

Proportion of Minimally Invasive Surgery for Renal Cell Carcinoma

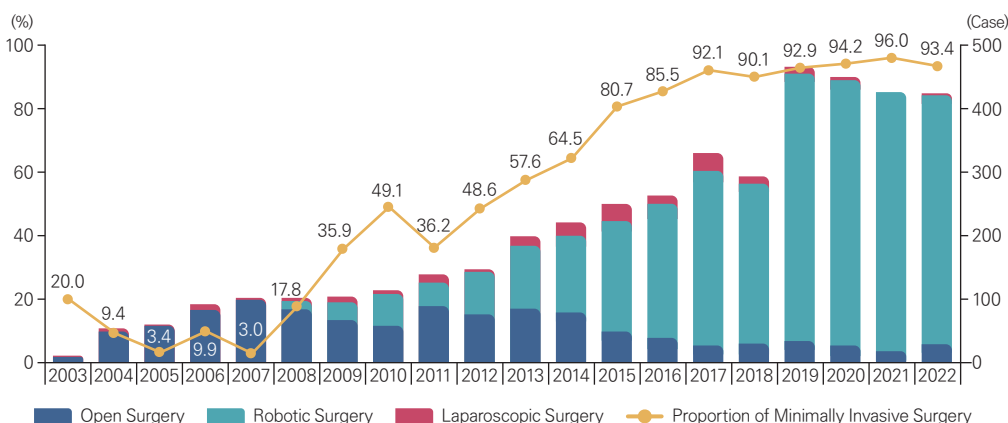
The proportion of surgeries performed with a minimally invasive approach (either laparoscopic or robotic) for renal cell carcinoma

Definitions

- ◆ **Robotic surgery:** A method of laparoscopic surgery where the surgeon remote-controls a patient-mounted medical robot, which is a cutting edge surgical device.
- ◆ **Laparoscopic surgery:** A method of surgery where the surgeon controls laparoscopic devices such as a video camera or laparoscopic instruments inserted into the abdominal cavity of the patient through a few small, not large, incisions made on the abdomen.

Result

May 1, 2003 – December 31, 2022



Interpretation

- ◆ Minimally Invasive Surgery has benefits including reduced bleeding, less painful and rapid recovery due to small surgical incisions, compared to the conventional open surgery.
- ◆ Robotic surgery, in particular, allows for the better field of vision than the laparoscopy and more precise surgery based on the degree of freedom of the robotic arm; hence, an increasing trend in the number of robotic surgeries could be seen.
- ◆ Despite overall decline in patient admissions and surgeries due to COVID-19, minimally invasive surgeries based on robotic surgical system have continuously increased in proportion.
- ◆ This is a result of the medical staff's increased experience and proficiency in robotic surgery, as well as efforts to standardize surgical procedures.

Data source: SNUBH EMR (Electronic Medical Record)

- Relevant Research
- 1) Dunn MD, Portis AJ, Shalhav AL, Elbahnasy AM, Heidorn C, McDougall EM, et al. "Laparoscopic versus open radical nephrectomy: a 9-year experience." *J Urol*, 2000;164: pp. 1153–9.
 - 2) In Gab Jeong, Yash S. Khandwala, Jae Heon Kim, et al. "Association of Robotic-Assisted vs Laparoscopic Radical Nephrectomy With Perioperative Outcomes and Health Care Costs, 2003 to 2015." *JAMA*, 2017;318(16): pp. 1561–1568.
 - 3) Oh JJ, Lee JK, Kim K, et al. "Comparison of the Width of Peritumoral Surgical Margin in Open and Robotic Partial Nephrectomy: A Propensity Score Matched Analysis." *PLOS*, 2016 Jun 23;11(6).

Average Length of Stay, Renal Cell Carcinoma Surgery

The average length of hospitalized days after receiving renal cell carcinoma surgery



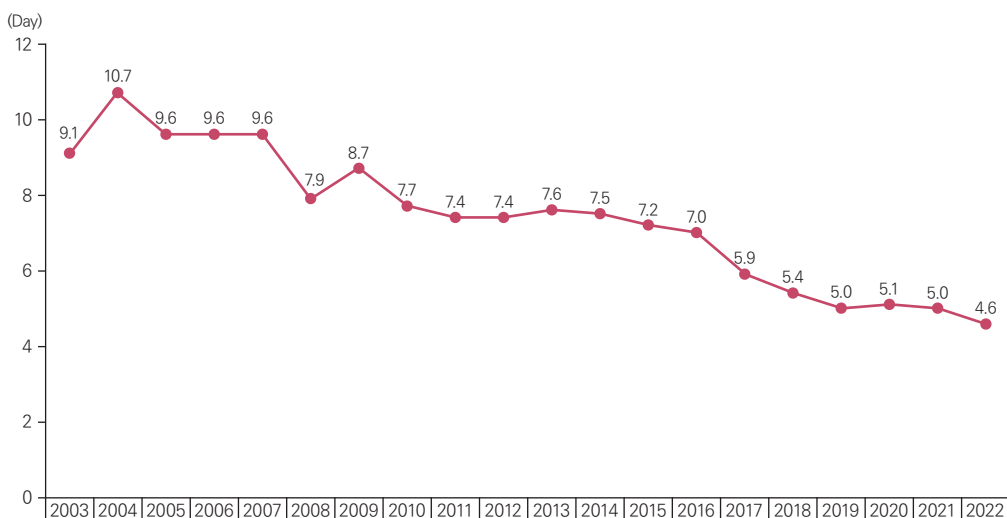
Definitions

- ◆ **Postoperative length of stay:** The number of days from the date of surgery to the date of discharge.
- ◆ **Average postoperative length of stay:** Calculated by dividing the total postoperative length of stay by the total number of patients who underwent surgery.



