The management of small renal masses: what is likely to change?

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ABSTRACT
The diffusion of imaging has determined an increased discovery of small renal masses (SRMs). Recent publications have been reviewed to present the state of the art in the management of SRMs and to try to foresee the next steps in this challenging condition.

The role of percutaneous biopsies is expanding, since management algorithms include also active surveillance and ablative therapies. However up to 30% of biopsies fail to provide histological diagnosis and there is the risk of under-evaluating high-grade tumors.

Active surveillance has been proposed in patients with reduced life expectancy and numerous comorbidities. The average growth of SRMs is slow, and metastatic progression has been observed in about 1%. Ablative therapies (cryotherapy and radiofrequency ablation) are used in patients with relevant comorbidities or advanced age and unfit for surgery, but who desire active treatment. Compared to conservative surgical treatment both techniques have increased local progression rates, while metastatic progression is relatively low.

Partial nephrectomy (PN) is the recommended curative treatment for SRMs and can be performed open, laparoscopically or robotically. Open PN represents the benchmark, with similar cancer specific survival and better preservation of renal function compared to nephrectomy. Laparoscopy is comparable to open surgery in terms of oncologic results, but a long learning curve is necessary.

Perioperative outcomes of robot-assisted PN appear superior to laparoscopy and the learning curve is shorter, but data for oncological results are still immature. With the increasing diffusion of robotic technology it is likely more SRMs will be managed with this approach.

Keywords: Renal cell carcinoma, Active surveillance, Cryoablation, Thermal ablation, Laparoscopic surgery, Robotic surgery

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represents a challenging issue, as there are multiple options available. For poor surgical candidates, AS or minimally invasive ablative treatments such as radiofrequency (RF) or percutaneous cryotherapy may be valid options. Surgical treatment with curative intent presently consists in partial nephrectomy (PN) with open, laparoscopic or robotic approach in the majority of cases, while radical nephrectomy (RN) is reserved for tumors with central location preventing nephron-sparing surgery.

The aim of this review is to present the current state-of-the-art in the rapidly evolving field of SRMs management and to try to foresee the next steps in this challenging condition.

Role of tumor biopsies

The role of percutaneous biopsies of SRMs is evolving, as they can provide valuable information in the management algorithm and are particularly indicated when contrast enhancement based imaging is not conclusive and when ablative therapies are planned, both before and after treatment.

Recently, biopsy has also been recommended in two different cohorts of patients: those with an intermediate risk for comorbidities and tumor progression, for whom accurate information is vital for choosing AS or primary intervention, and young females with masses 3 cm or less who have a high likelihood of benign lesions (20).

Biopsies are currently performed by interventional radiologists under CT or ultrasound guidance, generally under general anesthesia, and a core technique is adopted using a coaxial cannula, in order to minimize the contact between tumor cells and the long biopsy tract between the kidney and the skin, thereby reducing the risk of tumor seeding (21). Clinically significant bleeding is described in less than 1% of the cases, but untreated coagulopathy remains an absolute contraindication to SRM biopsy.

Historically, the reported technical failure rates were considerable (22) due to location of the mass on the anterior or hilar kidney areas, anatomic aberrations, biopsy technique and radiologist experience, but recent series demonstrate increasing efficacy (23-28). However, still 3-30% of biopsies fail to provide histological diagnosis (Tab. I): therefore, if the latter is considered important in the subsequent management, either repeated biopsy or surgery is recommended (29).

Besides providing diagnosis regarding the presence of malignant cells, SRM biopsy should also aim at characterizing the histologic subtype and the biologic aggressiveness of the lesion. Subtype discrepancies are less likely for clear-cell RCC, but they arise more frequently when papillary or chromophobe tumors are encountered, as well as for fat-poor angiomyolipomas. In particular, the present possibility to distinguish on core-biopsy specimens between oncocytoma and chromophobe RCC remains vague (30).

