

## Role of laparoscopy in the presence of a renal mass under 4 cm in size

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### Abstract

The increasingly common incidental diagnosis of small renal masses (SRMs) (measuring under 4 cm in size) has led to the consideration of applying minimally invasive techniques to deal with them - particularly in view of the high percentage of non-malignant conditions of this size that are radiologically indistinguishable from tumor lesions. Accordingly, laparoscopic access has gained great importance in the management of these masses, in an attempt to lessen the morbidity associated with lumbotomy.

Laparoscopic partial nephrectomy (LPN) is an evolving technique in most centers; on one hand it competes with open partial nephrectomy as the technique of choice, and on the other it will compete in the future with the non-excisional management techniques. These latter procedures in turn have become more precise thanks to laparoscopy.

Based on a standardized review of the abundant literature on the treatment of SRMs, the present study examines the technical innovations and improvements afforded by the laparoscopic approach, not only for excision purposes but also a vehicle for minimally invasive treatments. Likewise, the requirements of Services of Urology and the improvements that could be introduced in health systems for advancing the application of LPN in the management of SRMs are commented.

Progressive fine-tuning of the technique, with improvement of the laparoscopic repertoire and availability of hemostatic agents, will contribute to increase the indications for LPN in the future. The limited frequency of the disorder and the need to optimize the technique will require health care supervisors to centralize this type of pathology in centers with experience in laparoscopy and open partial nephrectomy.

Key words: Laparoscopy. Minimally invasive treatment. Renal carcinoma. Partial nephrectomy

In the year 2008, nobody questions laparoscopy as the technique of choice for adrenal gland removal<sup>1</sup>. Likewise, nobody questions the change in renal surgery produced by the introduction of laparoscopic radical nephrectomy<sup>2</sup>. On the other hand, we are all witnessing an exponential increase in the diagnosis of small renal masses (SRMs)<sup>3</sup>, these being understood as representing lesions under 4 cm in size, influenced by the TNM classification and the need to reach consensus in relation to the definition of such masses.

Despite these considerations, the clinical guides of the European Association of Urology define open partial nephrectomy as the technique of choice versus radical nephrectomy for the management of small renal masses measuring under 4 cm in size, with level 2b evidence<sup>4</sup>.

Why then is laparoscopy not standardized as the alternative of choice for the treatment of SRMs? Is only technical difficulty the factor limiting its development? What is wrong with our healthcare system when we continue to perform lumbotomies for SRMs, which in about 25-35% of all cases prove to be benign<sup>5</sup>?

Based on a standardized review of the abundant literature on the treatment of SRMs, an account is provided of the technical innovations and improvements afforded by the laparoscopic approach, not only for excision purposes but also a vehicle for minimally invasive treatments, from the personal perspective of three groups with laparoscopic experience in the European healthcare system.

As a personal opinion, mention will also be made of the requirements of Services of Urology and the improvements that could be introduced in health systems for advancing the application of laparoscopic partial nephrectomy (LPN) in the management of SRMs, with strict observance of safety, efficacy and minimal invasiveness.

## MATERIAL AND METHODS

Use was made of the information offered by the PubMed and Medline databases up until September 2008, using the terms *laparoscopic partial nephrectomy*, *nephron-sparing surgery*, *laparoscopic nephron-sparing surgery*, *open partial nephrectomy*, *series*, *complications and outcomes*. Consensus has been drawn from the experience of the three implicated centers in adopting the laparoscopic approach for the management of SRMs.

## RESULTS

### Usefulness of the laparoscopic approach for treating SRMs

#### *Laparoscopic partial nephrectomy*

Without doubt, laparoscopic partial nephrectomy (LPN) is the cornerstone in the application of laparoscopy to SRMs. It is not the aim of this study to provide a detailed account of the technique, based on the principles of open partial nephrectomy, and which can be consulted in many sources<sup>6-7</sup>.

