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Research review

Prolonged operative duration is associated with complications: a systematic review and meta-analysis



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ARTICLE INFO

Article history:

Received 2 October 2017

Received in revised form

27 February 2018

Accepted 14 March 2018

Available online xxx

Keywords:

Operative time

Complications

Surgery

Systematic review

ABSTRACT

Background: The aim of this study was to systematically synthesize the large volume of literature reporting on the association between operative duration and complications across various surgical specialties and procedure types.

Methods: An electronic search of PubMed, Cochrane Central Register of Controlled Trials, and Cochrane Database of Systematic Reviews from January 2005 to January 2015 was conducted. Sixty-six observational studies met the inclusion criteria.

Results: Pooled analyses showed that the likelihood of complications increased significantly with prolonged operative duration, approximately doubling with operative time thresholds exceeding 2 or more hours. Meta-analyses also demonstrated a 14% increase in the likelihood of complications for every 30 min of additional operating time.

Conclusions: Prolonged operative time is associated with an increase in the risk of complications. Given the adverse consequences of complications, decreased operative times should be a universal goal for surgeons, hospitals, and policy-makers. Future study is recommended on the evaluation of interventions targeted to reducing operating time.

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Introduction

Worldwide, an estimated 234 million major surgical procedures are performed every year, making surgical care an essential part of health care.¹ Surgical procedures are associated with considerable risk of complications (e.g., infections) that adversely affect patient outcomes and increase health care costs.^{2,3} The risk of complications is two to five times

greater in surgery than in general medicine, and approximately 40% of in-hospital complications are related to surgical procedures.^{4,5} Although it is difficult to generate precise estimates, the risk of complications has been noted to range from 3% to 17% among surgical patients in developed countries.⁶

In recent decades, a growing body of evidence has suggested that surgical or operative duration is an independent and potentially modifiable risk factor for complications. For

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<https://doi.org/10.1016/j.jss.2018.03.022>

instance, a positive association between the duration of surgical procedures and complications such as surgical site infection (SSI), venous thromboembolism (VTE), bleeding, hematoma formation, and necrosis has been reported in prospective and retrospective studies across various surgical procedures.⁶⁻¹⁰ Similarly, a systematic review by Visser *et al.*⁵ identified, categorized, and ranked various patient- and surgery-related risk factors for complications; prolonged operative duration was among the top three surgery-related factors. However, the review by Visser *et al.* only identified six studies that assessed operative duration and its relationship with surgery-related complications; three studies reported a statistically significant association, whereas three studies reported a nonstatistically significant association.

To our knowledge, a comprehensive review assessing and quantifying the association between operative duration and a variety of complications across surgical specialties has not been conducted. Because complications lead to worsened clinical status, emotional and financial burden for patients and families, and additional health care costs, the aim of this systematic review was to systematically synthesize the large volume of literature reporting on the association between operative duration and complications, across several surgical specialties and procedure types, to help inform decision-making, planning, and management. We hypothesized that prolonged operative duration would be associated with a greater risk of developing complications across surgical specialties.

Methods

Search strategy

PubMed, the Cochrane Central Register of Controlled Trials, and the Cochrane Database of Systematic Reviews were searched for relevant literature on April 19, 2015. The search strategy was limited to articles published in the English language between January 2005 and January 2015 (the search strategies are provided in [Appendix A](#)). Reference lists of retrieved articles and relevant reviews were hand-searched. The search was also supplemented through the “similar articles” search in PubMed to identify unique articles.

Study selection

The PICOS categories (i.e., population, intervention, comparator, outcomes, and study design) were used to define study inclusion criteria. All published meta-analyses, systematic reviews, randomized controlled trials, and observational studies (prospective or retrospective) reporting an effect measure for the association between operative duration and complications in humans, for all surgery types, were considered for inclusion. Studies were excluded if they were published in the form of case reports, letters, comments, or editorials or were conducted in nonhuman models. Based on the inclusion criteria, the eligibility of each publication was evaluated in a title and abstract review. If the abstract and title review suggested potential eligibility, a full-text screening followed. Reasons for exclusion were documented.

Data extraction

Two reviewers extracted data from full-text articles independently. The following study details were extracted: study authors, publication year, study time frame, sample size, study design, number and types of surgeries, complications and their rates, effect measures for the association between operative duration and complications, mean operative duration, and definitions of included complications, where available. Most studies reported odds ratios (ORs); however, a small number of studies reported risk ratios or hazard ratios. We extracted both adjusted and unadjusted effect measures and their 95% confidence intervals; however, only adjusted effect estimates were used for meta-analyses. The variables that were controlled for in adjusted effect measures varied across studies but often included a range of patient and surgical factors. Typically, increased operative duration was defined categorically relative to a cut point (e.g., <1 h or >1 h) or per minute(s) of surgery. If study results were reported in minutes, results were converted to hours for consistency. Data were reported if an association was noted for complications varying in severity or time point (e.g., major or minor complications and intraoperative or postoperative complications), and for various types of complications (e.g., wound, cardiovascular, and respiratory complications), where available.

Data synthesis and statistical methods

Several meta-analyses were performed to quantify the association between operative duration and complications for studies that reported adjusted effect measures. No additional adjustments, outside of those data provided from the original studies, were conducted in the meta-analyses. First, studies that reported adjusted ORs, the associated 95% confidence intervals, and operative time thresholds that fell within 20% of the hour were pooled by hourly operative time thresholds (e.g., <1 h versus >1 h). For example, if a study reported thresholds of ≥ 50 or < 50 min, this study would have been included in the 1-h time threshold analysis. Second, studies that reported increments of operative time (risk of complications per minute, per 30 min, etc.) were pooled. Third, all studies that reported an adjusted OR were pooled and analyzed by surgical specialty. We used the DerSimonian–Laird random-effects model for the meta-analyses. Heterogeneity was assessed using Q statistic and I^2 . Fourth, a meta-regression analysis was used to further validate the effect of incremental increases of operative time on the risk of complications. All analyses were conducted using STATA (version 14.2).

Results

Overall, 4556 studies—4343 through database searches and 213 through PubMed “similar” and manual bibliography searches—were identified ([Fig. 1](#)). Of the 4556 studies, 2349 were excluded following title and abstract screening. As such, 2207 studies underwent full-text review; 2141 studies were excluded for reasons detailed in [Figure 1](#). In total, seven prospective and 59 retrospective observational studies were

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