Result

May 1, 2003 – December 31, 2022



Interpretation

- ◆ The average length of stay of renal cell carcinoma patients over the last 20 years at SNUBH was shown to have decreased from 9.1 days in 2003 to 4.6 days in 2022, showing a reduction of around 55%.
- ◆ The reduced length of stay allowed for a more rapid return to daily life, while reducing the socio-economic burden such as hospitalization cost. This is considered to be the result of continuing improvement activities for quality enhancement at SNUBH, as well as the steady increase in the role and rate of minimally invasive surgery such as robotic surgery.



Improvement

- ◆ The hospitalization period was greatly reduced by specialization and efficiency of surgical methods, and standardization of postoperative management.

Data source SNUBH EMR (Electronic Medical Record)

Overall Survival Rate, Nephrectomy

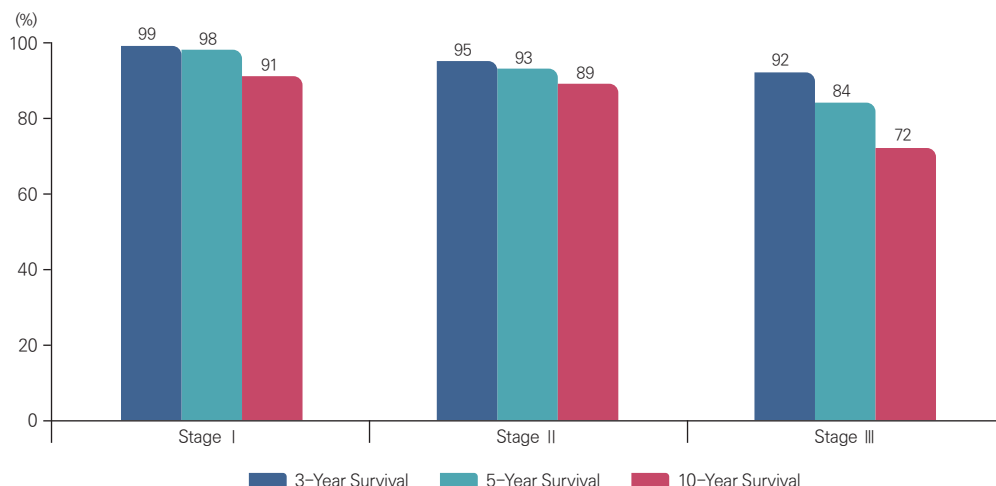
The overall proportion of surviving patients after surgery (radical or partial nephrectomy)

Definitions

- ◆ **Radical nephrectomy:** The most basic surgical treatment for renal cell carcinoma where the kidney and the layer of adipose or fascia surrounding the kidney are removed.
- ◆ **Partial nephrectomy:** A surgical treatment where only a part of the kidney surrounding the tumor lesion is removed and the rest are preserved.
- ◆ **Stage:** The progression of cancer determined based on the size of surgically removed renal cell carcinoma or metastasis to lymph node.
 - Stage I: The cancer is limited to the kidney, with ≤ 7 cm in greatest dimension.
 - Stage II: The cancer is limited to the kidney, with >7 cm in greatest dimension.
 - Stage III: The cancer has invaded the major veins or tissues around the kidney, but has not migrated beyond the fascia; or the case where the regional lymph node metastasis has occurred.
 - Stage IV: The case of the direct invasion to the adrenal gland on the same side, or the invasion beyond the fascia and into the surrounding organs; or the case where the distant metastasis has occurred.

Result

May 1, 2003 – December 31, 2022



* Exclusion criteria: Patients suspected of lymph node or distant metastasis at the time point of the surgery were excluded

	Stage I	Stage II	Stage III or above
Number of Patients	3,426	209	364

Data source: SNUBH EMR (Electronic Medical Record), Statistics Korea Survival Data

Relevant Research 1) Stages are classified according to the American Joint Committee on Cancer (AJCC) 8th Edition

2) Lee H, Jeong CW, et al. "Preoperative Cholesterol Level is Associated with Worse Pathological Outcomes and Post-Operative Survival in Localized Renal Cell Carcinoma Patients: A Propensity Score-Matched Study", "Clinical Genitourinary Cancer", 2017, 15(6), pp. 935-941.

3) Lee H, Kim YJ, Hwang EC, et al. "Preoperative Cholesterol Level as a New Independent Predictive Factor of Survival in Patients with Metastatic Renal Cell Carcinoma Treated with Cyto-Reductive Nephrectomy", "BMC Cancer", 2017, 17(1), pp. 304.

