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Review

Laparoscopic versus robotic adrenalectomy: A comprehensive meta-analysis

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HIGHLIGHTS

- Data from 13 studies comparing robotic to laparoscopic adrenalectomy were pooled.
- Robotic adrenalectomy was associated with longer operation duration, but shorter hospital stay.
- No difference was observed in terms of intraoperative and postoperative complications, mortality and conversion rates.

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ABSTRACT

Background: The benefit of robotic adrenalectomy (RA) compared to laparoscopic adrenalectomy (LA) is still debatable. The purpose of this paper was to systematically review and synthesize all available evidence comparing RA to LA so as to evaluate which procedure provides superior clinical outcomes.
Methods: A systematic literature search of PubMed and Scopus databases was performed with respect to the PRISMA statement (end-of-search date: January 31, 2016). Data on perioperative variables were extracted by three independent reviewers. Data were pooled using a random-effects model.
Results: Twenty-seven studies were included in this review (13 comparative and 14 non-comparative). Overall, 1162 patients underwent adrenalectomy (747 treated with RA and 415 with LA). There was no significant difference between the robotic and the laparoscopic groups for intraoperative complications (OR: 1.20; 95%CI, 0.33–4.38), postoperative complications (OR: 0.69; 95% CI, 0.36–1.31), mortality (OR: 0.42; 95%CI, 0.07–2.72), conversion to laparotomy (OR: 0.51; 95%CI, 0.21–1.23), conversion to laparotomy or laparoscopy (OR: 0.73; 95%CI, 0.32–1.69) and blood loss (WMD: −9.78; 95%, −22.10 to 2.53). For patients treated with RA, there was a significantly shorter hospital stay (WMD: −0.40; 95% CI, −0.64 to −0.17) and a significantly longer operating time (WMD: 15.60; 95%CI, 2.12 to 29.08).
Conclusions: Robotic adrenalectomy is a safe and feasible procedure with similar clinical outcomes as the laparoscopic approach in selected patient populations. High quality RCTs as well as uniform and detailed reporting of outcomes are needed to determine the role and cost-effectiveness of robotic adrenal surgery in the years to come.

1. Introduction

Over the last few decades, laparoscopic surgery has diminished ICU stay, hospitalization duration and post-operative complications while providing a superior cosmetic result [1]. Laparoscopic

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adrenalectomy (LA) was first reported by Gagner et al., in 1992 [2]. Since 2001, LA has prevailed over conventional open surgery as the standard of care for the management of small (<8 cm), benign adrenal tumors [3]. In selected cases, LA has also been utilized in the treatment of small (<5 cm) malignant adrenal cortical carcinomas [4]. Despite being a safe and effective procedure, LA does have certain shortcomings, namely the loss of three-dimensional vision, the unstable camera platform and the rigid instrumentation.

On the other hand, robotic equipment offers seven degrees of freedom allowing for precise movements in limited working spaces. Also, its 3D optics provide better resolution and depth perception to the surgeon. Finally, its ergonomic design maximizes the surgeon's comfort intraoperatively [5]. Indeed, robotic adrenalectomy has been proved useful in certain occasions, especially in the posterior retroperitoneoscopic approach where space is limited, when dealing with anatomic variants and in cortical-sparing adrenalectomy because it can achieve a safe resection while reducing post-operative steroid dependence [6,7]. However, RA has not yet demonstrated significant improvements in terms of estimated blood loss, conversion nor complication rates compared to the LA, while operative times remain significantly higher than laparoscopic surgery [8,9]. Also, there is a significant learning curve with the use of the robot, even for experienced laparoscopic surgeons [6]. Finally, despite the significantly shorter hospital stay for patients undergoing the robotic procedure, the overall cost of this approach remains higher compared to its laparoscopic counterpart [10]. With this systematic review and meta-analysis we aim to compare the clinical outcomes of patients treated with the robotic technique versus those underwent the laparoscopic procedure.

2. Materials and methods

2.1. Search strategy and eligibility of studies

The systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and in line with the protocol agreed by all authors [11]. Eligible articles were identified through research of the PubMed and SCOPUS bibliographical databases (end-of-search date on January 31, 2016) by two independent reviewers (KPE and AAS). The search algorithm used was "*Adrenalectomy AND (robotic OR robot OR robot-assisted)*". Reference lists were systematically searched for relevant articles in a "snowball" procedure.