Relatively few studies have compared percutaneous biopsy results with those of final pathology after surgical treatment: Schmidbauer et al (25) found an agreement of 91% for histological subtype, but only 76% for Fuhrman grade. A recent study from Johns Hopkins (31) concluded that even SRMs present considerable heterogeneity in tumor grade, and highest discordance was observed in high-grade tumors (31.3%) across the different histological subtypes. Therefore, the risk of under-evaluating biopsies from high-grade tumors may be not insignificant, and the authors question the value of biopsy-driven treatment algorithms.

The use of immunohistochemical techniques on SRM biopsy, and even more gene expression profiling are the tools to overcome these discrepancies and to choose the treatment option with greater confidence.

Active surveillance

The increased incidence of discovery of asymptomatic SRMs in patients with reduced life expectancy and numerous comorbidities has favored the option of AS as a rational therapeutic choice (Tab. II). This approach is endorsed both in the AUA guidelines (32) and in the recent update of the European ones (33). For renal masses, AS can be defined as initial monitoring of size with imaging techniques with subsequent intervention reserved for those who show progression, defined as size increase or onset of tumor-related symptoms (34).

### TABLE I - Selected series of active surveillance of SRMs

<table>
<thead>
<tr>
<th>Author</th>
<th>Reference</th>
<th>Number of patients (Pt) and tumors (T)</th>
<th>Mean age</th>
<th>Indications for AS</th>
<th>Mean size (cm)</th>
<th>Progression to M+</th>
<th>Overall death rate</th>
<th>Cancer-specific survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chawla</td>
<td>8</td>
<td>234 Pt Meta-analysis</td>
<td>NA</td>
<td>NA</td>
<td>2.6</td>
<td>3/234 (1.3%)</td>
<td>NA</td>
<td>100%</td>
</tr>
<tr>
<td>Abou Youssif</td>
<td>9</td>
<td>35 Pt 44 T</td>
<td>71.8</td>
<td>All absolute or relative</td>
<td>2.2</td>
<td>2/35 (5.7%)</td>
<td>9/35 (25%)</td>
<td>100%</td>
</tr>
<tr>
<td>Aboussaly</td>
<td>10</td>
<td>110 Pt</td>
<td>81</td>
<td>All &gt;75 y.o. - Mean Charlson score: 2</td>
<td>2.5</td>
<td>0/106 (0%)</td>
<td>34/106 (32%)</td>
<td>100%</td>
</tr>
<tr>
<td>Crispen</td>
<td>11</td>
<td>113 Pt 212 T</td>
<td>71</td>
<td>75% elective 25% absolute or relative</td>
<td>2.4</td>
<td>2/154 (1.3%)</td>
<td>NA</td>
<td>100%</td>
</tr>
<tr>
<td>Rosales</td>
<td>12</td>
<td>212 Pt 223 T</td>
<td>71</td>
<td>Mean Charlson score: 3</td>
<td>2.8</td>
<td>2/212 (0.9%)</td>
<td>15/212 (7%)</td>
<td>99.5%</td>
</tr>
<tr>
<td>Mason</td>
<td>13</td>
<td>82 Pt 84 T</td>
<td>74</td>
<td>Patients unfit for surgery</td>
<td>2.3</td>
<td>1/82 (1.2%)</td>
<td>8/82 (10%)</td>
<td>99%</td>
</tr>
<tr>
<td>Jewett</td>
<td>14</td>
<td>178 Pt 209 T Prospective</td>
<td>73.6</td>
<td>Patients unfit for surgery or refusal</td>
<td>2.4</td>
<td>12/767 (1.5%)</td>
<td>77/619 (12.5%)</td>
<td>99.4%</td>
</tr>
</tbody>
</table>
There is no consent on when to terminate AS, and the prospective study by Jewett et al (14) prompted termination of surveillance and active treatment when the diameter reached 4 cm and when doubling of the calculated mass volume occurred in less than 12 months.