Cancer-Specific Survival Rate, Nephrectomy

The proportion of patients who did not die of renal cell carcinoma after the surgery (radical or partial nephrectomy)



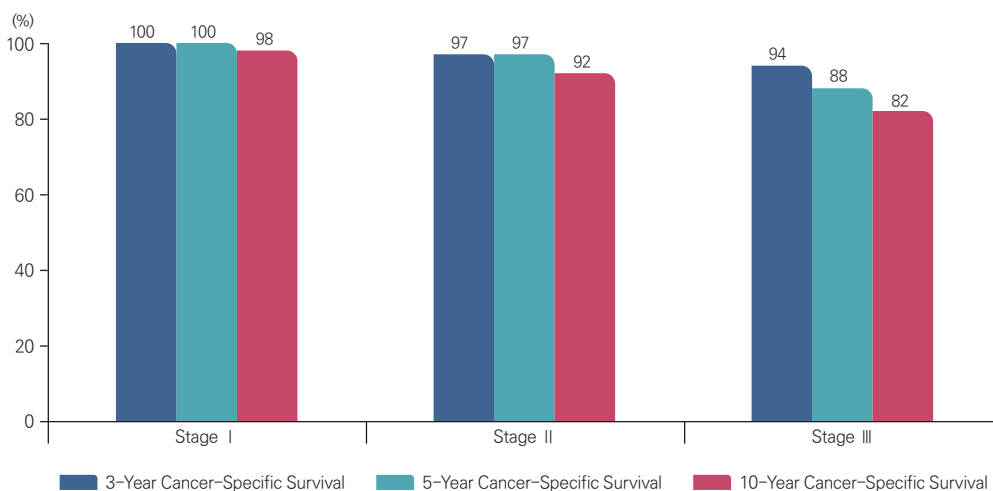
Definitions

- ◆ **Radical nephrectomy:** The most basic surgical treatment for renal cell carcinoma where the kidney and the layer of adipose or fascia surrounding the kidney are removed.
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 - Stage I: The cancer is limited to the kidney, with ≤ 7 cm in greatest dimension.
 - Stage II: The cancer is limited to the kidney, with >7 cm in greatest dimension.
 - Stage III: The cancer has invaded the major veins or tissue around the kidney, but has not migrated beyond the fascia; or the case where the regional lymph node metastasis has occurred.
 - Stage IV: The case of the direct invasion to the adrenal gland on the same side, or the invasion beyond the fascia and into the surrounding organs; or the case where the distant metastasis has occurred.



Result

May 1, 2003 – December 31, 2022



* Exclusion criteria: Patients suspected of lymph node or distant metastasis at the time point of the surgery were excluded

	Stage I	Stage II	Stage III or above
Number of Patients	3,426	209	364

Data source: SNUBH EMR (Electronic Medical Record), Statistics Korea Survival Data

Relevant Research 1) Stages are classified according to the American Joint Committee on Cancer (AJCC) 8th Edition

2) Kang HW, et al. "Low Preoperative Serum Cholesterol Level is Associated with aggressive Pathologic Features and Poor Cancer-Specific Survival in Patients with Surgically Treated Renal Cell Carcinoma" *Int J Clin Oncol.*, 2018, 23(1): pp. 142–150.

Recurrence Rate after Nephrectomy

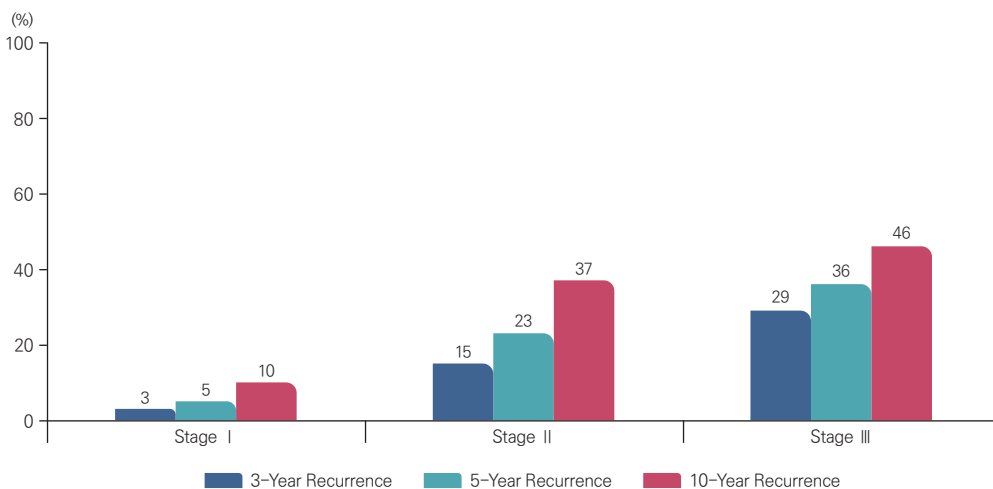
The proportion of patients with evidence of localized recurrence or distant metastasis after surgery (radical or partial nephrectomy)

Definitions

- ◆ **Radical nephrectomy:** The most basic surgical treatment for renal cell carcinoma where the kidney and the layer of adipose or fascia surrounding the kidney are removed.
- ◆ **Partial nephrectomy:** A surgical treatment where only a part of the kidney surrounding the tumor lesion is removed and the rest are preserved.
- ◆ **Stage:** The progression of cancer determined based on the size of surgically removed renal cell carcinoma or metastasis to lymph node.
 - Stage I: The cancer is limited to the kidney, with ≤ 7 cm in greatest dimension.
 - Stage II: The cancer is limited to the kidney, with >7 cm in greatest dimension.
 - Stage III: The cancer has invaded the major veins or tissue around the kidney, but has not migrated beyond the fascia; or the case where the regional lymph node metastasis has occurred.
 - Stage IV: The case of the direct invasion to the adrenal gland on the same side, or the invasion beyond the fascia and into the surrounding organs; or the case where the distant metastasis has occurred.

