Data Collection Process

Data extraction was performed independently by two reviewers using a standardized data extraction form. The extracted data included study characteristics (authors, year, country, sample size), participant characteristics (age, sex, surgical procedure), intervention details (type, duration, frequency), comparator details, and outcomes (postsurgical complications, LOS, functional capacity, QoL, pain). Disagreements were resolved through discussion or by consulting a third reviewer.

Risk of Bias Assessment

The risk of bias in the included studies was independently assessed by two reviewers (K.A.A.A. and J.A.A.A.Q.) using the Cochrane Risk of Bias tool 2 (RoB 2) for randomized trials (Sterne et al., 2019). The tool assesses bias in five domains: randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. Each domain is judged as having a low risk of bias, some concerns, or a high risk of bias. Disagreements were resolved through discussion or by consulting a third reviewer (M.A.S.A.).

Data Synthesis and Statistical Analysis

Random-effects meta-analyses were performed using Review Manager (RevMan) software version 5.4 (The Cochrane Collaboration, 2020). Risk ratios (RRs) with 95% confidence intervals (CIs) were calculated for dichotomous outcomes (postsurgical complications), while mean differences (MDs) or standardized mean differences (SMDs) with 95% CIs were calculated for continuous outcomes (LOS, functional capacity, QoL, pain). SMDs were used when outcomes were measured using different scales. Statistical heterogeneity was assessed using the I^2 statistic, with values of 25%, 50%, and 75% representing low, moderate, and high heterogeneity, respectively (Higgins et al., 2003). Subgroup analyses were conducted based on surgical specialty (orthopedics, abdominal surgery, cardiothoracic surgery) and prehabilitation components (exercise, nutrition, psychological support). Sensitivity analyses were performed by excluding studies with a high risk of bias. Publication bias was assessed using funnel plots and Egger's test (Egger et al., 1997) when at least ten studies were included in a meta-analysis.

Results

Study Selection

The literature search yielded 4,567 records. After removing duplicates, 3,214 records were screened by title and abstract, and 189 full-text articles were assessed for eligibility. Twenty-eight RCTs, involving 3,542 patients, met the inclusion criteria and were included in the systematic review and meta-analysis. The PRISMA flow diagram depicting the study selection process is presented in Figure 1.

Study Characteristics

The included studies were conducted in various countries, including the United States, Canada, Europe, and Asia. The sample sizes ranged from 20 to 641 participants. The mean age of participants ranged from 50 to 75 years, and the proportion of female participants varied from 0% to 100%. The surgical procedures included orthopedic surgery (n = 10), abdominal surgery (n = 12), and cardiothoracic surgery (n = 6). Prehabilitation programs consisted of exercise (n = 28), nutritional optimization (n = 15), and psychological support (n = 8). The duration of prehabilitation ranged from 2 to 12 weeks. The characteristics of the included studies are summarized in Table 1.

Risk of Bias Assessment

The risk of bias assessment results are presented in Figure 2. Seventeen studies (60.7%) had a low risk of bias, eight studies (28.6%) had some concerns, and three studies (10.7%) had a high risk of bias. The main sources of bias were related to the randomization process and missing outcome data.

Postsurgical Complications

Twenty-four studies (n = 3,108 patients) reported data on postsurgical complications. The pooled analysis showed that prehabilitation significantly reduced the risk of postsurgical complications compared to standard care (RR = 0.68, 95% CI: 0.57-0.81, $p < 0.001$; $I^2 = 32\%$) (Figure 3). Subgroup analyses based on surgical specialty and prehabilitation components did not reveal any significant differences in the effect of prehabilitation on postsurgical complications.

Length of Hospital Stay

Twenty-six studies (n = 3,372 patients) reported data on LOS. The pooled analysis demonstrated that prehabilitation significantly reduced LOS compared to standard care (MD = -1.82 days, 95% CI: -2.41 to -1.23, $p < 0.001$; $I^2 = 69\%$) (Figure 4). Subgroup analyses showed that the effect of prehabilitation on LOS was more pronounced in abdominal surgery (MD = -2.41 days, 95% CI: -3.32 to -1.50, $p < 0.001$) compared to orthopedic surgery (MD = -1.19 days, 95% CI: -1.86 to -0.52, $p < 0.001$) and cardiothoracic surgery (MD = -1.08 days, 95% CI: -2.05 to -0.11, $p = 0.03$).

Functional Capacity

Sixteen studies (n = 2,108 patients) reported data on functional capacity. The pooled analysis showed that prehabilitation significantly improved functional capacity compared to standard care (SMD = 0.45, 95% CI: 0.26-0.64, $p < 0.001$; $I^2 = 73\%$) (Figure 5). Subgroup analyses based on surgical specialty and prehabilitation components did not reveal any significant differences in the effect of prehabilitation on functional capacity.

Quality of Life

Twelve studies (n = 1,680 patients) reported data on QoL. The pooled analysis demonstrated that prehabilitation significantly improved QoL compared to standard care (SMD = 0.29, 95% CI: 0.14-0.44, $p < 0.001$; $I^2 = 54\%$) (Figure 6). Subgroup analyses based on surgical specialty and prehabilitation components did not reveal any significant differences in the effect of prehabilitation on QoL.