About one-third of SRMs under AS remain stable and the average growth is slow, between 0.15 and 0.3 cm/year. However, benign lesions can grow at similar rates of the malignant ones, and when there is biopsy-proven presence of renal cancer, SRMs can also decrease in size (30%) or remain stable (15%) (14). Progression to distant metastases has been observed in about 1% of cases in the published series, but with a relatively short follow-up (mean 33.5 months) (8-14, 21).

There is also no consensus on the adequate imaging protocol for follow-up, as repeated CT scans can determine radiation exposure, and there is an increasing trend in use of ultrasound in the follow-up of SRMs, as far as measurement of the lesion size, with re-evaluation performed every 6 months (3).

The majority of the available studies on AS (Tab. I) are retrospective, have a follow-up between 2 and 3 years and include a low number of patients with biopsy-proven renal tumors.

These shortcomings are partially obviated by the results of a multi-institutional prospective, although in nonrandomized study (20) that enrolled 497 patients, 55% chose primary intervention, 45% AS and 9% of the latter crossed over to surgical treatment. AS patients were older, had worse ECOG scores and total comorbidities. With a follow-up extending to 5 years, overall survival was lower for AS cases (75 vs. 92%) but no statistically significant difference was found in cancer-specific survival. Therefore, in a selected cohort of patients with intermediate follow-up, AS was not inferior to primary intervention.

These promising data are likely to broaden the support for AS, provided that patients are willing to undergo careful monitoring every 6 months, even more because there is evidence that delayed surgical treatment of SRMs does not increase the risk of local and metastatic progression (35, 36).

In conclusion, although AS has been advocated for every SRM less than 1 cm regardless of the patient life expectancy (3), presently those who are likely to benefit more from this approach in terms of preservation of the renal function and reduction of cardiovascular mortality are elderly and comorbid patients. On the contrary, young and healthy individuals can be closely monitored if they choose so, but the reduced invasiveness of the robotic approach is likely to extend the role of nephron-sparing surgery for the treatment of SRMs with curative intent.

### Ablative therapies

Tissue destruction of SRMs has been performed mainly with two techniques: cryoablation (CA) and RF using a percutaneous approach for posterior lesions and a transperitoneal laparoscopic one for anterior masses (29). Data on high-intensity focused ultrasound (HIFU) and other ablative technologies are still immature.

The majority of cases are patients with relevant comorbidities or advanced age, unfit for surgery but in whom an active treatment is desired. Tumor ablation can also be rational in patients with SRMs in solitary kidney or in multiple recurrences in presence of genetic alterations, in whom the issue of preservation of the renal function is more relevant than radical removal (33). Ablative therapies are not recommended for centrally located masses close to the pyelocaliceal system and the ureter, for those greater than 3 cm in diameter or those with irregular and infiltrative aspect (32). Other contraindications are represented by severe coagulation disorders, young age or presence of metastatic diffusion. These patients also have to accept the need for frequent cross-sectional imaging during the follow-up, and in order to reduce costs and radiation exposure, contrast-enhanced ultrasound has been proposed, with high specificity and negative predictive value (37).

CA causes tissue destruction by the insertion of hollow cryoprobes through which argon and helium gases are circulated: an expanding ice ball forms that causes cell death by destruction of the cell membrane and internal structures, as well as ischemia. When percutaneous and laparoscopic approaches are compared, the former has the advantage of reduced pain and hospitalization and shorter convalescence time, but a higher primary failure rate (38-40).

A selection of recent series of the results of CA for SRMs is reported in Table III: only one has a mean follow-up longer than 5 years. Biopsy-proven RCC, when obtained intraoperatively, was present in over half of the cases, and local recurrence rates range between 0 and 16.4% and CSS between 92 and 100%, but the follow-up is still relatively short.

RF ablation consists in the insertion inside the SRM of a multi-pronged needle to which mono or bipolar RF is applied.
generating local heat. When temperatures between 50° and 100° are maintained, coagulation necrosis is obtained, causing irreversible cell damage. During this kind of treatment, large renal vessels may have a heat sink effect, and therefore peripherally located tumors are more easily treated.

