available at www.sciencedirect.com
journal homepage: www.europeanurology.com

European Association of Urology

Surgery in Motion

Perioperative and Oncologic Outcomes of Nephrectomy and Caval Thrombectomy Using Extracorporeal Circulation and Deep Hypothermic Circulatory Arrest for Renal Cell Carcinoma Invading the Supradiaphragmatic Inferior Vena Cava and/or Right Atrium

Alessandro Nini[a,b,†], *Umberto Capitanio*[a,b,†], *Alessandro Larcher*[a,b], *Paolo Dell'Oglio*[a,b], *Federico Dehò*[a,b], *Nazareno Suardi*[a,b], *Fabio Muttin*[a,b], *Cristina Carenzi*[a], *Massimo Freschi*[c], *Roberta Lucianò*[c], *Giovanni La Croce*[a,b], *Alberto Briganti*[a,b], *Renzo Colombo*[a,b], *Andrea Salonia*[a,b], *Alessandro Castiglioni*[d], *Patrizio Rigatti*[a], *Francesco Montorsi*[a,b], *Roberto Bertini*[a,b,*]

[a] *Unit of Urology, University Vita-Salute San Raffaele, IRCCS San Raffaele Scientific Institute, Milan, Italy;* [b] *Division of Oncology, URI, Urological Research Institute, Renal cancer Unit, IRCCS San Raffaele Scientific Institute, Milan, Italy;* [c] *Unit of Pathology, University Vita-Salute San Raffaele, IRCCS San Raffaele Scientific Institute, Milan, Italy;* [d] *Unit of Cardiac Surgery, University Vita-Salute San Raffaele, IRCCS San Raffaele Scientific Institute, Milan, Italy*

Article info

Article history:
Accepted August 23, 2017

Associate Editor:
Alexandre Mottrie

Keywords:
Renal cell carcinoma
Thrombus
Caval thrombectomy
Extracorporeal circulation
Hypothermic circulatory arrest
Atrium

Please visit www.europeanurology.com and www.urosource.com to view the accompanying video.

Abstract

Background: Radical nephrectomy (RN) and caval thrombectomy (CT) for renal cell carcinoma, with extracorporeal circulation (ECC) and deep hypothermic circulatory arrest (DHCA) is a challenging surgical approach.
Objective: To assess peri-operative and oncologic outcomes of renal cell carcinoma patients treated with RN and CT, using ECC and DHCA.
Design, setting, and participants: We retrospectively evaluated 46 patients who underwent RN and CT using ECC and DHCA.
Surgical procedure: After retroperitoneal nodal dissection and RN, a cardiopulmonary bypass was placed and DHCA achieved. A combined approach through the abdomen and the thorax was described.
Measurements: Perioperative and long-term survival outcomes were reported.
Results and limitations: Median operative time and length of hospital stay were 545 min and 22 d. Overall, 33 patients (72%) did not require any additional interventional or surgical treatment. Thirty-day and 90-d mortality were 11% (5/46) and 15% (7/46). The 1-yr, 2-yr, and 3-yr cancer specific mortality (CSM)-free survival rates were 77%, 62%, and 56%, respectively. After stratification, according to metastatic status at diagnosis, CSM-free survival rates were significantly lower for cM1 patients compared with cM0 patients (1-yr 46% vs 93%, 2-yr 23% vs 81%, 3-yr 23% vs 73%, $p < 0.01$). Our study is limited by its retrospective and uncomparative nature.
Conclusions: RN with CT using ECC and DHCA is a challenging procedure which requires a dedicated multidisciplinary working team to minimise complications and maximise patients' outcomes.
Patient summary: Patients with kidney cancer and a thrombus within the inferior vena cava, which reaches above the diaphragm, can be treated with surgery. However, this kind of surgical treatment is challenging and requires a dedicated multidisciplinary team in order to accomplish the task.

† These authors contributed equally.
* Corresponding author. Unit of Urology, University Vita-Salute San Raffaele, IRCCS San Raffaele Scientific Institute, via Olgettina 60, Milan 20132, Italy. Tel. +39-2-2643-7286; Fax: +39-2-2643-7298.
E-mail address: bertini.roberto@hsr.it (R. Bertini).

http://dx.doi.org/10.1016/j.eururo.2017.08.019
0302-2838/

1. Introduction

Renal cell carcinoma (RCC) extends into the inferior vena cava (IVC) in 10% of cases at diagnosis and up to the right atrium in 1% of cases [1]. In this specific scenario, clinical presentation is often characterised by acute cardiovascular failure or major systemic symptoms due to the concomitant presence of locally advanced bulky tumour, caval involvement, and/or distant metastases. Although prognosis is usually poor, selected patients with RCC and supradiaphragmatic vena cava invasion may benefit from surgical treatment in the context of a multimodal management [2,3]. If surgical treatment is planned, thoracic access with median sternotomy is often required to perform cavotomy, extracorporeal circulation (ECC), and deep hypothermic circulatory arrest (DHCA) [4]. In those cases, surgery is usually challenging with significant postoperative morbidity and mortality [5].

