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

European Association of Urology

Platinum Priority – Kidney Cancer
Editorial by XXX on pp. x–y of this issue

Indications, Techniques, Outcomes, and Limitations for Minimally Ischemic and Off-clamp Partial Nephrectomy: A Systematic Review of the Literature

Giuseppe Simone [a,b,*], *Inderbir S. Gill* [c], *Alexandre Mottrie* [d], *Alexander Kutikov* [e], *Jean-Jacques Patard* [f], *Antonio Alcaraz* [g], *Craig G. Rogers* [h]

[a] *Department of Urology, "Regina Elena" National Cancer Institute, Rome, Italy;* [b] *Department of Urology, San Giovanni Bosco Hospital, Turin, Italy;* [c] *USC Institute of Urology, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA;* [d] *OLV Vattikuti Robotic Surgery Institute, Aalst, Belgium;* [e] *Division of Urologic Oncology, Fox Chase Cancer Center, Temple University Health System, Philadelphia, PA, USA;* [f] *Department of Urology, Bicêtre Hospital, Paris XI University, Le Kremlin-Bicêtre, France;* [g] *Department of Urology, Hospital Clínic i Provincial de Barcelona, Barcelona, Spain;* [h] *Vattikuti Urology Institute, Henry Ford Hospital, Detroit, MI, USA*

Article info

Article history:
Accepted April 13, 2015

Keywords:
Clampless
Ischemia
Off-clamp
Parenchymal clamp
Partial nephrectomy
Selective clamp
Segmental clamp
Unclamped
Zero-ischemia

Abstract

Context: On-clamp partial nephrectomy (PN) has been considered the standard approach to minimize intraoperative bleeding and thus achieve adequate control of tumor margins. The potential negative impact of ischemia on renal function (RF) led to the development of techniques to minimize or avoid renal ischemia, such as off-clamp PN and minimally ischemic PN techniques.
Objective: To review current evidence on the indications and techniques for and outcomes of minimally ischemic and off-clamp PN.
Evidence acquisition: A systematic review of English-language publications on PN without a main renal artery clamp from January 2005 to July 2014 was performed using the Medline, Embase, and Web of Science databases.
Evidence synthesis: The searches retrieved 52 papers. Off-clamp PN has been more commonly applied to small and peripheral renal tumors, while minimally ischemic PN is best suited for hilar and medially located renal tumors. These approaches are associated with increased intraoperative blood loss and perioperative transfusion rates compared to on-clamp PN. Minimally ischemic and off-clamp PN have potential functional benefits when longer ischemia time is anticipated, particularly for patients with lower baseline RF. Limitations include the lack of prospective randomized trials comparing minimally ischemic and off-clamp to on-clamp techniques, and the small sample size and short follow-up of most published series. The impact of different resection and renorrhaphy techniques on postoperative RF and its assessment via renal scintigraphy requires further investigations.
Conclusions: Minimally ischemic and off-clamp PN are established procedures that may be particularly applicable for patients with decreased baseline RF. However, these techniques are technically demanding, with potential for increased blood loss, and require considerable experience with PN surgery. The role of ischemia in patients with a contralateral healthy kidney and consequently an indication for elective minimally ischemic or off-clamp PN remains a debatable issue.
Patient summary: In this review we analyzed available evidence on minimally ischemic and off-clamp partial nephrectomy. These techniques, although technically demanding, may be particularly applicable for patients with decreased baseline renal function.

* Corresponding author. Department of Urology, "Regina Elena" National Cancer Institute, Via Elio Chianesi 53, 00144 Rome, Italy. Tel. +39 039 24689214; Fax: +39 06 52666983.
E-mail address: puldet@gmail.com (G. Simone).

http://dx.doi.org/10.1016/j.eururo.2015.04.020
0302-2838/

1. Introduction

The higher risk of chronic kidney disease (CKD) in patients receiving radical nephrectomy (RN) over partial nephrectomy (PN) for a small renal mass [1] has influenced current guidelines recommending (PN) over RN for cT1 renal tumors when technically feasible [2,3].

Key outcomes for PN include achieving negative tumor margins, a minimal decrease in renal function (RF), and no urologic complications [4]. Hilar clamping has been considered a standard approach for PN as it provides a relatively bloodless field for precise tumor resection and closure of the renal defect. However, the temporary interruption of blood flow may cause renal ischemic injury, potentially undermining the goal of RF preservation. Ischemia is considered a modifiable surgical predictor of postoperative RF, and retrospective evidence supports minimization of warm ischemia time (WIT) during PN, particularly in the case of imperative indications [5].