As a first step, it is essential to stress that the oncological results of LPN are fully equivalent to those of open partial nephrectomy, with a global and cancer-specific survival rate after 5 years of 86% and 100%, respectively<sup>8</sup>. The published positive resection margins rate (0-3.6%) is also comparable to that reported for open partial nephrectomy, in the same way as the local recurrence rate (0-2%) (Table 1). If nephrectomy is performed due to the presence of a positive resection margin, the patient should be made aware that residual disease might not be found, and that three years of follow-up in such cases has revealed no poorer progression / local recurrence rates<sup>9</sup>. This remains an unresolved issue in the literature, in the same way as with open partial nephrectomy.

**Table 1**

Positive resection margin and local recurrence rates. Summary of complications in the reviewed literature.

	n	+ Margins	Local recurrence	Complications
Link et al. 2005	217	7 (3.5%)	2 (1.4%)	4 conversions (1.8%). TR 6.9%. PO complications (27): prolonged ileus (4), Transfusion due to bleeding (3), embolization (1), UF (3), UTI (2), POS (2), ARF (2), AUR (1), cellulitis (1), hernia (1), hypertension (1), pneumonia (1), thrombophlebitis (1). GCR 10.6%.
Simmons et al. 2007	200	2 (1%)		2 conversions to open partial and 1 to radical lap. PO: bleeding 9 (4.5%), FU 4 (2%), TR; 16 (8%), reoperation rate; 1.5%: via lap (1), open (1) and nephrectomy (1). 2 embolizations (1%). ARF 1 (0.5%). Medical complications in 25 patients. GCR 19%.
Ramani et al. 2005	200			2 open conversions (1%), 4 reoperations (2%) and 1 nephrectomy. Intraoperative complications: 11 (5.5%). PO complications: 24 (12%). Delayed complications: 31 (15.5%). GCR 33%.
Venkatesh et al. 2006	123	3 (2.5%)	0%	Intraoperative complications 8 (6.3%): bleeding (2), hypercapnia (1), conversion (4) PO complications 18 (14.3%): FU (13, 10.5%), ileus (2), transfusion (2), medical (1). GCR 20.6%.
Nadu et al. 2007	110	4 (3.6%)	0%	3 conversions (2.7%). Intraoperative complications; ureteral sectioning (1), removal non-tumor renal tissue (1). PO complications: bleeding (5), FU (1), fever (5), pneumonia (1), AUR (3). GCR: 13.6%.