To date, detailed data regarding intra- and peri-operative as well as oncologic outcomes are rare in this specific setting. To overcome this limitation, we relied on the largest cohort of RCC patients with vena cava thrombi treated with radical nephrectomy (RN) and caval thrombectomy (CT) using ECC and DHCA. The objective of the current study was to describe the surgical technique and to assess intra- and peri-operative as well as oncologic outcomes in this subset of patients. We hypothesised that patients undergoing this type of surgery would experience a high rate of complications as well as high perioperative mortality.

2. Materials and methods

2.1. Study population

Between 1990 and 2013, 46 out of 48 patients diagnosed with RCC with vena cava thrombi at the level of or above the hepatic veins (grade III according to Mayo Clinic classification of tumour thrombus level [1]) or extending above the diaphragm (grade IV), were treated with RN and CT using ECC and DHCA. All patients had complete data including clinical and pathologic stage, intraoperative and peri-operative outcomes, as well as long-term oncologic follow-up.

2.2. Preoperative assessment and patient's preparation

All patients included in the study underwent clinical staging imaging procedures, namely total body computed tomography and bone scan. Cardiovascular asset was studied through transoesophageal echocardiography and coronary angiography. In the most recent cases, coronary computed tomography scan was performed instead of coronary angiography. Surgical procedures were always performed by a fixed team composed of two urologists (P.R. and R.B.) in collaboration with a cardiac surgery team. In case of bulky abdominal disease (namely, extremely big mass diameter, $>$ 10 cm, and/or presence of diffuse collateral circulation and/or complete obstruction of inferior vena cava flow, $n = 18$) embolization of renal artery of the kidney was performed the day before surgery. This procedure consisted of an injection of alcohol and lipiodol and, subsequently, microspheres of polyvinyl alcohol and Spongostan (Johnson & Johnson Gateway LLC, Piscataway, NJ, USA) into the renal artery. All patients were intubated with a double-lumen endotracheal tube. A transoesophageal echocardiographic probe was inserted to supervise the procedure, to confirm the upper extension of the tumour thrombus and to assess the mobility of the thrombus.

2.3. Urological surgery: first phase

A xiphosubumbilical midline incision was performed, followed by an incision of the anterior peritoneum, of the paracolic gutter ipsilaterally, and of the posterior peritoneum up to Treitz's ligament. The intestine was then derotated and gathered into a special protective bag. After retroperitoneal lymph node dissection, the IVC and the aorta were completely exposed. Renal artery and ipsilateral ureter were then isolated, ligated, and sectioned.

2.4. Heart-surgery: second phase

A median sternothomy (only minithoracotomy in 5 cases) was performed and the pericardium opened. The right atrium, aorta, intrapericardial IVC, and right superior pulmonary vein were exposed. Patients were then systemically heparinised. Ascending aorta and right atrium were cannulated. A vent cannula was inserted in ascending aorta. Aorta was clamped, cardiac arrest was achieved by antegrade crystalloid cardioplegia. A cardiopulmonary bypass (CBP) was placed and the patient cooled to 18 °C. DHCA was then achieved.

2.5. Urological surgery: third phase

A J-incision of the IVC was performed, including a circumferential incision at the bifurcation of the renal vein, to remove the thrombus with a combined approach through the abdomen and the thorax. Randall clamps and vascular dissectors were used to remove all the macroscopic portion of the tumour thrombus which adhered to the cava wall. Tumour thrombus and kidney were removed en bloc in order to avoid embolism and cancer dissemination. When macroscopic invasion of the cava wall was observed and partial removal of the cava wall was performed ($n = 9$). IVC was then closed with a prolene 4/0 running suture with vascular pledges. In two cases, a complete segmental resection of the cava was performed.

2.6. Heart-surgery: fourth phase

Patients were then progressively warmed. Aorta was declamped, electric cardioversion was used to restore sinus rhythm, and the CBP removed. Two pericardial drainages and one pleural, as well as temporary epicardial electrodes, were positioned.

2.7. Urological surgery: fifth phase

Peritoneum was completely reconstructed up to Treitz's ligament. Two or one drainages were positioned, depending on surgical complexity.

2.8. Postoperative management and oncologic follow-up

Routine postoperative care, deep vein thrombosis prophylaxis, and early ambulation were pursued. Postoperatively, subcutaneous low molecular weight heparin was prescribed, always balancing it with the bleeding risk for a maximum of 21 d. The preferred painkillers were antipiretic and opioid analgesics. Follow-up consisted of visits at 4 mo (whole body computed tomography/magnetic resonance imaging scan, laboratory tests, and urologist evaluation), 8 mo (abdomen ultrasound, chest x-ray, laboratory tests, and urologist consultation), and then annually (whole body computed tomography/magnetic resonance imaging scan, bone scan, laboratory tests, and urologist evaluation).

Please cite this article in press as: Nini A, et al. Perioperative and Oncologic Outcomes of Nephrectomy and Caval Thrombectomy Using Extracorporeal Circulation and Deep Hypothermic Circulatory Arrest for Renal Cell Carcinoma Invading the Supradiaphragmatic Inferior Vena Cava and/or Right Atrium. Eur Urol (2017), http://dx.doi.org/10.1016/j.eururo.2017.08.019