



REVIEW ARTICLE

Ex vivo Resection for Renal Cancer: Indications and Results in Specific Clinical Scenarios

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Abstract

To retrospectively evaluate databases for indications and results of “bench surgery technique” in ex vivo or ex situ renal cancer resection as a lost alternative of savage renal function in renal malignancy or benign large tumors. We retrospectively evaluated PUBMED databases, including studies from 1980 to 2020. Only very few studies had analyzed “ex vivo [and] ex situ renal resection, extracorporeal renal resection, [and] renal autotransplantation.” Ex vivo renal resection and autotransplantation is the last chance in patients with renal cancer, but manifests numerous difficulties during and after the surgery. However, we noted that in some patients it provided good control over cancer, prevented long-term dialysis, and avoided renal transplantation, thus giving patients a good quality of life.

Keywords: ex situ liver resection; extracorporeal liver resection; liver autotransplantation

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Introduction

Renal cancer requires a combination of demolitive surgery and therapy. However, some renal tumors are considered unresectable or not nephron-sparing because of large size or for involvement of the inferior vena cava (IHV) or because kidney cannot safely tolerate total vascular occlusion over about 90 min. Ex vivo renal resection and autotransplantation (EVRRT) means removal of the kidney from abdominal cavity, the subsequent resection of the tumor lesion on the table in cold ischemia (bench surgery) and the subsequent reimplantation of the same organ deprived of the tumor with nephro-sparing technique (NST). The first renal autotransplant was performed in 1963 by Hardy et al. (1)

in Jackson, MS, for a high ureteral injury during an aortic operation. Indications for EVRRAT are as follows: multiple bilateral tumors, tumors in patients with impaired renal function, tumors of the solitary kidney, and large benign tumors. In these cases, it is mandatory to preserve as many nephrons as possible (2–8).

Methods

We retrospectively evaluated PUBMED databases, including the studies from 1980 to 2020. Only a very few studies have analyzed “ex vivo [and] ex situ renal resection, extracorporeal renal resection, [and] renal autotransplantation.” Two

Table 1: Studies on Ex Vivo Renal Resection and Auto-Transplantation (EVRRAT)

Authors	Year	Indications for EVRRAT	Number of patients	Type of surgery	Operative time	Bench surgery time	Complications
Abraham et al. (10)	2014	Complex renal cell carcinoma, bilateral large angiomyolipoma	3	Laparoscopic	5–8 h	90–150 min	Post-op. hemodialysis
Gill et al. (11)	2000	Ureteral tumor, ureteral stricture, loin pain, hematuria syndrome	4	Laparoscopic	5.8 h	4 min	None
Meng et al. (12)	2004	High-grade urothelial carcinoma	2	Laparoscopic	4.5 h	2 h	None
Aslam et al. (22)	2017	Renal mass in a solitary functional kidney, bilateral renal tumors, previous failed pyeloplasties	3	Laparoscopic/ Open	—	—	Complete renal vein obstruction
Hitchcock et al. (9)	1993	Radiation nephritis was prevented by heterotopic transplantation of the kidney to a position outside the radiation field during Ewing's sarcoma treatment	1	Open	—	—	—
El Tayar et al. (13)	2003	Renal artery aneurysm	1	Open	—	—	—
Pretorian et al. (15)	2010	Reflux nephropathy	1	Open	—	—	—
Chandak et al. (16)	2014	Mycotic aneurysm	1	—	—	—	—
Maughan et al. (14)	2015	Renal artery aneurysms	1	—	—	—	—
Bourgi et al. (17)	2018	Extended ureteric disease, tumor on the solitary kidney, renal artery aneurysm, bilateral urothelial tumors, interrupted live kidney transplantation	9	Open	—	209 min	None
Pettersson et al. (18)	1984	Upper urinary tract urothelial carcinoma	8	Open	—	—	Infiltrating tumor recurrence with subsequent radical nephrectomy
Holmang and Johansson (19)	2005	Upper urinary tract urothelial carcinoma	23	Open	—	—	Death for cancer and dialyses
Komiakov et al. (20)	2013	Renal tumor	9	Open	297 min	112.6 min	None
Tran et al. (21)	2015	Various pathologies	52	Laparoscopic	—	—	None