Johnston et al. 2005	100	3 (3%)	0%	3 Conversions. 2 reinterventions. PO complications: bleeding (9), FU (2), PTE (1), DVT (1), hematoma (1), incisional hernial (5), ileus (1), pneumothorax (1), respiratory failure (1), cellulitis (5), AUR (2), UTI (1). GCR; 32%.
Desai et al. 2005	80	5	0% OS 98.7% CSS 100%	Intraoperative complications; 4 (5%): conversion (2 lap and 1 open) and damage to diaphragm (1) PO complications; 13 (16%): ileus (4), PTE (2), AUR (2), pneumonia (2), atelectasis (1), FU (1). transfusion 3 (3.7%). GCR 21%.
Brown et al. 2007	60	2 (3.3%)	0%	6 conversions (10%). PO complications: hematuria (2), pyelonephritis (1), reflux laryngitis (1), nausea (1), supraventricular tachycardia (1). GCR 12%
Weld et al. 2006	60	0	0%	Urological 8 (13.3%): conversion (1), bleeding (2), FU (5), UTI (1) non-urological 10 (16.7%): fever (3), ileus (2), wound infection (2), DVT (1), pleural effusion (1), congestive heart failure (1). GCR 30%
Rassweiler et al. 2000	53			4 conversions to open. PO complications: pneumothorax (1), re-explored hematoma (1), FU (14). GCR: 30%.
Jeschke et al. 2001	51	0	0%	No conversions. Intraoperative complications; (2%): pneumothorax (1). PO complications: 4 (6%): re-explored hematoma (1), FU (3), one reoperated. Reoperation rate 4%. GCR 10%.
Bhayani et al. 2008	50/52	0	1 (2%)	2 elective conversions. PO complications: transfusion (1), arrhythmia (1), lung edema (1), pneumonia (1), pseudoaneurysm (2), FU (1), renal artery embolism (nephrectomy)(1). GCR 16%.
Baughman et al. 2005	47	0	0%	1 Conversion. PO complications: FU (3), port infection (3), pneumothorax (1), lung edema (1). GCR 19%.
Wille et al. 2006	44	7 FS 0 Final	0%	Intraoperative complications; re-resection (5) and conversion (2) due to positive margin in peroperative sample. PO complications: transfusion (2), re-explored infected hematoma (1), lymphorrhagia (1), FU (2). GCR; 14%.
Orvieto et al. 2005	41	1 FS 0 Final	0%	Intraoperative complications: conversions (3), renal vein damage (1). PO complications: subcutaneous emphysema (1), PTE (1), incisional hernia (1), re-explored hematoma (1). GCR; 13.2%
Guillonneau et al. 2003	28	0	0%	No conversions. PO complications: FU (2), DVT (1), perirenal hematoma (1), bleeding (1), ARF (1), pancreatic damage (1), re-exploration (1). GCR; 28.6%
Beasley et al 2004	27	0	0%	No conversions. No intraoperative complications. PO complications: PTE (1), UTI (1), FU (1). GCR; 11%.
Häcker et al. 2007	25	0	0%	No conversions. No intraoperative complications. PO complications: perirenal hematoma (1), pneumonia (1). GCR; 8%.
Fogarty et al. 2005	21	0	0%	No intraoperative complications. PO complications: transfusion (2). GCR; 9.5%
Simon et al. 2003	20	0	0%	No conversions. Tumor fragmentation (1). PO complications: bleeding (1), dyspnea (1), pneumonia (1). GCR; 20%.
Yoshikawa et al. 2004	17		0%	Intraoperative complications: arterial damage – conversion (1). PO complications: FU (3), POS (1). GCR; 24%.

## 1.2.- Technological innovations and improvements of the technique

### Access route

As in other surgical fields, the choice of approach is conditioned by the experience of the surgeon. The series that have compared the retroperitoneal route versus the transperitoneal approach show differences in relation to tumor size, which is smaller in the former case. Apart from this, however, the retroperitoneal approach offers faster hilar control and shorter surgical times - no differences being noted in the complications rate or in terms of patient recovery<sup>10-12</sup>. Patients with chronic obstructive pulmonary disease may benefit from the retroperitoneal route<sup>13</sup>.

In general, large tumors (heminephrectomies) and those tumors located in the anterior zone and upper pole are more conveniently dealt with via the transperitoneal approach, which offers the advantage of a larger surgical field for suturing and improved spatial orientation. Tumors located in the posterior zone and lower pole in turn are also easily accessed via the retroperitoneal approach - the main disadvantages of the latter being spatial limitation and poorer triangulation. According to other authors, the need to dissect all the perirenal adipose tissue for full inspection of the kidney in search of second tumors, together with the aforementioned advantages, define the transperitoneal approach as the access of choice - particularly in the early stages of implementation of the technique.

#### *Hilar control*

Hilar control is recommendable in all LPNs; when not achieved, blood loss generally increases and the operating time is prolonged<sup>14</sup>. Different ways have been described for securing hilar control, including the use of Bulldog-type internal clamps<sup>15</sup> or Satinsky-type external clamps<sup>16-17</sup>, or a Rummel tourniquet<sup>18</sup>. After having evaluated all these options, we recommend the transcutaneous Satinsky clamp, since it is quickly applied and removed, without blocking a trocar. Caution is required in manipulating the clamp, since it may be accidentally displaced from outside the patient; furthermore, care is required to place the clamp so that it does not interfere with the camera or working trocars.

In our experience we always dissect the entire pedicle en bloc, without excessive blood vessel individualization, to leave a perihilar adipose pad and thus prevent intimal damage secondary to percutaneous clamping (Figure 1). Even in those cases where clamping is not performed because the tumor is markedly exophytic, we always leave the hilum ready for rapid and safe clamping, if needed.



