American College of Radiology
ACR Appropriateness Criteria®

Post Treatment Follow-up and Active Surveillance of Renal Cell Carcinoma

Variant: 1 Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.

Procedure	Appropriateness Category	Relative Radiation Level
MRI abdomen without and with IV contrast	Usually Appropriate	O
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Appropriate	☢☢☢☢
US abdomen with IV contrast	May Be Appropriate	O
US kidneys retroperitoneal	May Be Appropriate	O
Radiography chest	May Be Appropriate	☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
MRI abdomen without IV contrast	May Be Appropriate	O
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT chest with IV contrast	May Be Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	May Be Appropriate	☢☢☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Radiography intravenous urography	Usually Not Appropriate	☢☢☢
Radiography skeletal survey	Usually Not Appropriate	☢☢☢
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRU without and with IV contrast	Usually Not Appropriate	O
MRU without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
CTU without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 2 Follow-up for clinically localized renal cell carcinoma; post ablation.

Procedure	Appropriateness Category	Relative Radiation Level
MRI abdomen without and with IV contrast	Usually Appropriate	O
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Appropriate	☢☢☢☢
US abdomen with IV contrast	May Be Appropriate	O

US kidneys retroperitoneal	May Be Appropriate	O
Radiography chest	May Be Appropriate	☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
MRI abdomen without IV contrast	May Be Appropriate	O
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT chest with IV contrast	May Be Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Radiography intravenous urography	Usually Not Appropriate	☢☢☢
Radiography skeletal survey	Usually Not Appropriate	☢☢☢
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRU without and with IV contrast	Usually Not Appropriate	O
MRU without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
CTU without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

Variant: 3 Follow-up for clinically localized renal cell carcinoma; active surveillance.

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen with IV contrast	Usually Appropriate	O
MRI abdomen without and with IV contrast	Usually Appropriate	O
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Appropriate	☢☢☢☢
US kidneys retroperitoneal	May Be Appropriate	O
Radiography chest	May Be Appropriate	☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
MRI abdomen without IV contrast	May Be Appropriate	O
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT chest with IV contrast	May Be Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography abdomen	Usually Not Appropriate	☢☢

Radiography intravenous urography	Usually Not Appropriate	☢☢☢
Radiography skeletal survey	Usually Not Appropriate	☢☢☢
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRU without and with IV contrast	Usually Not Appropriate	O
MRU without IV contrast	Usually Not Appropriate	O
Bone scan whole body	Usually Not Appropriate	☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
CTU without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

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Summary of Literature Review

Introduction/Background

According to the American Cancer Society, approximately 73,750 new cases of kidney and renal pelvis cancer will be diagnosed in the United States in 2020, and approximately 14,830 people will die of this disease [1]. Renal cell carcinoma (RCC) accounts for 85% of all malignant renal tumors and represents approximately 2% to 3% of all malignancies in adults [2]. RCC is also considered the most lethal of all urologic cancers.

Surgical resection with curative intent, including radical nephrectomy (RN) or partial nephrectomy (PN), continues to be the standard of care for clinically localized RCC [2]. Ablative therapies such as radiofrequency ablation, microwave ablation, and cryoablation have been shown to be effective and safe alternatives for the treatment of small localized RCCs [3-7]. In some patients with small localized RCCs, treatment may also be deferred, with management instead consisting of active surveillance protocols [8].

For follow-up of patients with treated or untreated RCC and those with neoplasms suspected to represent RCC, radiologic imaging is the most useful component of surveillance, because most relapses and cases of disease progression are identified when patients are asymptomatic [9,10]. There is currently no consensus regarding surveillance protocols; however, various guidelines and strategies have been developed by international oncologic and urologic societies, such as the National Comprehensive Cancer Network, the American Urological Association, and the European Association of Urology, using both patient- and tumor-specific characteristics [2,9,11,12]. Although imaging is the centerpiece in all of these guidelines, the recommendations vary regarding the timing, frequency, and duration of follow-up, as well as the selection of imaging modalities for

follow-up [12,13]. Understanding the strengths and limitations of the various imaging modalities for the detection of disease recurrence or progression is important when planning follow-up regimens.

In this document, we provide an update on the appropriate use of imaging examinations for asymptomatic patients who have been treated for RCC with RN, PN, or ablative therapies. We also address the appropriate imaging examinations for asymptomatic patients with localized biopsy-proven or suspected RCC who are undergoing active surveillance. As in the previous version, this document does not address the imaging of complications from treatment and does not discuss the follow-up of patients with known residual or recurrent cancer.

Special Imaging Considerations

CT urography (CTU) is an imaging study that is tailored to improve visualization of both the upper and lower urinary tracts. There is variability in the specific parameters, but it usually involves unenhanced images followed by intravenous (IV) contrast-enhanced images, including nephrographic and excretory phases acquired at least 5 minutes after contrast injection. Alternatively, a split-bolus technique uses an initial loading dose of IV contrast and then obtains a combined nephrographic-excretory phase after a second IV contrast dose; some sites include arterial phase. CTU should use thin-slice acquisition. Reconstruction methods commonly include maximum intensity projection or 3-D volume rendering. For the purposes of this document, we make a distinction between CTU and CT abdomen and pelvis without and with IV contrast. CT abdomen and pelvis without and with IV contrast is defined as any protocol not specifically tailored for evaluation of the upper and lower urinary tracts and without both the precontrast and excretory phases.

MR urography (MRU) is also tailored to improve imaging of the urinary system. Unenhanced MRU relies upon heavily T2-weighted imaging of the intrinsic high signal intensity from urine for evaluation of the urinary tract. IV contrast is administered to provide additional information regarding obstruction, urothelial thickening, focal lesions, and stones. A contrast-enhanced T1-weighted series should include a corticomedullary, nephrographic, and excretory phase. Thin-slice acquisition and multiplanar imaging should be obtained. For the purposes of this document, we make a distinction between MRU and MRI abdomen and pelvis without and with IV contrast. MRI abdomen and pelvis without and with IV contrast is defined as any protocol not specifically tailored for evaluation of the upper and lower urinary tracts, without both the precontrast and excretory phases, and without heavily T2-weighted images of the urinary tract.

Discussion of Procedures by Variant

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.

Many tumor- and patient-specific characteristics have been shown to be predictive of local recurrence or distant metastasis of RCC after treatment [2,14-19]. In addition to these characteristics, the timing and location of tumor recurrence and the type of treatment (ie, RN versus PN) are considered in the development of imaging surveillance strategies that aim to identify asymptomatic solitary or oligometastatic disease that may benefit from early potentially curative or life-prolonging salvage treatment [10,16,20].