Result

May 1, 2003 – December 31, 2022



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	Stage I	Stage II	Stage III or above
Number of Patients	3,426	209	364

Data source SNUBH EMR (Electronic Medical Record), Statistics Korea Survival Data

Relevant Research 1) Stages are classified according to the American Joint Committee on Cancer (AJCC) 8th Edition

Postoperative Complications, Nephrectomy

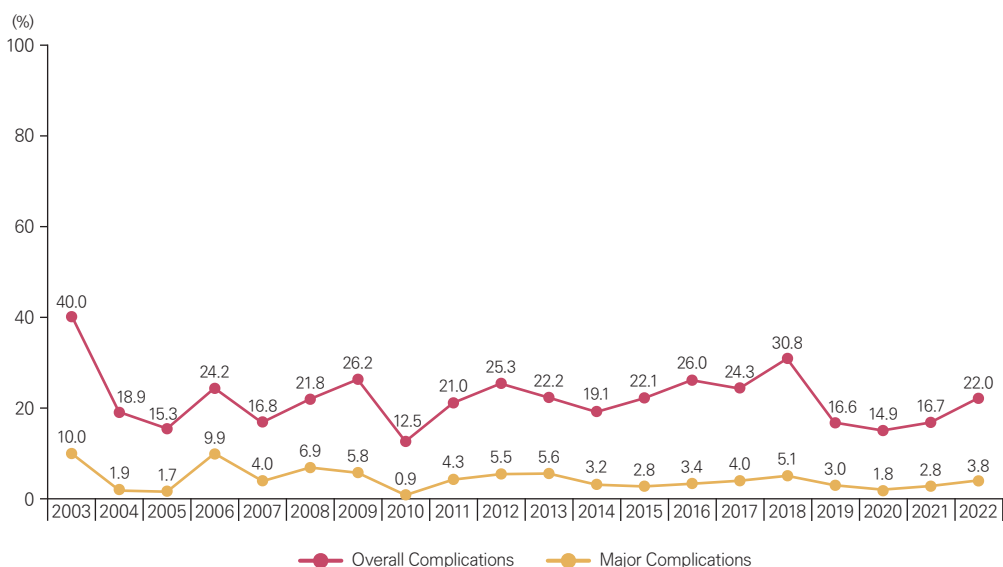
The proportion of patients with complications following nephrectomy

Definitions

- ◆ **Complication:** All medical and surgical complications after nephrectomy, from mild complications such as fever to serious complications such as bleeding that requires blood transfusion, acute kidney injury, a case that requires dialysis, pneumonia, atelectasis, and intestinal perforation.
- ◆ **Major complication:** A complication that requires an intervention such as embolization, revision surgery, or intensive treatment at Intensive Care Unit (\geq Clavien-Dindo IIIa).

Result

May 1, 2003 – December 31, 2022



Interpretation

- ◆ The complication rate after nephrectomy is roughly around 20%, with major complications accounting for about 4%. With the annual increase in the number of surgeries, it is believed to be on a slight upward trend overall. Furthermore, years with a higher number of open surgeries showed a higher frequency of complications.

Data source: SNUBH EMR (Electronic Medical Record)

Overall Survival Rate, Robotic Partial Nephrectomy

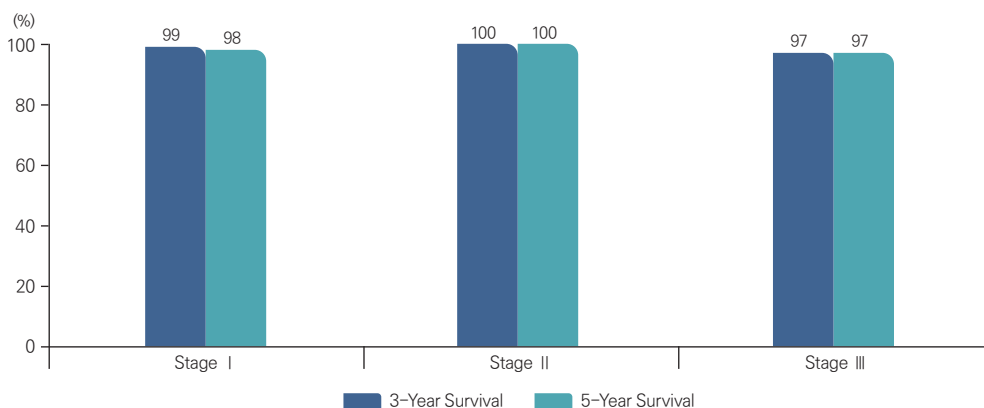
The overall proportion of surviving patients after the robotic partial nephrectomy

Definitions

- ◆ **Robotic partial nephrectomy:** A surgical treatment where only a part of the kidney surrounding the tumor lesion is removed and the rest are preserved, through the use of a surgical robot.
- ◆ **Stage:** The progression of cancer determined based on the size of surgically removed renal cell carcinoma or metastasis to lymph node.
 - Stage I: The cancer is limited to the kidney, with ≤ 7 cm in greatest dimension.
 - Stage II: The cancer is limited to the kidney, with >7 cm in greatest dimension.
 - Stage III: The cancer has invaded the major veins or tissue around the kidney, but has not migrated beyond the fascia; or the case where the regional lymph node metastasis has occurred.
 - Stage IV: The case of the direct invasion to the adrenal gland on the same side, or the invasion beyond the fascia and into the surrounding organs; or the case where the distant metastasis has occurred.