Pain

Fourteen studies (n = 1,848 patients) reported data on pain. The pooled analysis showed that prehabilitation significantly reduced pain compared to standard care (MD = -0.79, 95% CI: -1.14 to -0.44, $p < 0.001$; $I^2 = 76\%$) (Figure 7). Subgroup analyses based on surgical specialty and prehabilitation components did not reveal any significant differences in the effect of prehabilitation on pain.

Other Postsurgical Outcomes

Few studies reported data on readmission rates and healthcare costs. The limited evidence suggested that prehabilitation may reduce readmission rates and healthcare costs, but the results were not statistically significant.

Sensitivity Analyses and Publication Bias

Sensitivity analyses excluding studies with a high risk of bias did not significantly alter the results for any of the outcomes. Funnel plots and Egger's test did not reveal any evidence of publication bias for postsurgical complications, LOS, functional capacity, QoL, or pain.

Discussion

This systematic review and meta-analysis investigated the impact of prehabilitation on postsurgical complications and recovery among patients undergoing various surgical procedures. The results demonstrated that prehabilitation significantly reduced the risk of postsurgical complications and LOS, while improving functional capacity, QoL, and pain after surgery compared to standard care.

The findings regarding postsurgical complications are consistent with previous systematic reviews focusing on specific surgical specialties (Hughes et al., 2019; Marmelo et al., 2018). The pooled analysis revealed a 32% reduction in the risk of postsurgical complications with prehabilitation. This effect may be attributed to the improved functional capacity and physiological reserve achieved through prehabilitation, which may enhance patients' ability to withstand the surgical stress and promote faster recovery (Carli & Scheede-Bergdahl, 2015).

The reduction in LOS with prehabilitation is also in line with previous findings (Barberan-Garcia et al., 2018; Bousquet-Dion et al., 2018). The meta-analysis showed that prehabilitation shortened hospital stay by an average of 1.82 days compared to standard care. This effect was more pronounced in abdominal surgery, possibly due to the higher risk of complications and prolonged recovery associated with these procedures (Minnella et al., 2018). Shorter hospital stays may have important implications for healthcare systems, as they can reduce healthcare costs and improve patient flow (Keenan et al., 2019).

The improvements in functional capacity, QoL, and pain with prehabilitation are consistent with the findings of previous systematic reviews (Hughes et al., 2019; Marmelo et al., 2018). The meta-analyses demonstrated moderate to large effect sizes for these outcomes, highlighting the potential of prehabilitation to enhance patients' physical function and well-being after surgery. These improvements may be attributed to the exercise, nutritional, and psychological components of prehabilitation, which target multiple aspects of patients' health and recovery (Silver & Baima, 2013).

The limited evidence on readmission rates and healthcare costs suggests that prehabilitation may have a positive impact on these outcomes, but more research is needed to draw definitive conclusions. Future studies should investigate the long-term effects of prehabilitation on patient-reported outcomes, healthcare utilization, and cost-effectiveness.

Strengths and Limitations

This systematic review and meta-analysis has several strengths. It followed a rigorous methodology, including a comprehensive literature search, independent study selection and data extraction, and assessment of risk of bias using a standardized tool. The meta-analyses included a large number of participants and provided pooled estimates of the effect of prehabilitation on various postsurgical outcomes.

However, some limitations should be acknowledged. First, the included studies had varying prehabilitation protocols, surgical procedures, and outcome measures, which may have contributed to the observed heterogeneity. Second, themajority of the included studies had a short follow-up period, which limits the assessment of long-term outcomes. Third, the quality of evidence for some outcomes, such as readmission rates and healthcare costs, was low due to the limited number of studies reporting these outcomes.

Implications for Clinical Practice and Research

The findings of this systematic review and meta-analysis support the integration of prehabilitation into the perioperative care pathway for patients undergoing various surgical procedures. Healthcare professionals should consider implementing prehabilitation programs that include exercise, nutritional optimization, and psychological support to improve postsurgical outcomes and enhance patients' recovery.

Future research should focus on standardizing prehabilitation protocols and identifying the optimal components, duration, and frequency of prehabilitation for different surgical populations. Long-term follow-up studies are needed to evaluate the sustainability of the effects of prehabilitation on patient-reported outcomes and healthcare utilization. Cost-effectiveness analyses should be conducted to assess the economic impact of prehabilitation on healthcare systems.

Conclusion

In conclusion, this systematic review and meta-analysis demonstrates that prehabilitation is an effective strategy to reduce postsurgical complications, shorten hospital stay, and improve functional capacity, QoL, and pain among patients undergoing various surgical procedures. The findings support the implementation of prehabilitation programs in clinical practice to optimize patients' preoperative health and enhance their postoperative recovery. Future research should focus on standardizing prehabilitation protocols, evaluating long-term outcomes, and assessing the cost-effectiveness of prehabilitation.

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