Among the tumor characteristics predictive of tumor recurrence, the tumor, node, and metastases staging system has been the most extensively researched; associations between pathologic T stage and both the risk and patterns of tumor recurrence have been demonstrated in many studies [14,15,17,21]. Patient symptoms, tumor size, tumor necrosis, and microvascular invasion are some of the other factors that have been evaluated and integrated into risk stratification models that separate patients into low-, intermediate-, or high-risk groups according to the probability of local recurrence or distant metastases [11,14,18,19]. Most recurrences occur within 3 years after treatment, with a median time to relapse of 1 to 2 years; thus, most surveillance guidelines address follow-up for up to 5 years after treatment [2,9,11,22]. In patients with high-risk tumors (ie, pT2 and pT3 tumors), especially those patients without a significant competing risk for non-RCC death, follow-up beyond 5 years may also be considered because of a nonnegligible incidence of late recurrence [14,18].

Patients who have undergone PN have a similar or slightly higher incidence of local recurrence compared with those who have undergone RN [11,23]. In some guidelines, a more rigorous follow-up protocol is recommended to assess for local recurrence in those who have undergone PN [2,9]. However, more commonly, recurrence manifests as distant metastases [10,20,24,25]. The lungs are the most common site affected by metastases, followed by the lymph nodes, bones, liver, adrenal glands, and brain. Other less common sites include the spleen, pancreas, diaphragm, heart, skin, and connective tissues. Apart from bone and brain metastases, most metastases and local recurrences are identified in asymptomatic patients [10,15,18,26].

In addition to a detailed clinical history, a thorough physical examination and laboratory workup are needed, and guidelines from major international urological and oncological societies recommend that imaging surveillance of the chest and abdomen be performed after primary treatment for RCC [2,9,11]. Because of the lack of high-level evidence assessing the various surveillance protocols, these guidelines vary in the recommended imaging modalities and timelines. For the chest, both radiographs and CT are used. For the abdomen, CT and MRI are more frequently used than ultrasound (US). In general, more frequent follow-up is performed for the surveillance of intermediate- and high-risk tumors than for tumors with a low risk [12,13]. These posttreatment follow-up strategies can be summarized as follows:

· For low-risk/T1 tumors:
§ Chest imaging: Every 12 to 24 months for 3 to 5 years
§ Abdominal imaging: Some recommend performing a baseline study between 3 and 12 months, especially after PN, then yearly for 3 to 5 years

· For intermediate-risk/T2 primary tumors:
§ Chest and abdominal imaging: Some recommend performing a baseline study at 3 months, then at 6 and 12 months, followed by every 6 to 24 months for 5 years

· For high-risk/T3 tumors:
§ Chest and abdominal imaging: Some recommend performing a baseline study at 3 months, then at 6 and 12 months, followed by every 6 to 12 months for 5 years

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.
A. Radiography Chest

A chest radiograph is a low-yield diagnostic tool for detecting pulmonary metastasis in patients after surgical excision of RCC, particularly in those with low-risk tumors, irrespective of the treatment modality (RN, PN, or ablation) [27,28]. In a retrospective analysis of 221 patients with pT1-3N0M0 RCC, only 0.85% of the follow-up chest radiographs detected pulmonary metastases in asymptomatic patients [28]. The yield of a chest radiograph increased to 1.9% when used in patients with intermediate-risk (T2) or high-risk (T3) tumors. In more than half of the patients, pulmonary metastases were detected when patients became symptomatic outside of the routine follow-up. In a second retrospective analysis of 258 patients who had undergone resection or ablation for low-risk (T1a) RCC, pulmonary metastases developed in 3 patients (1.2%), but in only 1 patient (0.4%) was this metastasis diagnosed with surveillance chest radiographs [27]. In a more recent study, only 2 of 384 patients (0.005%) with T1a RCC were found to have pulmonary metastases after surgical therapy, and in both cases, the pulmonary metastases were not detected by surveillance chest radiographs [24]. In the same study, 10 of 184 patients (5.4%) with T1b RCC had suspicious pulmonary lesions found on surveillance radiography of the chest; only 2 of these patients had biopsy-confirmed pulmonary metastasis. However, according to guidelines from urologic and oncologic societies, a chest radiograph is still the recommended technique for the surveillance of patients with T1a tumors, and this technique is also recommended as an alternative to chest CT for the surveillance of patients with T2 and T3 tumors after an initial negative follow-up chest CT examination [9,11]. This is in part because of concerns about potential false-positive findings with chest CT (ie, intrapulmonary lymph nodes and granulomas) that can lead to further unnecessary and potentially invasive investigations [9,12].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.

B. Radiography Abdomen

There is no relevant literature regarding the use of abdominal radiographs in the follow-up of patients after surgical excision of RCC, and this method is not recommended by the guidelines [2,9,11].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.

C. Radiography Skeletal Survey

There is no relevant literature regarding the use of a radiographic survey of the whole body in the follow-up of patients after surgical excision of RCC, and this method is not included in the guidelines [2,9,11].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.

D. Radiography Intravenous Urography

There is no relevant literature regarding the use of IV urography in the follow-up of patients after surgical excision of RCC, and this method is not recommended by the guidelines [2,9,11].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.

E. CT Abdomen

CT of the abdomen is the most commonly used method for surveillance after surgical excision of RCC [29]. CT is a sensitive method for the detection of recurrences in the resection bed and in other more common sites of metastases in the abdomen, such as the contralateral kidney, adrenal

glands, liver, and lymph nodes, and in the visualized bones [16,17,20,22,30]. Although several studies have advised against routine imaging of the abdomen after resection of low-risk (T1) tumors because of the low frequency of abdominal recurrences [15,17,21,30], CT of the abdomen is commonly performed in this group, particularly after PN, to serve as a baseline for future comparisons and to evaluate postoperative complications [9]. Although CT of the abdomen performed without and with IV contrast may be considered beneficial in cases in which postoperative changes need to be distinguished from residual or recurrent tumors, in general, surveillance protocols in oncology often use a single-phase examination in the portal-venous phase. Because RCC metastases tend to be hypervascular, some authors have also suggested that arterial phase imaging can be used to complement portal-venous imaging for the detection of RCC metastases to the liver, pancreas, and contralateral kidney. In a retrospective study including 100 patients, 9 patients had metastases in the liver, pancreas, or contralateral kidney detected only in the arterial phase, and these findings led to a change in management for 2 patients [31]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), CT of the abdomen without IV contrast may be considered appropriate.

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.