A selection of recent series of the results of RF ablation for SRMs is reported in Table IV (45-48): there was a higher percentage of biopsy-proven renal tumors than CA and the local recurrence rate after one treatment ranged between 0.9 and 19.5%. This was generally judged by local persistence of contrast enhancement at control CT scan, but there is no consensus on standardized radiologic criteria of success, and post-treatment biopsies have been obtained rarely.

Studies comparing the pathological effects of RF ablation in patients subsequently undergoing surgical treatment demonstrate that viable tumor was still present in 23.5% of the specimens and that tumor ‘skipping’ is still a problem with this technique (49).

A retrospective study from the Mayo Clinic evaluated 751 renal tumors treated percutaneously with RF in 321 cases, CA in 430 and demonstrated a significant association of the R.E.N.A.L. nephrometry scoring system with both failures and complications (50). This system was originally proposed for the conservative surgical treatment of renal tumors and it includes five anatomical criteria: tumor radius, exophytic aspect, nearness to the collecting system, anterior or posterior location and location relative to the polar line (51). The authors note that some criteria relevant for surgical resectability are less important for percutaneous ablative treatments, such as position relative to the polar lines. On the contrary, the mass proximity to the bowel of upper ureter are risk factors for ablative treatments not scored in the original system.

Nephrometric scoring systems are therefore also important for treatments of SRM different from open surgery, but the relative value of some aspects such as anterior or posterior location and upper polar origin should receive different scores according to the new different approaches adopted.

A meta-analysis on SRMs management evaluating 99 series reached the conclusion that local recurrence is more common after RF (11.7%) than after CA (4.6%). When compared with conservative surgical treatment, both techniques had significantly increased local progression rates (relative risk 18.23 for RF and 7.45 for CA), while progression to metastatic diffusion was relatively low (2.3% for RF and 1.2% for CA) without statistically significant difference compared with surgical treatment (54).

Surgical treatment of SRMs

In the last decade, an accumulating body of evidence derived from high-quality clinical research has determined a shift from RN toward PN, which presently represents the recommended curative treatment for clinically localized renal tumors. The European Association of Urology states, in its 2015 Guidelines, that PN is recommended in patients with
T1a tumors and should be favored over RN in patients with T1b tumors whenever feasible (33).

When performing nephron-sparing surgery, the goals the urologist must keep in mind, despite the preferred surgical technique, are essentially three: oncological outcomes, functional outcomes and safety, which together constitute the so-called Trifecta (55).

Open partial nephrectomy

Since the first clinical series in the 1980s (56), open PN (OPN) has become the standard treatment for SRMs, and every comparison needs to be made with the results achievable with this approach (Tab. V).

With regard to oncological outcomes, several large retrospective studies (57-61), an analysis of the SEER database (62) and the randomized phase 3 EORTC trial 30904 (63) showed comparable cancer-specific survival (CSS) between PN and RN over an extensive period of follow-up. Specifically, CSS rates at 5 and 10 years for PN were 97.8% and 95.8%, while CSS for RN were 95.5% and 84.4%, respectively (59).

Preservation of renal function is of paramount importance in the management of SRMs and there is strong evidence suggesting a better preservation of renal function with PN (64-67), even if there are contrasting data with regard to overall survival. A SEER registry analysis showed an increase in overall mortality with RN (68), while the EORTC trial 30904 could not confirm this trend (63). When performing PN, it is well known and intuitive that a shorter ischemia time is associated with a better functional outcome and that every minutes counts. Warm ischemia time (WIT) more than 20 min and cold ischemia time (CIT) more than 35 min. correlate with a higher risk of acute renal failure and an increased chance of developing chronic kidney insufficiency (69, 70).

Complications of open PN reported in literature are slightly more than those occurring after open RN (71), with a higher rate of severe hemorrhage (3.1 vs. 1.2%) or reoperation (4.4 vs. 2.4%); furthermore, in PN, a potential complication not occurring in RN is the development of urinary fistulae (4.4%).