Result

May 1, 2003 – December 31, 2022



* Exclusion criteria: Patients suspected of lymph node or distant metastasis at the time point of the surgery were excluded

	Stage I	Stage II	Stage III or above
Number of Patients	2,305	23	56

Interpretation

- ◆ During robot-assisted laparoscopic partial nephrectomy, surgeons can accurately differentiate the tumor based on 3D imaging that can be magnified up to 10 times, and the robotic arm, in particular, which is able to move freely up to 540° in the abdomen, allows faster and finer incision of the tumor while preserving normal anatomies. This can lead to improved survival rates.

Data source SNUBH EMR (Electronic Medical Record), Statistics Korea Survival Data

Relevant Research 1) Stages are classified according to the American Joint Committee on Cancer (AJCC) 8th Edition

Cancer-Specific Survival Rate, Robotic Partial Nephrectomy

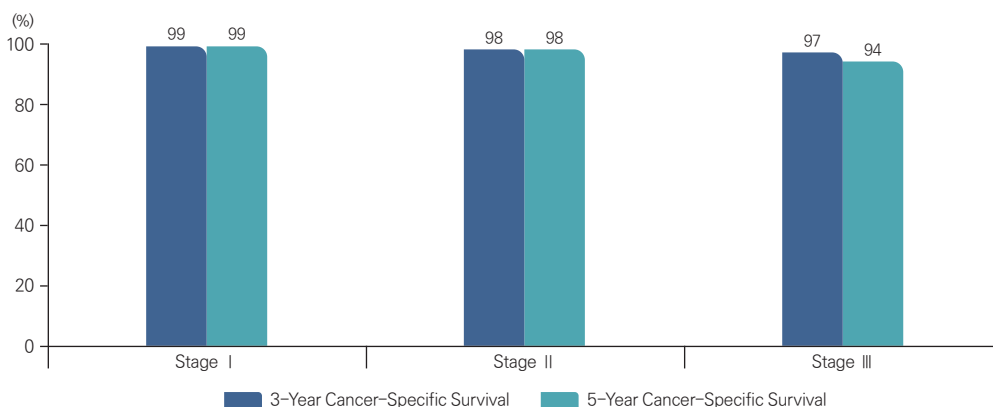
The proportion of patients who did not die of renal cell carcinoma after the robotic partial nephrectomy

Definitions

- ◆ **Robotic partial nephrectomy:** A surgical treatment where only a part of the kidney surrounding the tumor lesion is removed and the rest are preserved, through the use of a surgical robot.
- ◆ **Stage:** The progression of cancer determined based on the size of surgically removed renal cell carcinoma or metastasis to lymph node.
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Result

May 1, 2003 – December 31, 2022



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Data source SNUBH EMR (Electronic Medical Record), Statistics Korea Survival Data

Relevant Research 1) Stages are classified according to the American Joint Committee on Cancer (AJCC) 8th Edition

Recurrence Rate after Robotic Partial Nephrectomy

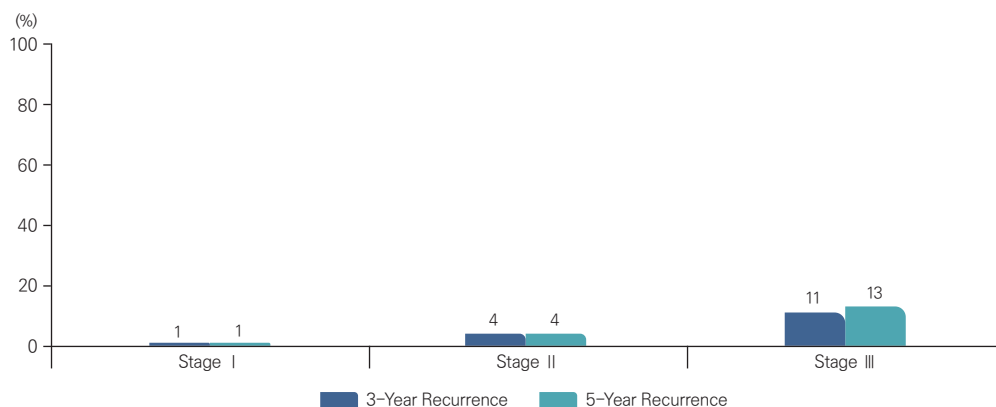
The proportion of patients showing evidence of localized recurrence or distant metastasis, among those who received the robotic partial nephrectomy

Definitions

- ◆ **Robotic partial nephrectomy:** A surgical treatment where only a part of the kidney surrounding the tumor lesion area is removed and the rest are preserved, through the use of a surgical robot.
- ◆ **Stage:** The progression of cancer determined based on the size of surgically removed renal cell carcinoma or metastasis to lymph node.
 - Stage I: The cancer is limited to the kidney, with ≤ 7 cm in greatest dimension.
 - Stage II: The cancer is limited to the kidney, with >7 cm in greatest dimension.
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May 1, 2003 – December 31, 2022



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Interpretation

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Data source SNUBH EMR (Electronic Medical Record), Statistics Korea Survival Data

Relevant Research 1) Stages are classified according to the American Joint Committee on Cancer (AJCC) 8th Edition