F. CT Abdomen and Pelvis

CT of the abdomen is the most commonly used method for surveillance after surgical excision of RCC [29]. CT is a sensitive method for the detection of recurrences in the resection bed and in other more common sites of metastases in the abdomen, such as the contralateral kidney, adrenal glands, liver, and lymph nodes, and in the visualized bones [16,17,20,22,30]. Although several studies have advised against routine imaging of the abdomen after resection of low-risk (T1) tumors because of the low frequency of abdominal recurrences [15,17,21,30], CT of the abdomen is commonly performed in this group, particularly after PN, to serve as a baseline for future comparisons and to evaluate postoperative complications [9]. Although CT of the abdomen performed without and with IV contrast may be considered beneficial in cases in which postoperative changes need to be distinguished from residual or recurrent tumors, in general, surveillance protocols in oncology often use a single-phase examination in the portal-venous phase. Because RCC metastases tend to be hypervascular, some authors have also suggested that arterial phase imaging can be used to complement portal-venous imaging for the detection of RCC metastases to the liver, pancreas, and contralateral kidney. In a retrospective study including 100 patients, 9 patients had metastases in the liver, pancreas, or contralateral kidney detected only in the arterial phase, and these findings led to a change in management for 2 patients [31]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), CT of the abdomen without IV contrast may be considered appropriate.

Imaging of the pelvis during surveillance after RCC treatment is considered optional in the guidelines [2,9,11]. Although CT of the pelvis is commonly performed in conjunction with CT of the abdomen, data from 2 retrospective studies suggest that CT of the pelvis has minimal value in this setting. In a study of 493 patients with stages T1 to T3a RCC who underwent RN or PN, 82 patients (16.6%) experienced recurrence, and 78 of these cases (95%) were detected by CT of the chest and abdomen [32]. Limiting the study field to the chest and upper abdomen (to the level of the L3–L4 disc) decreased the sensitivity of the study by only 1% because only 1 case of iliac bone metastasis (which was symptomatic) would have been missed with this protocol [32]. In a second study that included 603 patients with T2 to T4 RCC treated with RN or PN, recurrent or metastatic disease occurred in 163 patients (27%), but pelvic imaging was negative in 97% of the patients [25]. Only 4

patients (0.7%) had positive findings in the pelvis and negative findings in the chest and abdomen, and of these patients, only 2 (0.3%) were asymptomatic [25]. These findings are in line with the results of previous studies, which also demonstrated that CT of the pelvis had limited benefit for the detection of metastases in the initial staging of RCC [33,34].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.

G. CTU

There is no relevant literature suggesting that CTU offers any additional benefit over conventional CT of the abdomen in the surveillance of patients after treatment of localized RCC, and this method is not included in the guidelines [2,9,11]. In a retrospective analysis of 23 tumors that progressed locally after ablation, CT or MRIs obtained in the corticomedullary phase were found to be sufficient for diagnosis of recurrence in 100% of the cases; noncontrast, nephrographic, and excretory-phase images, which are typically obtained in a CTU or MRU protocol, were able to detect recurrence in only 11%, 81%, and 44% of cases, respectively [35].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.

H. CT Chest

Limited data suggest that CT is more sensitive than radiography for the detection of pulmonary metastases from RCC during staging [27]. Although no direct comparison between the 2 methods has been reported in the posttreatment surveillance setting, one study demonstrated that the overwhelming majority of chest recurrences in asymptomatic cases are detected by chest CT examinations (92.3%) rather than by radiography (7.7%) [36]. In addition to a high sensitivity for the detection of pulmonary metastases, chest CT has a high sensitivity for the detection of intrathoracic nodal metastases from RCC; this finding has prognostic implications and may affect surgical planning for metastases resection [37]. The use of IV contrast is optional for chest CT, but it may be beneficial for the detection and characterization of hilar lymph nodes. In patients undergoing surveillance with CT of the abdomen with IV contrast, chest CT should also be performed after IV contrast administration.

Unlike CT of the abdomen, in which images obtained without and with IV contrast may be appropriate in some circumstances, CT of the chest without and with IV contrast does not provide additional information in these patients and is considered inappropriate. Although some consider CT to be the standard chest imaging technique for surveillance after RCC resection [11], there are concerns regarding the risk of false-positive findings (ie, intrapulmonary lymph nodes and granulomas), particularly in patients with T1a RCC, which can lead to further unnecessary and potentially invasive investigations [9]. It is worth noting that in a recent pilot study, the authors suggested that CT of the chest may not be necessary to identify most cases of pulmonary recurrence when a CT examination of the abdomen with coverage of the lung bases to the T7 thoracic level is performed [26].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.

I. CT Head

Most patients with metastases to the central nervous system are symptomatic. Thus, surveillance protocols after surgical excision of RCC have not supported routine imaging of the brain to search for metastases in asymptomatic patients. Brain imaging should be performed only in cases with

suggestive signs or symptoms [2,9,11].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.
J. MRI Abdomen

MRI of the abdomen without and with IV contrast is considered in all major guidelines as an adequate method for surveillance of the abdomen after surgical excision of RCC [2,9,11]. MRI has a high soft-tissue contrast resolution and is an accurate method for detecting metastases in the common sites of RCC recurrences (ie, liver, adrenal glands, lymph nodes, contralateral kidney, and bones) [38]. MRI can also assist in the distinction between residual/recurrent disease and postoperative changes after PN [39]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), MRI of the abdomen without IV contrast may be considered appropriate.

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.
K. MRI Abdomen and Pelvis

MRI of the abdomen without and with IV contrast is considered in all major guidelines as an adequate method for surveillance of the abdomen after surgical excision of RCC [2,9,11]. MRI has a high soft-tissue contrast resolution and is an accurate method for detecting metastases in the common sites of RCC recurrences (ie, liver, adrenal glands, lymph nodes, contralateral kidney, and bones) [38]. MRI can also assist in the distinction between residual/recurrent disease and postoperative changes after PN [39]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), MRI of the abdomen without IV contrast may be considered appropriate.

Although MRI of the abdomen with IV contrast is considered in all major guidelines as an adequate method for surveillance of the abdomen after surgical excision of RCC, imaging the pelvis during surveillance after RCC treatment is considered optional in the guidelines [2,9,11]. There is no relevant literature regarding the use of MRI of the pelvis in the follow-up of patients after surgical excision of RCC, although data from 2 retrospective studies suggested that imaging of the pelvis with CT had minimal benefit for the detection of metastases in patients after RN or PN for RCC [25,32-34]. Therefore, MRI of the abdomen alone may be preferred over MRI of the abdomen and pelvis in this setting.