Laparoscopic partial nephrectomy

In experienced hands, laparoscopic PN (LPN) is an alternative to OPN, with equivalent oncologic results (61, 72-74), and the rate of positive surgical margins has been proved to be comparable, attesting at 2.4% (75) (Tab. VI).

The laparoscopic approach has been found to be associated with decreased blood loss and shorter hospital stay, while operative time and WIT are generally longer (76, 77). The rate of postoperative complications has been proved to be higher with LPN [odds ratio (OR) 3.52], with cortical, smaller and exophytic tumors being usually those with a lower risk (61). In a comparison of 100 OPN and 100 LPN, overall rates of grade 1-4 complications were 5, 6, 3 and 1% in the laparoscopic group and 11, 6, 3 and 1% in the open group, respectively. No grade 5 complications were observed in either group. In the LPN group, conversion rate to open surgery was 2% (78). The rate of complications is inversely correlated with the surgeon experience: a significant reduction in complications can be reached after more than 200 cases (79), and the MIC rate (margins, WIT <20 min and complications) appeared to increase from 63 to 84.9% approaching the 200 cases; interestingly, the PADUA nephrometric score was found to be inversely correlated with MIC rate (80). The long learning curve constitutes the greatest limitation of LPN, therefore limiting its applicability on a large scale.

One potential concern of LPN is the longer WIT and thus the higher risk of postoperative renal failure. In the above-mentioned comparison of 100 LPN and 100 OPN, the decline of postoperative GFR at 24 h after surgery was higher after LPN (8.8%) than after OPN (0.8%); however, after a mean follow-up

<table>
<thead>
<tr>
<th>Author</th>
<th>Reference</th>
<th>Years</th>
<th>Number of patients</th>
<th>Mean follow-up (months)</th>
<th>Cancer-specific survival %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Becker</td>
<td>59</td>
<td>1975-2002</td>
<td>216</td>
<td>66</td>
<td>97.8</td>
</tr>
<tr>
<td>Patard</td>
<td>60</td>
<td>1984-2001</td>
<td>314</td>
<td>50.7</td>
<td>97.8</td>
</tr>
<tr>
<td>Gill</td>
<td>61</td>
<td>1998-2005</td>
<td>1028</td>
<td>15</td>
<td>99.2</td>
</tr>
<tr>
<td>Crepel</td>
<td>62</td>
<td>1988-2004</td>
<td>1622</td>
<td>60</td>
<td>97.5</td>
</tr>
<tr>
<td>Van Poppel</td>
<td>63</td>
<td>1992-2003</td>
<td>268</td>
<td>112</td>
<td>97.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Author</th>
<th>Reference</th>
<th>Years</th>
<th>Number of patients</th>
<th>Mean follow-up (months)</th>
<th>Cancer-specific survival %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gill</td>
<td>61</td>
<td>1998-2005</td>
<td>771</td>
<td>15</td>
<td>99.3</td>
</tr>
<tr>
<td>Lane</td>
<td>72</td>
<td>1999-2008</td>
<td>145</td>
<td>74.4</td>
<td>97</td>
</tr>
<tr>
<td>Permpongkosol</td>
<td>73</td>
<td>1996-2004</td>
<td>85</td>
<td>40.4</td>
<td>98.8</td>
</tr>
<tr>
<td>Favaretto</td>
<td>74</td>
<td>2000-2010</td>
<td>150</td>
<td>38</td>
<td>97</td>
</tr>
</tbody>
</table>
of 3.6 years, the decline in GFR was identical in both groups and a comparable percentage of patients developed chronic kidney disease (21% LPN vs. 18% OPN). On multivariate regression analysis, preoperative GFR, ischemia time and surgical access independently predicted the immediate postoperative (24-48 h) GFR decline, while surgical access was not found to be associated with long-term GFR (78). It has been demonstrated that, although renal function recovery is strongly associated with quality and quantity of preserved kidney (81), potentially irreversible kidney damage occurs during LPN when warm ischemia is more than 30 min (82). In an effort to keep WIT below 30 min, ‘early unclamping’, ‘zero ischemia’ either with pharmacologically induced hypotension and/or with anatomic microdissection, and ‘selective clamping of segmental renal artery’ have been proposed (83-85), thus reducing the WIT. However, differences in GFR at 6 months appear to be comparable when WIT is kept below 30 min (86). Albeit promising, these innovations need to be assessed worldwide for their safety and applicability and not only in the hands of the most experienced surgeons.