Postoperative Complications, Robotic Partial Nephrectomy

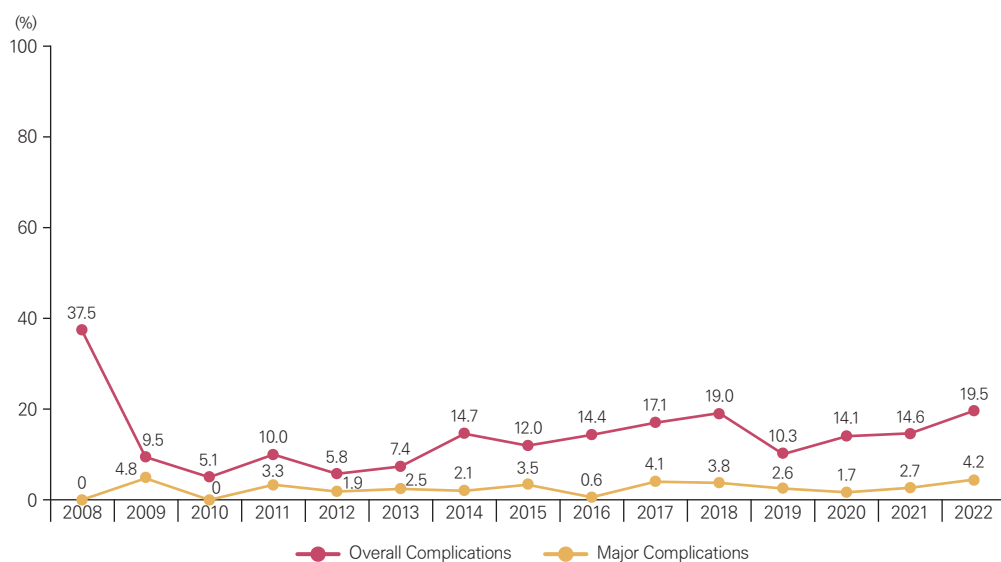
The rate of patients showing complications after receiving robotic partial nephrectomy

Definitions

- ◆ **Complication:** All medical and surgical complications after nephrectomy, from mild complications such as fever to serious complications such as bleeding that requires blood transfusion, acute kidney injury, a case that requires dialysis, pneumonia, atelectasis, and intestinal perforation.
- ◆ **Major complication:** A complication that requires an intervention such as embolization, revision surgery, or intensive treatment at Intensive Care Unit (\geq Clavien-Dindo IIIa).

Result

January 1, 2008 – December 31, 2022



Interpretation

- ◆ Compared to the incidence of complications observed in all nephrectomy patients regardless of surgical technique (minimally invasive or robotic), as large as half the incidence was shown to have decreased.
- ◆ The result may be attributed to small incision site, reduced vessel damage via fine manipulations, and maximal preservation of the kidney.

Data source: SNUBH EMR (Electronic Medical Record)

Postoperative GFR: Radical vs Partial Nephrectomy

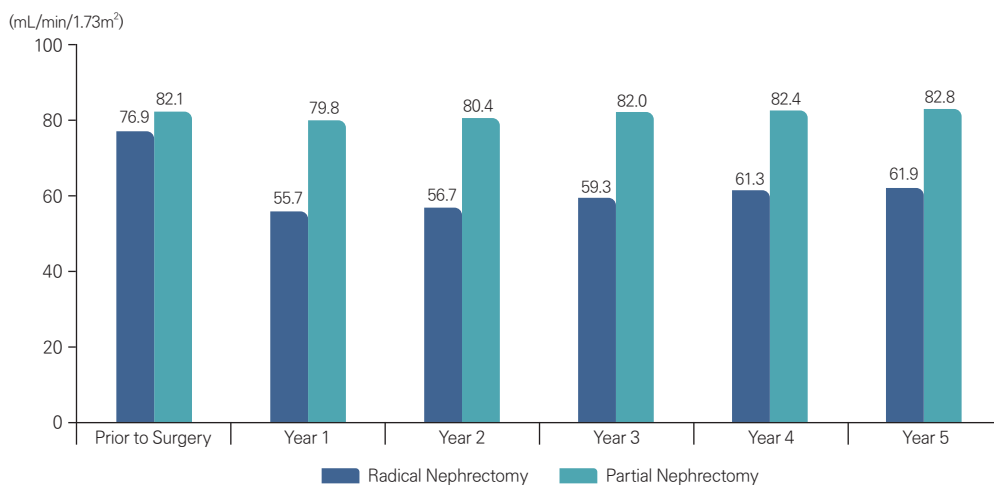
A comparison between radical and partial nephrectomy for the 5-year postoperative changes in renal function in patients who received renal cell carcinoma surgery

Definitions

- ◆ **Radical nephrectomy:** The most basic surgical treatment for renal cell carcinoma that removes the kidney and the adipose tissue and fascia surrounding the kidney.
- ◆ **Partial nephrectomy:** A surgical treatment that removes only a part of the kidney including the tumor lesion while preserving the remaining areas.
- ◆ **Glomerular filtration rate (GFR):** It is defined as the level of plasma at which the kidney can filter a particular substance within a given period of time. GFR is regarded as an index that best reflects the renal function.

Result

May 1, 2003 – December 31, 2022



Interpretation

- ◆ An overall higher GFR in patients of partial nephrectomy can be seen prior to surgery. Patients with radical or partial nephrectomy showed GFR increase from Year 1.
- ◆ This may be due to a time-dependent compensatory increase in renal function.