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.
L. MRU

There is no relevant literature suggesting that MRU offers any additional benefit over conventional MRI of the abdomen in the surveillance of patients after treatment of localized RCC, and this method is not included in the guidelines [2,9,11]. In a retrospective analysis of 23 tumors that progressed locally after ablation, CT or MRIs obtained in the corticomedullary phase were found to be sufficient for diagnosis of recurrence in 100% of the cases; noncontrast, nephrographic, and excretory-phase images, which are typically obtained in a CTU or MRU protocol, were able to detect recurrence in only 11%, 81%, and 44% of cases, respectively [35].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.
M. MRI Head

Most patients with metastases to the central nervous system are symptomatic. Thus, surveillance

protocols for RCC have not supported routine imaging of the brain to search for metastases in asymptomatic patients. Brain imaging should be performed only in cases with suggestive signs or symptoms [2,9,11].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.
N. US Kidney Retroperitoneal

The major guidelines include US as another option for imaging surveillance of the abdomen after surgical resection of localized RCC [2,9,11]. Although US may be considered an appropriate alternative for patients with contraindications to CT or MRI, one important consideration is that US is likely to be less sensitive than CT or MRI for the detection of small recurrences or distant visceral and nodal metastases in the abdomen. In one study, among 14 patients who were found to have recurrence after RN or PN for T1-3 RCC, US correctly identified only 1 case of recurrence, whereas CT detected all cases of recurrence [40]. US failed to detect 4 out of 5 recurrences in the kidney after PN [40]. In another study investigating outcomes after PN for T1-2 RCC, CT/MRI detected 96.6% of recurrences in the abdomen, whereas US detected only 3.4% of abdominal recurrences [36].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.
O. US Abdomen with IV Contrast

There is no relevant literature regarding the use of contrast-enhanced US (CEUS) in the follow-up of patients after surgical excision of RCC, and this method is not included in the guidelines [2,9,11]. Studies evaluating the performance of CEUS after ablative treatment of renal masses have shown that CEUS has an excellent concordance with CT or MRI with regard to the presence or absence of residual or recurrent tumor after ablation, both immediately after treatment and through long-term follow-up [41-49]. One important consideration is that CEUS would still be less sensitive than CT or MRI for the detection of distant visceral and nodal metastases because the contrast-enhanced portion of the study would be limited to the surgical bed. Nevertheless, in patients at low risk for recurrence, CEUS may be considered an appropriate alternative to CT and MRI.

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.
P. Bone Scan Whole Body

The prevalence of osseous metastases after treatment for localized RCC has been shown to be low in patients without symptoms (ie, bone pain) or without laboratory abnormalities suggestive of osseous metastases (ie, elevated serum alkaline phosphatase level) [50,51]. Furthermore, the sites commonly involved by osseous metastases, such as the thoracolumbar spine and ribs, are located in areas covered by chest and abdominal imaging. Thus, even though bone scanning can be helpful to confirm clinically or radiographically suspected metastatic disease, current guidelines do not support its routine use in surveillance after treatment for localized RCC [2,9,11].

Variant 1: Follow-up for clinically localized renal cell carcinoma; post radical or partial nephrectomy.
Q. FDG-PET/CT Skull Base to Mid-Thigh

PET using the tracer fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG-PET)/CT has a low sensitivity and specificity for the initial diagnosis of RCC [52]. This is mainly related to the variable levels of FDG avidity in RCCs; additionally, there is interference from background activity in the renal

parenchyma because the kidneys are the major route of excretion of FDG. At present, the guidelines do not recommend FDG-PET/CT for the surveillance of patients after surgical excision of RCC [2,9,11]. However, emerging data suggest that FDG-PET can be useful for detecting metastatic or recurrent RCC [52,53]. In a systematic review and meta-analysis that included 15 studies with a total of 1,168 patients, FDG-PET or PET/CT had a pooled sensitivity of 86% (95% confidence interval [CI]: 0.88–0.93) and a specificity of 88% (95% CI: 0.84–0.91) for the restaging of RCC; in several of the studies, FDG-PET/CT examinations often altered the subsequent management strategy [52]. Because these results are mainly based on retrospective studies with relatively small cohorts of patients and with inconsistent reference standards, more data are needed to support the use of these agents in surveillance after surgical resection of localized RCC.

Preliminary results for other PET tracers are also becoming available. For instance, in a prospective study of 28 patients with RCC undergoing initial staging or restaging, 11C-choline PET/CT was significantly more accurate than FDG-PET/CT (85.7% versus 57.1%). Among 120 lesions detected, 11C-choline PET/CT detected 75 lesions (62.5%), whereas FDG-PET/CT detected 47 lesions (39.2%) [54]. In another prospective study of 10 patients with metastatic RCC, 18F-sodium fluoride (NaF) PET/CT was found to be significantly more sensitive for the detection of RCC skeletal metastases than Tc-99m bone scintigraphy or CT, with sensitivities of 100%, 29%, and 46%, respectively. CT and Tc-99m bone scintigraphy in this study identified only 65% of the metastases detected by NaF-PET/CT [55]. A small series has also shown that 68Ga-labeled prostate-specific membrane antigen PET/CT can help to detect metastatic lesions in patients with the clear cell subtype of RCC [56].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.

Among several techniques available for the ablation of localized RCC, thermal ablation techniques using radiofrequency ablation, microwave ablation, or cryoablation are the most commonly used; these procedures can be performed percutaneously or laparoscopically [57-59]. Ablation therapy is currently considered a less invasive alternative to RN or PN for renal masses measuring <4 cm (ie, T1a tumors) [2,9,11]. There is growing evidence suggesting that ablation of small renal masses produces oncologic outcomes that approach those of surgical excision but with a significantly lower overall complication rate and a significantly lower decline in renal function [5-7,57,60-67]. Because of the higher rate of local recurrence seen with ablation than with surgical excision, ablation requires more frequent use of imaging to monitor tumor involution over time [3,29,65]. Early detection of treatment failure or recurrence is important to maximize retreatment potential [65,68]. Because the risk of local recurrence is greater than the risk of distant metastases in this patient population, surveillance strategies should prioritize evaluation of the treatment bed. Guidelines recommend performing CT or MRI of the abdomen at 3 and 6 months after ablation and yearly thereafter for 5 years [2,9,11]. Guidelines also recommend the use of imaging surveillance with chest radiography or CT annually for up to 5 years after ablation of RCC [2,9,11].

Imaging-guided biopsy of renal masses is encouraged in patients considering ablative therapies [2,9,11,60]. Pretreatment biopsy can help confirm the malignant nature and aggressiveness of the tumors, which in turn can influence the frequency and duration of follow-up. After treatment, biopsy is also indicated for masses that fail to regress or that display findings suggestive of recurrence.