**Robot-assisted partial nephrectomy**

The Da Vinci surgical system (Intuitive Surgical, USA), with its endowrist technology, 3D vision and optical magnification constitutes a tremendous facilitation in minimally invasive surgery, allowing for greater visualization and precise instruments control, thus reducing the length of the learning curve. Whereas the learning curve for LPN is more than 200 cases (79), the learning curve for robot-assisted PN (RAPN) is reported to be about 25 cases (87). RAPN is an enabler of PN in general, whereas LPN may be viewed as a hurdle to nephron sparing: in the United States from 2000 to 2011, PN increased from 8.6 to 27%; OPN decreased by 33% while minimally invasive RN increased by 15%. On the contrary, RAPN increased significantly from 2008 to 2011, reaching a rate of 10% in non-academic institutions and of 14% in university hospitals (88).

A recent editorial in European Urology remarks that, despite identical dissections can be performed laparoscopically and robotically, the advantages of robotics reside in the ability to precisely sculpt the excision and efficiently suture the parenchyma, making it clear that LPN is presently suboptimal. Indeed, robotic technology has been nowadays adopted in most centers previously performing an elevated number of LPNs. The procedures competing with RAPN at most centers are not LPN but rather RN, ablation or observation (89).

With regard to oncologic outcomes, the prevalence of PSM is 0.7-3.8%, while CSS at 5 years has been reported to be 99 %, results comparable with those achievable with OPN and LPN (90-95) (Tab. VII).

When comparing OPN and RAPN, only few well-conducted studies are available. In a recent matched-pair analysis of 200 OPN and 200 RAPN, RAPN was proved to be equivalent to OPN in terms of operating time, perioperative complications (21.5% OPN vs. 14% RAPN), positive margins (5.5% OPN vs. 5.7% RAPN) and functional outcomes (3-month reduction in GFR 16.6 ml/min OPN vs. 16.4 ml/min RAPN). Mean WIT was shorter in OPN (15.4 ± 5.9 min OPN vs. 19.2 ± 7.3 min RAPN), while the median blood loss was in favor of RAPN (150 ml OPN vs. 100 ml RAPN) (96).

When comparing RAPN and LPN, the evidence is of low quality, as there are no prospective randomized controlled studies, there is great heterogeneity between the series and the follow-up is often insufficient. In 2013, Froghi et al specifically compared the outcomes of RAPN vs. LPN in pTa tumors. In a meta-analysis of six studies including 256 patients (102 RAPN and 154 LPN), they did not observe any significant difference in terms of blood loss, complications, length of stay and WIT, thus supporting the thesis that for small renal tumors, both LPN and RAPN are feasible and safe procedures (97). In 2014, Zhang et al performed a new meta-analysis of 14 studies comprising 1539 patients and again did not note any significant difference with regard to operative time, blood loss, complications, length of hospital stay and positive surgical margins. They confirmed how RAPN has a significantly lower WIT, thus reinforcing its advantages over LPN (98). In a recent systematic review and meta-analysis, Choi et al have compared the perioperative outcomes of LPN and RAPN analyzing 23 studies including 2240 patients (1088 LPN and 1152 RAPN). No significant differences were noted in terms of operative time, estimated blood loss, positive surgical margins, change of serum creatinine and complications. Noticeably, RAPN was associated with a significantly lower rate of conversion to open surgery and to radical surgery, as well as with shorter length of stay, shorter WIT and smaller change of eGFR, thus revealing the superiority of RAPN (99).

