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Laparoscopic Versus Open Radical Nephrectomy for Renal Cell Carcinoma: a Systematic Review and Meta-Analysis

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Abstract

BACKGROUND: The aim of this study is to summarize and quantify the current evidence on the therapeutic efficacy of laparoscopic radical nephrectomy (LRN) compared with open radical nephrectomy (ORN) in patients with renal cell carcinoma (RCC) in a meta-analysis. *METHODS:* Data were collected by searching Pubmed, Embase, Web of Science, and ScienceDirect for reports published up to September 26, 2016. Studies that reported data on comparisons of therapeutic efficacy of LRN and ORN were included. The fixed-effects model was used in this meta-analysis if there was no evidence of heterogeneity; otherwise, the random-effects model was used. *RESULTS:* Thirty-seven articles were included in the meta-analysis. The meta-analysis showed that the overall mortality was significantly lower in the LRN group than that in the ORN group (odds ratio [OR] =0.77, 95% confidence interval [CI]: 0.62-0.95). However, there was no statistically significant difference in cancer-specific mortality (OR = 0.77, 95% CI: 0.55-1.07), local tumor recurrence (OR = 0.86, 95% CI: 0.65-1.14), and intraoperative complications (OR = 1.27, 95% CI: 0.83-1.94). The risk of postoperative complications was significantly lower in the LRN group (OR = 0.71, 95% CI: 0.65-0.78). In addition, LRN has been shown to offer superior perioperative results to ORN, including shorter hospital stay days, time to start oral intake, and convalescence time, and less estimated blood loss, blood transfusion rate, and anesthetic consumption. *CONCLUSION:* LRN was associated with better surgical outcomes as assessed by overall mortality and postoperative complications compared with ORN. LRN has also been shown to offer superior perioperative results to ORN.

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Introduction

Renal cell carcinoma (RCC) is the third most common urological malignancy after prostate and bladder cancer [1]. Open radical nephrectomy (ORN) was considered as the primary treatment method for RCC until 1990, as described by Robon et al. in1969 [2]. After that, laparoscopic radical nephrectomy (LRN) has gained wide acceptance as a standard treatment for RCC since it was first reported in 1991 [3]. Many studies indicate that LRN is associated with oncologic long-term outcomes similar to those of ORN [4,5]. Moreover, LRN has been shown to markedly decrease postoperative discomfort and shorten overall recovery duration compared with ORN. Some researchers have even regarded LRN as the new gold standard in therapy of stage T1 to T2 kidney cancer [6]. However, to our knowledge, a comprehensive comparison of LRN and ORN for RCC from a meta-analysis is not currently available. We therefore conducted a systematic review and meta-analysis to summarize and quantify the current evidence on the therapeutic outcomes of LRN compared with ORN in patients with RCC.

Material and Methods

Search Strategy and Selection Criteria

We followed the PRISMA guidelines [7] to complete the meta-analysis. Pubmed, Embase, Web of Science, and ScienceDirect were systematically

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searched for reports published between January 1, 1991, and September 26, 2016, using a combined text and MeSH heading search strategy with the following terms: "laparoscopic," "laparoscopy," "nephrectomy," "radical nephrectomy," "open radical nephrectomy," "carcinoma, renal cell," "renal cell carcinoma," "renal cancer," "renal tumor," "kidney tumor," and "kidney cancer." The search strategy was limited to human studies and those published in the English language. We included studies after 1990 because the LRN method was first reported in 1991. Reference lists of identified studies were also checked for other potentially relevant studies. We contacted the authors for additional data as needed.

An eligible study should meet the following inclusion criteria: prospective design or retrospective design; masked assessment of outcomes; reported data on results of therapy of LRN and ORN (overall mortality, cancer-specific mortality, tumor recurrence, and/or complications); and reported sufficient information to calculate odds ratios (ORs) with 95% confidence intervals (CIs) for the association between LRN and ORN for therapy of RCC. Studies were excluded if they did not provide information to calculate the estimate, did not make comparison between LRN and ORN, used partial nephrectomy method, or were review studies.

Data Extraction and Study Quality Evaluation

The characteristics of each included study were extracted, including author, country, study design, sample size, mean age of participants, gender proportion, mean follow-up duration, mean tumor size, number of death from all cause, number of death from RCC, number of tumor recurrence, number of complications, mean operative time, estimated blood loss, hospital stay, number of blood transfusion required, time to start oral intake, convalescence time, and/or anesthetic consumption, if available. The quality of each included study was assessed using the Newcastle-Ottawa Scale recommended by Wells and colleagues [8]. The quality of each study ranges from one to nine stars.