**Figure 1. En bloc dissection of the left renal pedicle for clamping above the left adrenal vein, seen in the image.**

The most recommendable clamping modality is complete clamping (artery and vein), since in our opinion the benefits in terms of rapidity and safety offered by a bloodless field exceed the possible (and undemonstrated) protective effect of not clamping the vein.

#### *Shortening of ischemia time*

Ischemia time in LPN is the most conflictive aspect of the technique (along with hemostasia). The reported mean ischemia times range from 21 to 41 minutes<sup>15,19</sup>, though all series (even those from centers of excellence) have described cases of up to 60 minutes.

The different ways of performing cold ischemia have not gained popularity in LPN, due to the technical complexity involved and/or its questionable reproducibility. As a result, in our opinion, the intervention of complex cases in which ischemia times of over 30 minutes are expected should lead us to use open route hypothermia.

In the monorenal porcine model, ischemia times of up to 90 minutes have been shown to be tolerated<sup>20</sup>. In humans, isotopic monitoring with DMSA has shown that renal clamping for over 30 minutes during LPN allows acceptable functional recovery<sup>21</sup>. This therefore raises the question of whether the increased pressure associated with the pneumoperitoneum might exert a protective effect against more prolonged ischemia times. The physiopathology of renal ischemia is presently the center of intense debate, and in the coming years we may see variations in the allowed ischemia time, as well as the introduction of drugs offering protection against renal damage<sup>22</sup>.

For the time being, different authors have proposed maneuvers to shorten the ischemia time, for example by declamping after completing the first line of continuous parenchymal suturing, and performing the second suture line and renorrhaphy without ischemia<sup>23</sup>. Percutaneous clamping upon demand and according to the needs has also been proposed<sup>24</sup>, though this suggestion has been criticized from the physiopathological perspective, since it may increase renal damage. A surgical maneuver that has become popular is to avoid knotting on renal parenchyma and use clips as stops for tightening the continuous sutures. Clips prepared to this effect are available (Lapra-Ty), though hem-o-lock clips can also be used. This procedure eliminates the risk of parenchymal tearing and also shortens the ischemia time.

#### *Improvements in hemostasia*

Many products for securing hemostasia are available and have not been compared on a scientific basis<sup>25-26</sup>.

A range of LPN techniques have been published without hilar clamping, resorting to different energy sources (argon scalpel, Tissue-link, etc.), though none have become consolidated, except in application to small and highly exophytic tumors. Recently, a supraseductive embolization technique has been described for application to single and preferably exophytic SRMs, allowing excision without hilar clamping<sup>27</sup>. In our experience, we have almost always regretted failure to clamp, despite the presence of highly exophytic tumors, due to the generation of increased bleeding and a loss of tissue plane definition. Only in the case of those tumors with anatomical features and a location allowing supraseductive clamping of the feeding artery or arteries (Figure 2) do we decide against clamping - though as commented above, preparation for clamping is always made in case it becomes necessary.



**Figure 2. Dissection of the vascular branching of a renal hilum allowing supraseductive clipping of the tumor feeder vessels without having to clamp the renal pedicle.**

The tendency is to reproduce the open technique, first performing continuous suturing of the route and surgical bed with Vicryl 2/0 and using a CT-1 or 36 mm needle. The hemostatic material or substance is usually placed over this suture, in a second plane. In a multicentric review of 1347 cases in 18 centers of excellence in Europe and the United States, some hemostatic agent was seen to be used in 77.4% of all cases<sup>28</sup>. The most widely used agents in our setting are Flo-Seal, Tachosil, Bio-Glue and Surgicel<sup>25</sup>. Finally, Vicryl 0 mattress sutures are placed with a 36 mm needle, transverse to the bed and compressing a Surgicel hemostatic pack, obviating the need for suturing with clips (Lapra-Ty, hem-o-lock).