In order to ulteriorly reduce WIT, also in RAPN, minimally ischemic and off-clamp techniques have been proposed, with good perioperative, oncological and functional results. These techniques are technically demanding and have the potential of increased blood loss but may be particularly useful and applicable for patients with decreased baseline RF (95, 100, 101).

**TABLE VII - Relevant series of robot-assisted partial nephrectomy**

<table>
<thead>
<tr>
<th>Author</th>
<th>Reference</th>
<th>Number of patients</th>
<th>Mean follow-up (months)</th>
<th>Positive surgical margins %</th>
<th>Cancer-specific survival %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kyllo</td>
<td>90</td>
<td>124</td>
<td>29</td>
<td>1.6</td>
<td>99.1</td>
</tr>
<tr>
<td>Khalifeh</td>
<td>91</td>
<td>943</td>
<td>63.6</td>
<td>2.2</td>
<td>5-year recurrence-free 94.8</td>
</tr>
<tr>
<td>Khalifeh</td>
<td>92</td>
<td>427</td>
<td>36</td>
<td>0.7</td>
<td>99.04</td>
</tr>
<tr>
<td>Dulabon</td>
<td>93</td>
<td>446 41 hilar 405 non hilar</td>
<td>-</td>
<td>2.4 hilar 1.5 non hilar</td>
<td>-</td>
</tr>
<tr>
<td>Benway</td>
<td>94</td>
<td>183</td>
<td>26</td>
<td>3.8</td>
<td>-</td>
</tr>
<tr>
<td>Kaczmarek</td>
<td>95</td>
<td>66 off-clamp</td>
<td>21</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>
An increasing number of publications prove today that RAPN has favorable short-term oncologic results, promising functional outcomes and an acceptable learning curve, all associated with the advantages of a minimally invasive procedure able to offer the accuracy of open surgery. It is likely that RAPN will in the next years take over most actual indications for nephron-sparing surgery.

Cost analysis

Lastly, an issue to be considered is that of cost-effectiveness. LPN has been shown to be the most cost-effective ($10,311) when compared with open PN ($11,427), given the longer hospital stay, and RAPN ($11,962), in consideration of the highest acquiring and maintenance costs of the Da Vinci surgical system (102).

Conclusion

The ever increasing number of SRMs discovered frequently places the urologist in front of the choice between observation, minimally invasive ablation or surgical removal. Observation is a sound choice in patients with relevant comorbidities and reduced life expectancy, in consideration that SRMs grow slowly. A core needle biopsy should be obtained whenever possible, as it provides a reliable guide to further treatment. About 40% of patients undergoing AS are crossed to surgical treatment within 2 years, and delayed surgery does not appear to worsen the prognosis.

Minimally invasive ablation is more attractive for posteriorly located masses that can be easily reached percutaneously. It is uncommon that a single institution may have available both CA and RF, and in this case CA provides better results in terms of local recurrence.

On the contrary, when general anesthesia and pneumoperitoneum are required, the present diffusion of robotic technology makes nephron-sparing excision more appealing than CA and RF, particularly for anterior and polar masses. However, considerable expertise is required, and although the learning curve appears to be shorter than for traditional laparoscopy, in the early phase, significant complications may occur and the oncologic medium-term results of RAPN are still unavailable.

Open PN still remains the benchmark in term of oncologic and functional results, with more than 30 years of experience, although its invasiveness reduces somehow the appeal.

Prospective randomized studies between all forms of treatment are the theoretical answer to the current therapeutic dilemma, but historically they have been conducted with long recruiting time even when only two forms of surgery were considered (radical vs. nephron sparing) (63) and it is unlikely that with the present rapid technological evolution, it will be possible to gather the information required this way.

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References

Small renal masses management