Eligible studies were: (1) published in English, (2) reporting evidence in humans, (3) including more than 3 patients ($n > 3$), (4) and were primary research papers comparing patients who have been treated with robotic vs. laparoscopic adrenalectomy. Criterion #4 was not required for the identification of non-comparative studies. Ineligible studies met at least one of the following exclusion criteria: (1) papers reporting on single-port robotic adrenalectomy, (2) experimental studies in animals, (3) reviews and meta-analyses, (4) editorials, perspectives and letters to the editor. The outcomes assessed as categorical variables in this meta-analysis are: (1) intraoperative complications, (2) postoperative complications, (3) mortality, (4) conversion to laparotomy and (5) conversion to laparoscopy or laparotomy. The continuous outcomes investigated in this meta-analysis are: (1) operative time, (2) length of hospital stay and (3) blood loss. In case of overlapping study populations, only the larger study was included. Nevertheless, when analyses on additional outcomes were presented in several eligible articles, data were extracted from all. Evidently their population was not summed in the overall subject numbers, as they represented additional analyses on the same cohort.

2.2. Data extraction and effect estimates

Three reviewers, blind to each other (KPE, KSM and AAS), independently reviewed the full papers of eligible studies and performed the data extraction and tabulation. All disagreements were resolved with discussion and final decision was reached by consensus. Particularly, the following data were extracted: first author, year of publication, country of enrollment, study interval, study design, number of patients who received LA or RA, patient demographics (age, gender, preoperative Body Mass Index (BMI), prior abdominal operations, tumor size, tumor laterality), operative time, estimated blood loss, conversion rate to laparotomy, conversion rate to laparoscopy/laparotomy, intraoperative and post-operative complications, mortality and length of hospital stay. Regarding categorical outcomes, data pertaining to the underlying 2×2 tables were extracted (namely numbers of patients presenting with the outcome and those free of the outcome, separately for the laparoscopic and robotic groups); regarding continuous outcomes, the mean, standard deviation and number of patients were extracted, separately for the laparoscopic and robotic arms.

If the required data for the meta-analysis (i.e. for the comparative studies) were not readily available in the published articles, the corresponding authors were contacted twice (a reminder e-mail was sent 10 days after the first e-mail).

2.3. Meta-analysis and sensitivity analyses

Based on extracted data, odds ratio (ORs) and 95% Confidence Intervals (CI) were calculated by means of 2×2 tables for each categorical outcome; OR>1 denoted outcome more frequently present in the laparoscopic group. Moreover, weighted mean difference (WMD) with its 95% CI was calculated for each continuous outcome; WMD > 0 corresponded to larger values in the laparoscopic group. When continuous data were presented as medians and range we applied the Hozo et al. method to estimate the respective means and standard deviations [12]. Random-effects (DerSimonian-Laird) models were appropriately used to calculate pooled effect estimates. Between-study heterogeneity was assessed through Cochran Q statistic and by estimating I^2 [13]. Sensitivity analyses was performed by exclusion of studies for the outcomes that this was deemed clinically important with the aim to provide the readership with a more robust and clinically useful evidence synthesis.

2.4. Assessment of study quality and publication bias

Regarding the risk of bias, the quality of the included studies was evaluated using the Newcastle-Ottawa Quality scale [14]. In the item assessing whether the follow-up period was long enough for outcomes to occur, the cut-off value was *a priori* set at 30 post-operative days, whereas regarding the item about the adequacy of follow-up, a 90% rate was also *a priori* adopted. Evidently, items pertaining to the comparability of groups were marked as "not applicable" in the non-comparative studies. Two reviewers (KPE and AAS) working independently rated the studies and final decision was reached by consensus with a third reviewer (KSM).

Although our initial purpose was to evaluate the existence of publication bias using the Egger's formal statistical test [15], statistical evaluation was performed only when the number of included studies was adequate (10 or more) given that the power of the test is otherwise substantially compromised [13]. For the interpretation of Egger's test, statistical significance was defined as $p < 0.1$ [15]. Statistical analysis was performed using STATA/SE version 13 (Stata Corp, College Station, TX, USA).