It is not the purpose of the present article to describe the advantages or inconveniences of the different hemostatic agents without actually having used them ourselves. In this context, of those we have used, we can recommend Flo-Seal placed beneath the Surgicel packing. We have also found it very useful to use TachoSil patches after the first parenchymal suture line, placed without further warm ischemia, since it is effective and readily available - though insertion through the trocars and posterior unfolding of the patch can prove technically difficult (Figure 3).



**Figure 3. Initial TachoSil patch application over the bed after tumor exeresis and first continuous suture line. Note the glove finger with which it is inserted through the 10-mm trocar.**

At the end of the intervention, we recommend voiding the pneumoperitoneum, with removal of the surgical piece in its bag, and sealing and restoration of the pneumoperitoneum to only 6 mmHg after checking the bed. In addition, the patient is kept under controlled hypotension during the first postoperative hours.

### **Laparoscopically guided cryotherapy**

Laparoscopically guided cryotherapy offers the advantages of precision, direct tumor location, the possibility of direct tumor biopsy, and "in situ" checking under magnification of the physiopathological effects of the cooling/warming cycles. Another potential advantage versus percutaneous application of the technique is the possibility of local bleeding control.

The technique can be consulted in many sources<sup>29</sup>. The most important advantage with respect to other non-excisional techniques such as radiofrequency ablation or high-intensity focused ultrasound (HIFU) is that displacement of the piece of ice can be monitored "in vivo" using an intraabdominal ultrasound transducer. In fact, a recent metaanalysis has reported a lower local recurrence rate in the case of tumors subjected to cryoablation than in those subjected to radiofrequency ablation<sup>30</sup>.

Validation of the procedure from the oncological perspective will still take some time, though the 5-year results that are presently available, with cancer-specific survival rates of 98-100%<sup>31-32</sup> that are somewhat higher than the 97% rate reported for the percutaneous route<sup>33</sup>, define this non-excisional technique as a very attractive alternative to open or laparoscopic partial nephrectomy.

### ***Laparoscopically guided radiofrequency ablation***

The application of radiofrequency to a SRM has also been defined as a non-excisional alternative technique, with indications very similar to those of cryotherapy - though as has been commented above, the results appear to be comparatively less encouraging<sup>30</sup>. The technique and results are presented in another chapter of this same monograph.

Its development in application to metastases of the liver and other locations has made percutaneous application of the technique a truly minimally invasive alternative for the treatment of SRMs. However, its disadvantage is that ultrasound and/or CAT cannot be used to delimit the ablative effect. MRI has been suggested to be the technique of choice for guiding the effect of radiofrequency ablation, though its applicability is limited by high costs and the need for specific software.

Accordingly, laparoscopically guided radiofrequency ablation, selecting exophytic SRMs, allows visualization of tumor ablation with a 5-mm safety margin, adapting electrode placement to the tumor volume, and of course offering the possibility of biopsy and bleeding control unavailable to the percutaneous approach.

### ***Laparoscopically guided high-intensity focused ultrasound (HIFU)***

The introduction of this high-frequency ultrasound tissue destruction technique in application to an organ such as the kidney - located deep, mobile and with several interfaces from the skin - has been strongly conditioned by its questionable results when performed percutaneously<sup>34</sup>.

Recently, an initial experience with HIFU has been published, using the technique with an intracavitary probe applied directly under laparoscopic guidance. Eight SRMs with a mean size of 22 mm were treated with HIFU and posteriorly removed. Most of them showed thermal necrosis<sup>35</sup>. This innovation suggests that fine-tuning of the technique may in future define it as another minimally invasive alternative for the treatment of SRMs, though at present this is still regarded as an experimental procedure.

## **Measures for optimizing the technique**

### ***Structuring of Services of Urology***

Laparoscopic partial nephrectomy is regarded as a top-level laparoscopic technique<sup>14</sup>. The impact of the learning curve upon the complications rate is reflected in all the published series that have evaluated their own LPN procedures on an internal basis according to the time / number of operations made<sup>36-37</sup>, even when more technically complex cases are considered<sup>16</sup>.