Data source SNUBH EMR (Electronic Medical Record)

Relevant Research

- 1) Lesley A.Inker, Brad C.Astor, et al "KDOQI US Commentary on the 2012 KDIGO Clinical Practice Guideline for the Evaluation and Management of CKD" 『AJKD』 2014;63: pp. 713-735.
- 2) Joong Seo Ahn, Hyung Joon Kim, et al "Predictive Preoperative Factors for Renal Insufficiency in Patients Followed for More Than 5 Years After Radical Nephrectomy" 『KJU』 2013;54: pp. 303-310.
- 3) Luigi Tarantini, Giulia Barbati, et al. "Clinical implications of the CKD epidemiology collaboration (CKD-EPI) equation compared with the modification of diet in renal disease (MDRD) study equation for the estimation of renal dysfunction in patients with cardiovascular disease". 『IMJ』 2015;10: pp. 955-963.

Postoperative GFR: Non-Robotic vs Robotic Radical Nephrectomy

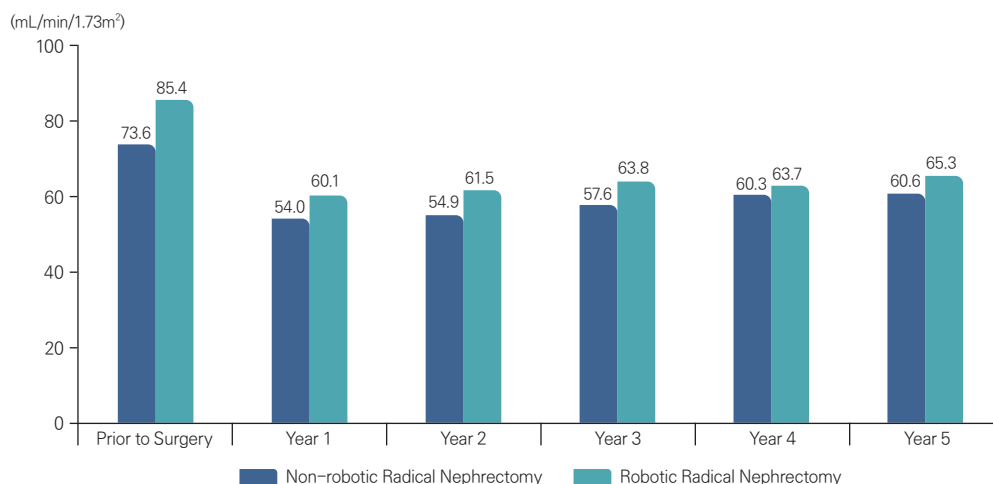
A comparison of the 5-year postoperative changes in renal function in patients who received radical nephrectomy according to surgical technique (non-robotic or robotic)

Definitions

- ◆ **Non-robotic radical nephrectomy:** Radical nephrectomy including open surgery and laparoscopy without the use of robot.
- ◆ **Robotic radical nephrectomy:** Radical nephrectomy performed using a robot.
- ◆ **Glomerular filtration rate (GFR):** It is defined as the level of plasma at which the kidney can filter a particular substance within a given period of time. GFR is regarded as an index that best reflects the renal function.

Result

May 1, 2003 – December 31, 2022



Interpretation

- ◆ When compared with the GFR changes of all patients who underwent radical nephrectomy, GFR was lower in non-robotic surgery and higher in robotic cases.
- ◆ Although it is difficult to make a fragmentary judgment because it is not a result of controlling various variables, it can be seen that the renal function remains higher if a robotic surgery is performed.

Data source SNUBH EMR (Electronic Medical Record)

- Relevant Research**
- 1) Lesley A.Inker, Brad C.Astor, et al "KDOQI US Commentary on the 2012 KDIGO Clinical Practice Guideline for the Evaluation and Management of CKD" 『AJKD』 2014;63: pp. 713-735.
 - 2) Joong Seo Ahn, Hyung Joon Kim, et al "Predictive Preoperative Factors for Renal Insufficiency in Patients Followed for More Than 5 Years After Radical Nephrectomy" 『KJU』 2013;54: pp. 303-310.
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Postoperative GFR: Non-Robotic vs Robotic Partial Nephrectomy

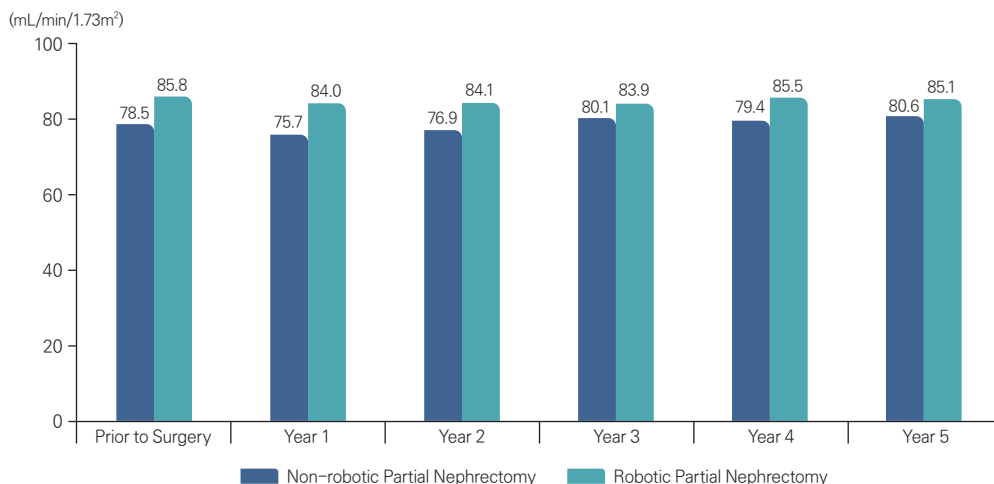
A comparison of the 5-year postoperative changes in renal function in patients who received partial nephrectomy according to surgical technique (non-robotic or robotic)