independent research conducted the review. The search terms were identified with medical subject heading (MeSH). Research inclusion criteria were the following terms: “ex vivo, ex situ renal resection, extracorporeal renal resection, [and] renal autotransplantation.” The outcomes were: indications, operative time, morbidity and mortality, and oncologic results. We excluded abstracts of all manuscripts as well as non-English manuscripts. After rejecting review articles and repetitive reports, the relevant literature included 14 manuscripts.

Results

In 1993, Hitchcock et al. (9) reported EVRRAT in a 12-year-old patient with spinal Ewing sarcoma underwent renal sparing autotransplantation to avoid radiation nephritis by positioning the kidney outside the field of radiation to prevent radiation damage. Abraham et al. (10), in their retrospective study of three patients, showed an operative time of 5–8 h and a cold ischemia of 90–150 min through laparoscopic approach. The authors confirmed that it was a good procedure if possible to apply. Gill et al. (11) and Meng and colleagues (12) reported on retroperitoneal laparoscopic nephrectomy and autotransplantation in four and two patients, respectively. Aslam et al. (22) had reported three case series of laparoscopic EVRRAT with one deep vein thrombosis and renal infarction of transplanted kidney. El Tayar et al. (13) and Maughan et al. (14) treated a large aneurysm by nephrectomy, ex vivo repair, and autotransplantation. Pretorian et al. (15) saved a patient from renal insufficiency due to renal reflux by performing a two-stage renal autotransplantation. Chandak et al. (16) applied EVRRAT for mycotic aneurysm. Bourgi et al. (17) treated nine patients for various pathologies, demonstrating a good postoperative creatinine clearance. While Pettersson et al. (18) showed the good oncologic result after 32 months of EVRRAT for urothelial carcinoma of the upper urinary tract, demonstrating only one radical nephrectomy for cancer recurrence in eight patients. Holmang and Johansson (19) conducted autotransplantation in 23 patients with urothelial neoplasm of the upper urinary tract, and concluded that renal autotransplantation could be harmful compared with standard nephroureterectomy. Komiakov et al. (20) in a 4-year follow-up of EVRRAT for renal tumors in nine patients established no dissemination of tumor and functional condition of the transplanted kidney. In 2015, Tran et al. (21), in their study of 52 patients, referred to more than 90% success rate over a 6-year follow-up period.

Discussion

EVRRAT achieves nephron-sparing in renal tumors. Kidney autotransplantation is performed to

preserve renal parenchyma. If correct indications are followed, EVRRAT presents a viable and last option before nephrectomy whereas traditional surgery exposes the patient to chronic renal insufficiency (CRI) (17). Open surgery in EVRRAT is the best choice, but laparoscopic approach could be used to reduce morbidity of the procedure. Laparoscopic technique allows minimal skin incision. Renal extraction and subsequent transplantation could be performed through a standard extraperitoneal Gibson incision, with minimization of postoperative pain and length of hospital stay (11). Renal autotransplantation is an option for a highly selected group of patients having multiple bilateral tumors, tumors in patients with impaired renal function, and tumors of the solitary kidney; complex renal artery aneurysms; and high ureteric injuries, which are the most common indications of EVRRAT (17). It has short- and long-term complication rates comparable with those of other major surgical procedures.

Conclusions

EVRRAT is the last chance in patients with renal cancer. However, it has manifested numerous difficulties during and after surgery, with a local recurrence rate of 25% and a vascular thrombosis of 20%. However, as encountered in literature reviews, we noted that in some patients it provided good control over cancer, prevented long-term dialysis, and avoided renal transplantation, thereby giving the patients a good quality of life (2–8,22,23).

Human Rights Statement

All procedures and experiments met the ethical standards.

Competing interests

The authors declare no competing interests.

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