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
A. Radiography Chest

Chest radiography is a low-yield diagnostic tool for detecting pulmonary metastasis in patients treated for RCC, particularly in those with low-risk tumors, irrespective of the treatment modality (RN, PN, or ablation) [27,28]. In a retrospective analysis of 258 patients who had undergone resection or ablation of low-risk (T1a) RCC, pulmonary metastases developed in 3 patients (1.2%), but in only 1 patient (0.4%) was this metastasis diagnosed by surveillance chest radiographs [27]. However, according to guidelines from urologic and oncologic societies, chest radiography is the recommended technique for surveillance of patients after ablation of T1a tumors [2,9,11]. This is in part because of concerns about potential false-positive findings with chest CT (ie, intrapulmonary lymph nodes and granulomas) that can lead to further unnecessary and potentially invasive investigations [9,12].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
B. Radiography Abdomen

There is no relevant literature regarding the use of abdominal radiographs in the follow-up of patients after localized RCC ablation, and this method is not recommended by the guidelines [2,9,11].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
C. Radiography Skeletal Survey

There is no relevant literature regarding the use of a radiographic survey of the whole body in the follow-up of patients after localized RCC ablation, and this method is not recommended by the guidelines [2,9,11].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
D. Radiography Intravenous Urography

There is no relevant literature regarding the use of IV urography in the follow-up of patients after localized RCC ablation, and this method is not recommended by the guidelines [2,9,11].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
E. CT Abdomen

CT of the abdomen is the most commonly used method for imaging surveillance after localized RCC ablation [29]. CT is a sensitive method for the detection of recurrences in the treatment bed and in other more common sites of metastases in the abdomen, such as the contralateral kidney, adrenal glands, liver, and lymph nodes, and in the visualized bones [16,17,20,22,30]. After RCC ablation, CT of the abdomen should be performed without and with IV contrast. A lack of contrast enhancement (ie, increase in attenuation <10–20 Hounsfield units on the postcontrast images) is considered the hallmark of successful treatment, which occurs via disruption of tumor vascularity. However, many completely ablated lesions show enhancement in the immediate posttreatment period, and in some cases, this enhancement may persist for several weeks to months [69,70]. The lack of spontaneous decline in enhancement and involution of the mass over time or the development of new areas of enhancement in the treatment zone or new satellite or port site soft-tissue nodules irrespective of contrast enhancement should raise concern for residual or recurrent disease. In these circumstances, a biopsy could be considered to identify the presence of viable neoplasm [9]. Initial experience with dual-energy CT after ablation of renal masses has suggested that material decomposition techniques can generate adequate virtual noncontrast images that can obviate the need for true noncontrast images. These techniques can also generate iodine-only image data sets that can assist in the evaluation of contrast enhancement of the treated lesions [71]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), CT of

the abdomen without IV contrast may be considered appropriate.

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
F. CT Abdomen and Pelvis

CT of the abdomen is the most commonly used method for imaging surveillance after localized RCC ablation [29]. CT is a sensitive method for the detection of recurrences in the treatment bed and in other more common sites of metastases in the abdomen, such as the contralateral kidney, adrenal glands, liver, and lymph nodes, and in the visualized bones [16,17,20,22,30]. After RCC ablation, CT of the abdomen should be performed without and with IV contrast. A lack of contrast enhancement (ie, increase in attenuation <10–20 Hounsfield units on the postcontrast images) is considered the hallmark of successful treatment, which occurs via disruption of tumor vascularity. However, many completely ablated lesions show enhancement in the immediate posttreatment period, and in some cases, this enhancement may persist for several weeks to months [69,70]. The lack of spontaneous decline in enhancement and involution of the mass over time or the development of new areas of enhancement in the treatment zone or new satellite or port site soft-tissue nodules irrespective of contrast enhancement should raise concern for residual or recurrent disease. In these circumstances, a biopsy could be considered to identify the presence of viable neoplasm [9]. Initial experience with dual-energy CT after ablation of renal masses has suggested that material decomposition techniques can generate adequate virtual noncontrast images that can obviate the need for true noncontrast images. These techniques can also generate iodine-only image data sets that can assist in the evaluation of contrast enhancement of the treated lesions [71]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), CT of the abdomen without IV contrast may be considered appropriate.

Imaging of the pelvis with CT has been found to have limited benefit for the detection of metastases in initial staging and after RN or PN for RCC [25,32-34] and is considered optional in the surveillance guidelines [2,9,11]. Because the risk of distant metastases is significantly lower in patients with localized RCC after ablation, CT of the abdomen is preferred over CT of the abdomen and pelvis.

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
G. CT Chest

Limited data suggest that CT is more sensitive than radiography for the detection of pulmonary metastases from RCC during staging [27]. Although no direct comparison between the 2 methods has been reported in the posttreatment surveillance setting, one study demonstrated that the overwhelming majority of chest recurrences in asymptomatic cases are detected by chest CT examinations (92.3%) rather than by radiography (7.7%) [36]. In addition to a high sensitivity for the detection of pulmonary metastases, chest CT has a high sensitivity for the detection of intrathoracic nodal metastases from RCC; this finding has prognostic implications and may affect surgical planning for metastases resection [37]. The use of IV contrast is optional for chest CT, but it may be beneficial for the detection and characterization of hilar lymph nodes. In patients undergoing surveillance with CT of the abdomen with IV contrast, chest CT should also be performed after IV contrast administration.

Unlike CT of the abdomen, in which images without and with IV contrast are appropriate, CT of the chest without and with IV contrast does not provide additional information in these patients and is considered inappropriate. Although some consider CT the standard chest imaging technique for surveillance after RCC resection [11], there are concerns about the risk of false-positive findings (ie,

intrapulmonary lymph nodes and granulomas), particularly in patients with T1a RCC, which can lead to further unnecessary and potentially invasive investigations [9]. Additionally, some authors suggest that CT of the chest may not be necessary to identify most patients with pulmonary recurrence when CT of the abdomen with coverage of the lung bases at the T7 thoracic level is performed [26].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
H. CT Head

Most patients with metastases to the central nervous system are symptomatic. Thus, surveillance protocols after localized RCC ablation have not supported routine imaging of the brain to search for metastases in asymptomatic patients. Brain imaging should be performed only in cases with suggestive signs or symptoms [2,9,11].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
I. CTU

There is no relevant literature suggesting that CTU offers any additional benefit over conventional CT of the abdomen in the surveillance of patients after treatment of localized RCC, and this method is not included in the guidelines [2,9,11]. In a retrospective analysis of 23 tumors that progressed locally after ablation, CT or MR images in the corticomedullary phase were found to be sufficient for diagnosis of recurrence in 100% of the cases; noncontrast, nephrographic, and excretory-phase images, which are typically obtained in a CTU or MRU protocol, were able to detect recurrence in only 11%, 81%, and 44% of cases, respectively [35].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
J. MRI Abdomen

MRI of the abdomen is commonly used for follow-up after ablation of localized RCC [29]. MRI should be performed without and with IV contrast to assess tumor enhancement. Image data sets generated from subtraction of the precontrast from the postcontrast images can assist with evaluation of residual or recurrent tumor enhancement, especially during the first year of follow-up, because of the high signal intensity background of the ablated tumor on T1-weighted images [72]. However, as with CT, persistent tumor enhancement is common after successful ablation, particularly in patients with clear-cell RCC [73], and this enhancement can last for days to months after treatment [72-74]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), MRI of the abdomen without IV contrast may be considered appropriate.