In the opinion of the authors, the lesser frequency of indication of LPN (compared with laparoscopic radical prostatectomy, for example), and the fact of having to operate against ischemia time, make it necessary to limit the practice of the technique to only two members of the laparoscopic team in each Service, with experience in other laparoscopic procedures and who dominate the suturing process - the second physician beginning as first surgeon once 100 operations have been jointly completed by both team members. In addition, these two urologists are required to have completed prior training in open partial nephrectomy, thereby allowing safe conversion to open surgery if necessary.

### ***Improvements of the healthcare systems***

Minimally invasive management of SRMs poses a challenge that is difficult to resolve in countries such as Spain. The procedure is attractive for the urologist and is clearly beneficial for the patient, considering the accepted principle of reducing the use of large incisions for removing small masses (which are normally extractable by dilating the trajectory with a 10-mm trocar). However, the low incidence of the technique and the illogical atomization of the healthcare system leads to the dispersion of cases within the public healthcare system - thus precluding the optimization of LPN.

As is presently done in the case of renal transplantation, the healthcare policy makers should select specific centers for each Autonomous Community (in the concrete case of Spain) in which LPN or the above described non-excisional techniques are centralized, as in other healthcare systems. Only in this way can the number of operations made by one same team guarantee the full optimization of LPN and to the consequent patient benefits of the technique.

If these principles are not followed, full optimization of LPN may prove elusive, thereby limiting its consolidation and diffusion. In such a case, SRMs should continue to be treated by open partial nephrectomy as the technique of choice, since this type of surgery can effectively be assimilated by most hospitals<sup>38</sup>.

## **Laparoscopy in risk patients**

### ***Elderly patients***

In patients over 70-75 years of age, the diagnosis of a SRM often implies the need to first evaluate whether the condition should be treated or not. Simple patient monitoring in such cases generally offers the opportunity to identify the lesion growth rate and its radiological behavior over time, allowing possible posterior exeresis without placing the life of the patient at risk<sup>5</sup>.

On the other hand, these patients usually present associated morbidities that imply increased advantages if a minimally invasive technique can be used. Accordingly, we are of the opinion that the different non-excisional techniques and procedures that do not require renal clamping logically should receive more widespread acceptance among elderly patients who need or request active treatment. In comparison, when dealing with younger patients, surgery - whether open or laparoscopic - will always be the gold standard where comparisons must be made of the long-term results of the different options.

LPN in patients over 70 years of age who present creatinine levels  $> 1.5$  ng/ml has been associated to increased surgical conversion rates and a poorer course of renal function<sup>39-40</sup>.

### ***Obese patients***

This increasingly frequent type of patient stands to gain most benefit from avoiding large incisions. The same consideration holds for LPN. An article has recently been published, comparing LPN with open partial nephrectomy, and demonstrating differences in pre- and postoperative parameters in favor of the minimally invasive technique in obese patients<sup>41</sup>. Previously, however, the large LPN series of the Cleveland Clinic revealed no statistically significant differences in the peroperative parameters or complications rate of LPN in obese versus non-obese individuals<sup>42</sup>.

### ***Central tumors***

A sinusal or intrarenal SRM location constitutes a challenge in laparoscopic surgery, as well as in open surgery. In those centers where no intraabdominal ultrasound probe is available, such surgery is usually performed via the open route, in order to make use of tactile exploration to locate the lesion and ensure a careful technique to remove the lesion while preserving renal viability.

However, the literature contains series from centers of excellence where the laparoscopic approach to such masses has been shown to be viable and comparable in terms of the oncological results to open surgery - though at the cost of a 4% greater incidence of postoperative complications<sup>43</sup> than in the case of peripheral SRMs. In any case, and in concordance with the experience gained in open partial nephrectomy, a central location entails an increased risk of urinary fistulization and hilar vessel damage<sup>44</sup>.