However, limited WIT periods (<20–25 min) during PN may have negligible effects on RF [6–9], which is strongly associated with the baseline estimated glomerular filtration rate (eGFR) and the percentage of parenchyma preserved [10]. A prospective analysis of structural and functional responses of the human kidney to on-clamp (On-C) PN in 40 patients showed an unexpected short-term tolerance to ischemia [11]. The ideal WIT safety threshold remains an area of debate. It has been demonstrated that cold ischemia has a protective effect on RF, even for extended clamp times [12], but may be difficult to achieve during minimally invasive (MI) PN. The potential negative impact of warm ischemia on RF led to the development of techniques to minimize global ischemia, such as zero-ischemia MIPN, as described by Gill et al [13].

This systematic review focuses on PN techniques, both open and minimally invasive, performed without clamping of the main renal artery, and thus includes techniques without ischemia (off-clamp [Off-C] PN), as well as those with segmental or selective ischemia (MIPN). We evaluate these techniques by analyzing the results and limitations of published series.

2. Evidence acquisition

A systematic review of the English-language literature was performed in August 2014 using the Medline, Scopus, and Web of Sciences databases.

The literature search was carried out using the terms "partial nephrectomy" in combination with keywords "clampless", "off-clamp", "unclamped", "segmental clamp", "selective clamp", "parenchymal clamp", "zero ischemia", "superselective microdissection" or "controlled hypotension". We limited our search to articles published between January 2005 and July 2014 because current techniques to minimize ischemia during PN, particularly MIPN, were developed over the past decade. Additional records on this topic were identified from references cited in the selected articles and previous review articles on this topic. A full update of the searches was performed on December 27, 2014. This process was independently carried out by two authors (G.S. and C.R). Discrepancies were resolved by open discussion. Other significant studies cited in the reference lists of the selected papers were evaluated.

All studies reporting intraoperative and perioperative data (operative time, blood loss, transfusion rate, in-hospital stay, readmission, complication rates), functional data (RF at discharge and/or at last follow-up), and oncologic data (positive surgical margins, disease-free survival, cancer-specific survival, and overall survival) for PN were collected.

Studies reporting single case reports, experimental studies on animal models, congress abstracts, review papers, editorials, and book chapters were not included in the review. The systematic review was performed in agreement with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [14].

3. Evidence synthesis

Figure 1 shows a flow diagram of the selection process for this systematic review of the literature. Out of a total of 248 articles screened, 177 were excluded on title and abstract review and 61 full-text articles were assessed for eligibility. In total, 52 articles were selected and critically analyzed.

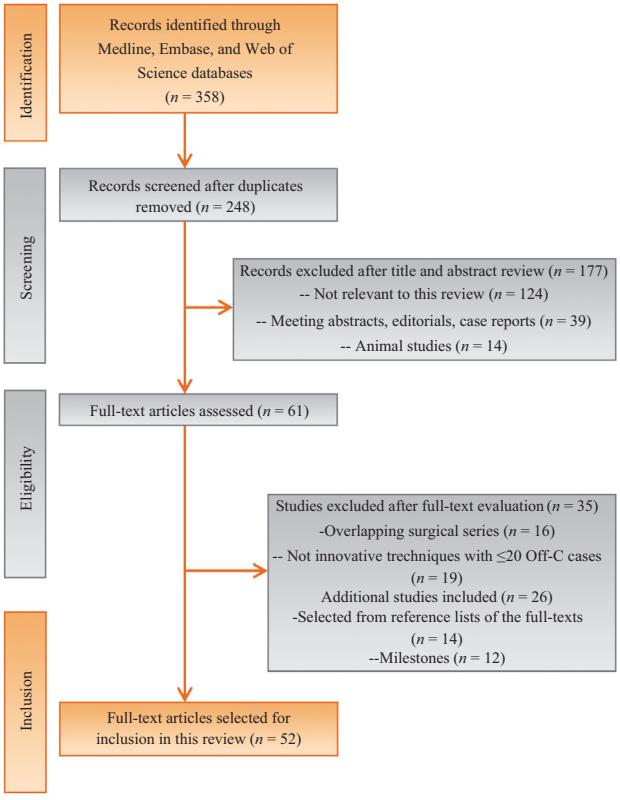

Fig. 1 – Flow diagram of evidence acquisition in a systematic review of selective-clamp and off-clamp (Off-C) partial nephrectomy in the treatment of renal tumors.

Please cite this article in press as: Simone G, et al. Indications, Techniques, Outcomes, and Limitations for Minimally Ischemic and Off-clamp Partial Nephrectomy: A Systematic Review of the Literature. Eur Urol (2015), http://dx.doi.org/10.1016/j.eururo.2015.04.020