

1 **Data S1**

2

3 *Inclusion and exclusion criteria.* The inclusion criteria for the present study were as follows: i)  
4 Histopathologically confirmed renal cell carcinoma with recurrent metastatic lesions  
5 confirmed by positron emission tomography/CT or other systemic imaging; ii) patients with  
6  $\leq 5$  metastatic lesions amenable to complete lesion coverage radiotherapy or  $>5$  lesions with  
7  $\geq 3$  suitable for radiotherapy, as evaluated by the Departments of Radiotherapy and Imaging;  
8 iii) an age of 18-80 years; iv) an expected survival time of  $\geq 12$  weeks; v) measurable disease  
9 based on Response Evaluation Criteria in Solid Tumors version 1.1; and vi) an Eastern  
10 Cooperative Oncology Group performance status of 0-2, hemoglobin  $\geq 90$  g/l, white blood  
11 cell count  $\geq 3 \times 10^9/l$ , neutrophil count  $\geq 1.5 \times 10^9/l$ , platelet count  $\geq 100 \times 10^9/l$ , total bilirubin  $\leq 2$   
12 times the upper limit of normal (ULN), alanine transaminase and aspartate transaminase  $\leq 2.5$   
13 times the ULN, creatinine  $\leq 1.5$  times the ULN or creatinine clearance  $\geq 50$  ml/min, thyroid  
14 stimulating hormone levels less than or equal to the ULN or triiodothyronine and thyroxine  
15 within normal limits, all measured within 7 days before enrolment.

16 The exclusion criteria were as follows: i) History of anti-programmed cell death protein 1  
17 or programmed-death ligand 1 antibody therapy or radiotherapy; ii) use of corticosteroids or  
18 other immunosuppressants within 14 days before treatment; iii) autoimmune diseases or  
19 interstitial lung diseases; iv) history of other malignancies; v) history of surgery within 28  
20 days before treatment; and vi) allergy to study drug components.

21

22 *Adverse events.* Adverse event attribution was systematically performed through a  
23 multidisciplinary adjudication process involving oncologists, radiation oncologists and  
24 clinical pharmacists. The determination was based on three key criteria: i) Temporal  
25 relationship, assessed as onset timing relative to treatment cycles (such as immune-related  
26 adverse events that typically manifest  $\geq 2$  weeks after immunotherapy initiation, whereas  
27 radiation toxicities were mapped to anatomical treatment fields and were often relieved after  
28 radiation treatment); ii) known toxicity profiles, which were referenced from established  
29 guidelines (Common Terminology Criteria for Adverse Events version v5.0) and  
30 drug/radiation package inserts to identify modality-specific adverse reaction patterns; and iii)  
31 exclusion of confounders, where alternative explanations (such as disease progression,  
32 comorbidities or concurrent medications) were rigorously ruled out through laboratory tests,  
33 imaging studies and medication reconciliation. For overlapping toxicities (such as  
34 pneumonitis potentially attributable to both immunotherapy and radiation), a hierarchical

1 attribution protocol was implemented: Radiation-related toxicities required spatial  
2 concordance with treatment fields (confirmed by dosimetry review), and  
3 immunotherapy-related toxicities required histopathological confirmation (when feasible) and  
4 responsiveness to steroid therapy.