Statistical Analysis

Associations with continuous outcome variables were pooled as weighted mean differences (WMDs) with 95% CI. Associations with dichotomous were pooled as ORs with 95% CI. The fixed-effects model was used in this meta-analysis if there was no evidence of heterogeneity; otherwise, the random-effects model was used. We used χ^2 test and the I^2 statistic to explore the heterogeneity among studies. $P < .10$ for χ^2 test or large I^2 (>50%) suggests substantial heterogeneity among studies. We did several subgroup analyses: geographic location (Europe, North America, or Asia), study design (prospective or retrospective), mean age of participants (<60 years vs ≥ 60 years), and mean tumor size (< cm in both groups vs ≥7 cm in both groups). We use 7 cm as the cutoff value of mean tumor size because most studies regard kidney tumor of over 7 cm as large tumor [9]. Publication bias were examined using funnel plots, and Egger's regression test and Begg-Mazumdar test were used to further assess publication bias. Statistical significance was defined as a two-tailed $P < .05$. All statistical analyses were conducted with RevMan, version 5, from the Cochrane Collaboration (http://www.cochrane.org/) or Stata Version 12.0 software (Stata Corp, College Station, TX).

Results

Study Characteristics

Our initial search yielded 2045 records, of which 1984 remained after removal of duplications (Figure 1). After title and abstract assessment, 71 articles were qualified for selection. Overall, 37 studies met the inclusion criteria and were included in the meta-analysis [9–45]. Table 1 shows the baseline characteristics of all 37 included studies. Data were available from 14,515 RCC patients, of whom 4844 used LRN and 9671 used ORN for treatment of RCC.

Overall Mortality

Data on overall mortality were available for analysis in 1934 patients in LRN group with 176 deaths and 2902 patients in ORN group with 295 deaths. The meta-analysis showed that the overall mortality was significantly lower in the LRN group than that in the ORN group (OR = 0.77, 95% CI: 0.62-0.95) (Figure 2). There was no evidence of heterogeneity among individual studies ($P = .50$ and $I^2 = 0\%$). The results varied in some subgroup analyses (Table 2). Particularly, the beneficial outcome on overall mortality for LRN was only seen in patients with mean tumor size smaller than 7 cm (OR = 0.72, 95% CI: 0.58-0.91) but not in those with mean tumor size larger than 7 cm (OR = 1.17, 95% CI: 0.65-2.10), and in patients with tumor grade of T_1 to T_2 only (OR = 0.73, 95% CI: 0.58-0.91) but not in those with tumor grade of T_3 or above involved (OR = 1.07, 95% CI: 0.51-2.24).

Cancer-Specific Mortality

Data on cancer-specific mortality were available for analysis in 804 patients in LRN group with 71 deaths and 1016 patients in ORN group with 170 deaths. The results of meta-analysis indicated that LRN group had lower cancer-specific mortality than ORN group, but it did not reach statistical significance (OR = 0.77, 95% CI: 0.55-1.07) (Figure 3). There was no substantial between-study heterogeneity ($P = .37$ and $I^2 = 8\%$). The nonsignificant results were not materially changed in the subgroup analyses of geographic location, study design, mean age of participants, mean tumor size, and tumor grade (Table 2).

Local Tumor Recurrence

Data on local tumor recurrence were available for analysis in 1757 patients in LRN group with 83 events and 2774 patients in ORN group with 152 events. Meta-analysis did not show significant difference in local tumor recurrence between LRN group and ORN group (OR = 0.86, 95% CI: 0.65-1.14) (Figure 4). No evidence of heterogeneity was observed ($P = .96$ and $I^2 = 0\%$). The nonsignificant results were not materially changed in the subgroup analyses of geographic location, study design, mean age of participants, mean tumor size, and tumor grade (Table 2).

Intraoperative Complications

Data on intraoperative complications were available for analysis in 695 patients in LRN group with 64 events and 559 patients in ORN group with 48 events. The pooled analysis showed that there was no significant difference in intraoperative complications between LRN group and ORN group (OR = 1.27, 95% CI: 0.83-1.94) (Figure 5). There was no substantial between-study heterogeneity ($P = .10$ and $I^2 = 40\%$). Subgroup analyses showed that LRN group had significantly higher risk of intraoperative complications than ORN group in patients with mean tumor size smaller than 7 cm (OR = 2.48, 95% CI: 1.03-5.93) (Table 2).

Postoperative Complications

Data on postoperative complications were available for analysis in 4282 patients in LRN group with 905 events and 8295 patients in ORN group with 2646 events. The meta-analysis showed that the