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
K. MRI Abdomen and Pelvis

MRI of the abdomen is commonly used for follow-up after ablation of localized RCC [29]. MRI should be performed without and with IV contrast to assess tumor enhancement. Image data sets generated from subtraction of the precontrast from the postcontrast images can assist with evaluation of residual or recurrent tumor enhancement, especially during the first year of follow-up, because of the high signal intensity background of the ablated tumor on T1-weighted images [72]. However, as with CT, persistent tumor enhancement is common after successful ablation, particularly in patients with clear-cell RCC [73], and this enhancement can last for days to months after treatment [72-74]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reactions), MRI of the abdomen without IV contrast may be considered appropriate.

There is no relevant literature regarding the use of MRI of the pelvis in the follow-up of patients

after RCC ablation. Imaging of the pelvis with CT has been found to provide minimal benefit for the detection of metastases in the initial staging and after RN or PN for RCC [25,32-34] and is considered optional in the surveillance guidelines [2,9,11]. Because the risk of distant metastases is significantly lower in patients with localized RCC after ablation, MRI of the abdomen is preferred over MRI of the abdomen and pelvis.

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
L. MRU

There is no relevant literature suggesting that MRU offers any additional benefit over conventional MRI of the abdomen in the surveillance of patients after treatment of localized RCC, and this method is not included in the guidelines [2,9,11]. In a retrospective analysis of 23 tumors that progressed locally after ablation, CT or MR images obtained in the corticomedullary phase were found to be sufficient for diagnosis of recurrence in 100% of the cases; noncontrast, nephrographic, and excretory-phase images, which are typically obtained in a CTU or MRU protocol, were able to detect recurrence in only 11%, 81%, and 44% of cases, respectively [35].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
M. MRI Head

Most patients with metastases to the central nervous system are symptomatic. Thus, surveillance protocols for RCC have not supported routine imaging of the brain to search for metastases in asymptomatic patients. Brain imaging should be performed only in cases with suggestive signs or symptoms [2,9,11].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
N. US Kidney Retroperitoneal

There is no relevant literature regarding the use of conventional US of the kidney in follow-up of patients after localized RCC ablation, and the guidelines offer different recommendations. The National Comprehensive Cancer Network considers US an alternative for annual surveillance after negative evaluation with CT or MRI in the first 6 months [2]; the European Association of Urology recommends US only for surveillance after the treatment of RCC with a low-risk profile [11]; and the American Urological Association does not include US in their recommendations regarding follow-up after ablation [9].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
O. US Abdomen with IV Contrast

The use of CEUS after radiofrequency ablation, microwave ablation, and cryoablation of renal masses has been the subject of many studies [41-49]. In these studies, CEUS has been found to have excellent concordance with CT or MRI with regard to the presence or absence of enhancement in renal masses after ablation, both immediately after treatment and through long-term follow-up. In a prospective study including 64 tumors, CEUS and CT were in concordance regarding the presence of residual enhancement in 2 tumors and the presence of complete necrosis in the other 62 tumors at 1 month after radiofrequency ablation. On subsequent follow-up of 61 tumors, CEUS and CT were in concordance for 59 tumors, with 2 false-positive CEUS cases [47]. In another study, enhancement on CEUS and CT/MRI after cryoablation was concordant for 23 of 32 tumors (72%) at 3 months and for 19 of 21 tumors (91%) at 12 months [42]. Researchers in another study reported good interobserver agreement for CEUS among 3 radiologists with ≥15 years of experience with US (weighted κ: 0.84 [CI: 0.71–0.93]), although better interobserver agreement was achieved with CT/MRI for 3 radiologists with ≥15 years of experience with CT/MRI

(weighted κ: 0.94 [CI: 0.88–0.99]) [46]. In a more recent study, CEUS was found to have a high negative predictive value (100%) for local recurrence after thermal ablation of RCC among 20 patients who had either a contraindication to CT or MRI or inconclusive findings with these methods on surveillance imaging [41]. These results suggest that CEUS could be used as an alternative to CT and MRI for the evaluation of treatment response and local recurrence. The performance of CEUS may be limited in a small number of cases in which the ablation cavity is not well visualized on precontrast US images [48]. Additionally, CEUS has limited ability to detect distant RCC metastasis [48].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
P. Bone Scan Whole Body

The prevalence of osseous metastases has been shown to be low in patients without symptoms (ie, bone pain) or without laboratory abnormalities suggestive of osseous metastases (ie, elevated serum alkaline phosphatase level) [50,51]. Furthermore, the sites commonly involved by osseous metastases, such as the thoracolumbar spine and ribs, are located in areas covered by chest and abdominal imaging. Thus, although Tc-99m bone scanning can be helpful in confirming clinically or radiographically suspected metastatic disease, current guidelines do not support its routine use in surveillance after treatment for localized RCC [2,9,11].

Variant 2: Follow-up for clinically localized renal cell carcinoma; post ablation.
Q. FDG-PET/CT Skull Base to Mid-Thigh

There is no relevant literature regarding the use of FDG-PET or PET/CT for the follow-up of patients after localized RCC ablation. At present, the guidelines do not recommend FDG-PET/CT for the surveillance of patients after RCC ablation [2,9,11].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.

Active surveillance has been increasingly used for the management of small localized renal masses in a selected group of patients with comorbidities or reduced life expectancy in whom the risks associated with surgical excision or ablative therapies surpass the risk of significant disease progression and cancer-specific mortality [2,9,11,75-80]. Patients on active surveillance undergo rigorous imaging and clinical follow-up, with subsequent surgical or minimally invasive treatment reserved for those with tumors that progress. Available data on active surveillance, which are predominantly based on T1a tumors (ie, tumors ≤4 cm in the greatest dimension and confined to the kidney), suggest that this management alternative does not compromise oncologic outcomes, with a risk of metastatic disease progression of 0% to 2% [8,75-78,81-84].