### ***LPN in monorenal patients***

Imperative partial nephrectomy in such patients implies increased responsibility in both open and laparoscopic surgery. The importance of clamping time in this patient subgroup has been reflected by a recent study from the Cleveland Clinic, comparing the functional results of 169 open procedures versus 30 LPNs in patients with a single kidney. The ischemia time was 9 minutes longer in the LPN group, while the need for postoperative dialysis was 0.6% and 10%, and the need for definitive dialysis after one year was 0.6% and 6.6% for open partial nephrectomy and LPN, respectively<sup>45</sup>.

Therefore, with the exception of highly exophytic and easily accessible tumors, open partial nephrectomy must continue to be viewed as the technique of choice in these patients.

## Complications of laparoscopy in treating SRMs

The great number of published articles and the different ways in which the complications are described make the standardization of data collection and analysis difficult. Table 1 describes the number of cases treated, the positive resection margin and local recurrence rates, and the complications reported by the representative literature series.

Assuming the mentioned data dispersion, the global complications rate is 8-33% (Table 1), which is comparable to the complication rate reported for open partial nephrectomy (5.5-38%)<sup>38,46-47</sup>.

Bleeding complications are observed in 2-9.5% of the cases in the most representative series, with a transfusion rate of 6.9%<sup>16,8</sup>. These aspects are those most closely correlated to surgeon experience. The generalized tendency to emulate the principles of open partial resection, the growing use of pedicle clamping, and the application of hemostatic agents have served to reduce the frequency of such problems.

The urinary fistulization rate is comparable to that seen in open surgery; however, in contrast to bleeding complications, this rate has not decreased in the principal series due to the progressively increasing treatment of more endophytic or central tumors. In our experience, when dealing with any tumor presenting an internal margin located less than 1 cm from the urinary tract, we preoperatively insert a double-J catheter and instill methylene blue in the bladder after tumor exeresis. The catheter is then removed during the same hospital admission in the absence of fistulization.

The risk factors for worsening of renal function are a patient age of over 70 years with a warm ischemia time of more than 30 minutes, previous renal functional impairment, re-clamping of the renal artery, and a warm ischemia time of over 60 minutes. Considering the data published in the literature, the principles commented above in relation to monorenal patients do not apply in the case of elective surgery, where the acute renal failure rate is 0.5-0.9%<sup>16,49</sup>, i.e., fully comparable to the rates obtained in open surgery.

Recently, the Cleveland Clinic has published an internal retrospective study comparing 1028 open partial nephrectomies and 771 LPNs in patients with single tumors measuring under 7 cm in size - most operations being carried out on an elective basis. According to their multivariate analysis, LPN is associated with a shorter surgical time ( $p < 0.0001$ ), smaller blood loss ( $p < 0.0001$ ), and a shorter hospital stay ( $p < 0.0001$ ). The peroperative complications and preserved renal function rates (99.6% versus 97.9%) were similar for both techniques. However, LPN was associated with a longer warm ischemia time, more postoperative complications (particularly of a urological nature), and a larger number of procedures needed to resolve them<sup>50</sup>.

## CONCLUSIONS

Laparoscopic partial nephrectomy is presently a good alternative to open surgery in selected patients. The technique has been shown to be reliable in relation to all the parameters of oncological control. Progressive fine-tuning of the technique, with improvement of the laparoscopic repertoire and availability of hemostatic agents, will contribute to increase the indications for LPN in the future. However, we feel that LPN, considering its inherent advantages with respect to open surgery, the limited frequency of the disorder and the need to optimize the procedure, will require centralization in concrete hospital centers with experience in laparoscopy and open partial nephrectomy - in contrast to the situation seen with other more frequent pathologies. The healthcare policy makers should work in this direction.

## Abbreviations

TR (transfusion rate), PO (postoperative), UF (urinary fistula), UTI (urinary tract infection), POS (pyeloureteral ostium stenosis), ARF (acute renal failure), AUR (acute urinary retention), GCR (global complications rate), PTE (pulmonary thromboembolism), DVT (deep venous thrombosis), FS (frozen section).

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