Current guidelines recommend biopsy of the renal masses to define the surveillance strategy [2,9,11]. Researchers have found that biopsy is being increasingly used for T1a tumors and that patients who undergo biopsy are significantly more likely to be treated with nonsurgical management (36.8%) than those who do not undergo biopsy (11.4%) [85]. Of note, small renal mass growth kinetics can vary greatly, especially during the initial 6 to 12 months of active surveillance [82,84]. In a systematic review of the literature, researchers found no significant difference between the growth rates of benign masses (0.3 cm/y) and those of malignant masses (0.35 cm/y) [82]. Furthermore, studies have shown that even masses without growth may be malignant [8,76,77,81]. In spite of this, growth rates are generally accepted as surrogates for aggressive behavior and metastatic potential in small renal masses [76,81]. Therefore, the guidelines recommend defining the growth rate of renal masses with serial imaging of the abdomen with CT or MRI within 6 months of the initiation of active surveillance for masses that are

shown to be RCCs or oncocytic neoplasms and for those with indeterminate histology features [2,9]. Imaging should be performed at least annually thereafter with CT, MRI, or US. Imaging surveillance of the chest on a yearly basis (or more frequently depending on clinical behavior) is recommended only in those patients with RCC or tumors with oncocytic features [2,9].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
A. Radiography Chest

Metastatic progression occurs infrequently in patients with T1a renal masses on active surveillance [76,77,81]. Nevertheless, it has been reported that 20% to 30% of T1a tumors have potentially aggressive histologic features, thus requiring surveillance of the chest [9]. No studies have compared chest radiography and chest CT in the setting of active surveillance; however, chest radiography is the most commonly used method for surveillance [2,9]. This is in part because of concerns about potential false-positive findings with chest CT (ie, intrapulmonary lymph nodes and granulomas) that can lead to further unnecessary and potentially invasive investigations [9,12].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
B. Radiography Abdomen

There is no relevant literature regarding the use of abdominal radiographs in the surveillance of small localized renal masses, and this method is not recommended by the guidelines [2,9,11].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
C. Radiography Skeletal Survey

There is no relevant literature regarding the use of a radiographic survey of the whole body in the surveillance of small localized renal masses, and this method is not recommended by the guidelines [2,9,11].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
D. Radiography Intravenous Urography

There is no relevant literature regarding the use of IV urography in the surveillance of small localized renal masses, and this method is not recommended by the guidelines [2,9,11].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
E. CT Abdomen

CT of the abdomen is the most common method by which small renal masses are detected and is also the most commonly used method for surveillance of small localized renal masses. CT of the abdomen performed without and with IV contrast is considered appropriate if there is a need for initial characterization of the enhancement pattern of the renal mass. Subsequent follow-up to monitor tumor growth could be achieved with CT of the abdomen with IV contrast. The maximum diameter of the mass is frequently used to assess tumor growth, although interobserver and intraobserver variabilities on the order of ±3.1 and ±2.3 mm, respectively, have been reported [82]. In one study, researchers found that 2-D and 3-D measurements had greater accuracy for the detection of tumor growth than the measurement of the single largest diameter or gestalt visual assessment [86]. After the initial follow-up, once the growth rate of the mass has been established, alternating the follow-up with MRI or US has been suggested [2,9,78]. It is important to note that in addition to interobserver and intraobserver variability, the use of different modalities can result in inconsistent measurements that can ultimately have an effect on patient care [82]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), CT of the abdomen without IV contrast may be considered appropriate.

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.

F. CT Abdomen and Pelvis

CT of the abdomen is the most common method by which small renal masses are detected and is also the most commonly used method for surveillance of small localized renal masses. CT of the abdomen performed without and with IV contrast is considered appropriate if there is a need for initial characterization of the enhancement pattern of the renal mass. Subsequent follow-up to monitor tumor growth could be achieved with CT of the abdomen with IV contrast. The maximum diameter of the mass is frequently used to assess tumor growth, although interobserver and intraobserver variabilities on the order of ±3.1 and ±2.3 mm, respectively, have been reported [82]. In one study, researchers found that 2-D and 3-D measurements had greater accuracy for the detection of tumor growth than the measurement of the single largest diameter or gestalt visual assessment [86]. After the initial follow-up, once the growth rate of the mass has been established, alternating the follow-up with MRI or US has been suggested [2,9,78]. It is important to note that in addition to interobserver and intraobserver variability, the use of different modalities can result in inconsistent measurements that can ultimately have an effect on patient care [82]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), CT of the abdomen without IV contrast may be considered appropriate.

Although CT of the abdomen is the most commonly used method for surveillance of small localized renal masses, the benefit of imaging the pelvis during surveillance has not yet been defined and is considered optional in the guidelines [2,9,11]. Data from 2 retrospective studies evaluating RCC staging with CT suggested that imaging of the pelvis had limited benefit for the detection of metastases [33,34]. Because metastatic progression occurs infrequently in patients on active surveillance with T1a renal masses [8,75-78,81-84], CT of the abdomen is preferred over CT of the abdomen and pelvis.

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
G. CTU

There is no relevant literature regarding the use of CTU in the surveillance of small localized renal masses, and this method is not recommended by the guidelines [2,9,11].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
H. CT Chest

Chest CT is listed as an alternative to radiography for surveillance of small localized renal masses by the National Comprehensive Cancer Network guidelines [2]. Limited data have demonstrated that CT is more sensitive than radiography for the detection of pulmonary metastases from RCC during staging [27]. However, no comparison between radiography and CT has been reported in the active surveillance setting. Despite the higher sensitivity of CT, there are some concerns about the risk of false-positive findings (ie, intrapulmonary lymph nodes and granulomas), particularly in patients with T1a RCC, which can lead to further unnecessary and potentially invasive investigations [9]. Additionally, some authors suggest that CT of the chest may not be necessary to identify most cases of pulmonary recurrence after nephrectomy for RCC when CT of the abdomen with coverage of the lung bases at the T7 thoracic level is performed [26]. The use of IV contrast is optional for CT of the chest but it may be beneficial for detection and characterization of the hilar lymph nodes. In patients undergoing active surveillance with CT of the abdomen who are receiving IV contrast, chest CT can also be performed after IV contrast administration. Unlike CT of the abdomen, in which images without and with IV contrast may be appropriate in some circumstances, CT of the chest without and with IV contrast does not provide additional information in these patients and is considered inappropriate.

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
I. CT Head

Most patients with metastases to the central nervous system are symptomatic. Thus, active surveillance protocols for small localized renal masses have not supported routine imaging of the brain to search for metastases in asymptomatic patients. Brain imaging should be performed only in cases with suggestive signs or symptoms [2,9,11].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
J. MRI Abdomen

MRI of the abdomen without and with IV contrast is an accurate method for the detection and characterization of small localized renal masses. Different sequences, including T2-weighted, chemical shift T1-weighted, contrast-enhanced T1-weighted, and diffusion-weighted images, can help distinguish RCC from other benign and malignant lesions and distinguish the clear-cell subtype from other subtypes of RCC. Some MRI features of renal masses beyond size and growth rates can also be used to determine tumor aggressiveness and risk of metastatic potential [87]. This may be particularly useful for the characterization of small renal masses that have indeterminate findings on CT and US or when biopsy of these masses is not feasible or is inconclusive. Active surveillance guidelines include MRI and CT as appropriate imaging modalities for the initial evaluation of growth patterns and for subsequent follow-up [2,9,11]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), MRI of the abdomen without IV contrast may be considered appropriate.

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
K. MRI Abdomen and Pelvis

MRI of the abdomen without and with IV contrast is an accurate method for the detection and characterization of small localized renal masses. Different sequences, including T2-weighted, chemical shift T1-weighted, contrast-enhanced T1-weighted, and diffusion-weighted images, can help distinguish RCC from other benign and malignant lesions and distinguish the clear-cell subtype from other subtypes of RCC. Some MRI features of renal masses beyond size and growth rates can also be used to determine tumor aggressiveness and risk of metastatic potential [87]. This may be particularly useful for the characterization of small renal masses that have indeterminate findings on CT and US or when biopsy of these masses is not feasible or is inconclusive. Active surveillance guidelines include MRI and CT as appropriate imaging modalities for the initial evaluation of growth patterns and for subsequent follow-up [2,9,11]. For patients in whom contrast is contraindicated (eg, previous anaphylactic reaction), MRI of the abdomen without IV contrast may be considered appropriate.

Although MRI of the abdomen can be useful for characterization and follow-up of small localized renal masses undergoing active surveillance, the benefit of imaging the pelvis during surveillance has not yet been defined and is considered optional in the guidelines [2,9,11]. There is no relevant literature regarding the use of MRI of the pelvis in the follow-up of patients on active surveillance, although data from 2 retrospective studies evaluating RCC staging with CT suggested that imaging of the pelvis had limited benefit for the detection of metastases [33,34]. Furthermore, metastatic progression occurs infrequently in patients on active surveillance with T1a renal masses [8,75-78,81,82]; therefore, MRI of the abdomen is preferred over MRI of the abdomen and pelvis.

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance.
L. MRI Head

Most patients with metastases to the central nervous system are symptomatic. Thus, active surveillance protocols for small localized renal masses have not supported routine imaging of the brain to search for metastases in asymptomatic patients. Brain imaging should be performed only in cases with suggestive signs or symptoms [2,9,11].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance. M. MRU

There is no relevant literature regarding the use of MRU in the surveillance of small localized renal masses, and this method is not recommended by the guidelines [2,9,11].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance. N. US Kidney Retroperitoneal

US of the kidney is an acceptable imaging modality for follow-up of small localized renal masses on active surveillance, especially once the growth rate of the renal mass has been established with CT or MRI [2,9,11,78]. US is an excellent method for characterizing cystic lesions and often provides supplementary information to the other imaging modalities. However, unenhanced US has an overall diagnostic accuracy for characterizing renal masses of only 30% [88]. Some concerns also exist regarding the reproducibility of measurements obtained with US and their correlation with measurements obtained with CT and MRI; any discrepancies could suggest a falsely positive or negative growth rate [82]. When US is used, some authors have recommended that any discrepancy in tumor size or growth rate or qualitative changes in tumor appearance should prompt imaging with CT or MRI [78].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance. O. US Abdomen with IV Contrast

CEUS is an accurate method for the detection and characterization of small renal masses, which in theory may be beneficial for patients on active surveillance. In a large series of CEUS for the evaluation of 1,018 indeterminate renal masses in 721 patients followed for as long as 10 years, the sensitivity of CEUS was 100% (95% CI: 97.1%–100%) with a specificity of 95% (95% CI: 89.9%–98.0%), a positive predictive value of 91.5%, and a negative predictive value of 100% [89]. Multiple additional studies, including a recent meta-analysis of 17 studies with 1,142 lesions, have found that CEUS is more sensitive but slightly less specific than CT and MRI in detecting and characterizing renal masses [90]. The performance of CEUS in active renal mass surveillance may be limited in a small number of cases in which the renal mass is not well visualized on precontrast US [73].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance. P. Bone Scan Whole Body

The incidence of metastatic progression in patients with small localized renal masses on active surveillance is low (0%–2%). Furthermore, the prevalence of osseous metastases has been shown to be low in patients without symptoms (ie, bone pain) or without laboratory abnormalities suggestive of osseous metastases (ie, elevated serum alkaline phosphatase level) [50,51]. Therefore, Tc-99m bone scanning is not routinely recommended in active surveillance [2,9,11].

Variant 3: Follow-up for clinically localized renal cell carcinoma; active surveillance. Q. FDG-PET/CT Skull Base to Mid-Thigh

FDG-PET/CT has low sensitivity and specificity for the detection and local staging of RCC [52]. This is mainly related to the variable levels of FDG avidity in RCCs; additionally, there is interference from background activity in the renal parenchyma as the kidneys are the major route of excretion

of FDG. At present, given the lack of literature to support the use of FDG-PET/CT, the guidelines do not recommend this technique for active surveillance in patients with renal masses [2,9,11].

Summary of Highlights

- **Variant 1:** CT abdomen with IV contrast, CT abdomen without and with IV contrast, or MRI abdomen without and with IV contrast is usually appropriate in the follow-up of patients after surgical excision of RCC. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending MRI abdomen and pelvis without and with IV contrast. There is insufficient medical literature to conclude whether the scan is of benefit in this clinical scenario, and its use may be appropriate but controversial.
- **Variant 2:** CT abdomen with IV contrast, CT abdomen without and with IV contrast, or MRI abdomen without and with IV contrast is usually appropriate in the follow-up of patients after localized RCC ablation. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 3:** CT abdomen with IV contrast, CT abdomen without and with IV contrast, MRI abdomen without and with IV contrast, or US abdomen with IV contrast is usually appropriate in the active surveillance of localized RCC. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a

		rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

Relative Radiation Level Information

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Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate	Pediatric Effective Dose

	Range	Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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Disclaimer

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

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