Definitions

- ◆ **Non-robotic partial nephrectomy:** Partial nephrectomy including open surgery and laparoscopy without the use of robot.
- ◆ **Robotic partial nephrectomy:** Partial nephrectomy performed using a robot.
- ◆ **Glomerular filtration rate (GFR):** It is defined as the level of plasma at which the kidney can filter a particular substance within a given period of time. GFR is regarded as an index that best reflects the renal function.

Result

May 1, 2003 – December 31, 2022



Interpretation

- ◆ Compared to radical nephrectomy, the cases of partial nephrectomy can be seen to have maintained higher GFR values regardless of surgical technique.
- ◆ Notably, for robotic surgery, the GFR value has been maintained above 85 at Year 5.

Data source SNUBH EMR (Electronic Medical Record)

Relevant Research

- 1) Lesley A.Inker, Brad C.Astor, et al "KDOQI US Commentary on the 2012 KDIGO Clinical Practice Guideline for the Evaluation and Management of CKD" 『AJKD』 2014;63: pp. 713-735.
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- 3) Luigi Tarantini, Giulia Barbati, et al. "Clinical implications of the CKD epidemiology collaboration (CKD-EPI) equation compared with the modification of diet in renal disease (MDRD) study equation for the estimation of renal dysfunction in patients with cardiovascular disease". 『IM』 2015;10: pp. 955-963.

Postoperative Chronic Kidney Disease: Radical vs Partial Nephrectomy

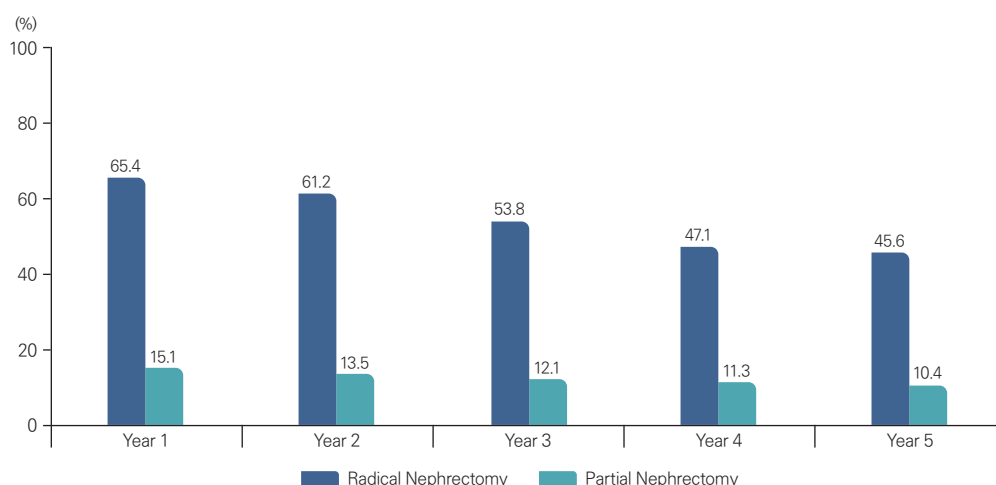
The annual rate of patients with normal renal function who progress to chronic kidney disease within 5 years after kidney cancer surgery

Definitions

- ♦ **Radical nephrectomy:** The most basic surgical treatment for renal cell carcinoma that removes the kidney and the adipose tissue and fascia surrounding the kidney.
- ♦ **Partial nephrectomy:** A surgical treatment that removes only a part of the kidney including the tumor lesion while preserving the remaining areas.
- ♦ **Glomerular filtration rate (GFR):** It is defined as the level of plasma at which the kidney can filter a particular substance within a given period of time. GFR is regarded as an index that best reflects the renal function.
- ♦ **Chronic kidney disease:** A case where GFR falls below 60.

Result

May 1, 2003 – December 31, 2022



Interpretation

- ♦ Patients who undergo partial nephrectomy progress to chronic kidney disease less compared to radical nephrectomy. When patients receive robotic surgery, they can benefit from a more precise resection, preserving more renal tissue, which connects to lower chance of progression to chronic kidney disease.

Data source SNUBH EMR (Electronic Medical Record)

Relevant Research

- 1) Lesley A.Inker, Brad C.Astor, et al "KDOQI US Commentary on the 2012 KDIGO Clinical Practice Guideline for the Evaluation and Management of CKD" 『AJKD』 2014;63: pp. 713-735.
- 2) Joong Seo Ahn, Hyung Joon Kim, et al "Predictive Preoperative Factors for Renal Insufficiency in Patients Followed for More Than 5 Years After Radical Nephrectomy" 『KJU』 2013;54: pp. 303-310.
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Postoperative Chronic Kidney Disease: Non-Robotic vs Robotic Radical Nephrectomy

The annual rate of patients with normal renal function who progress to chronic kidney disease within 5 years after kidney cancer surgery



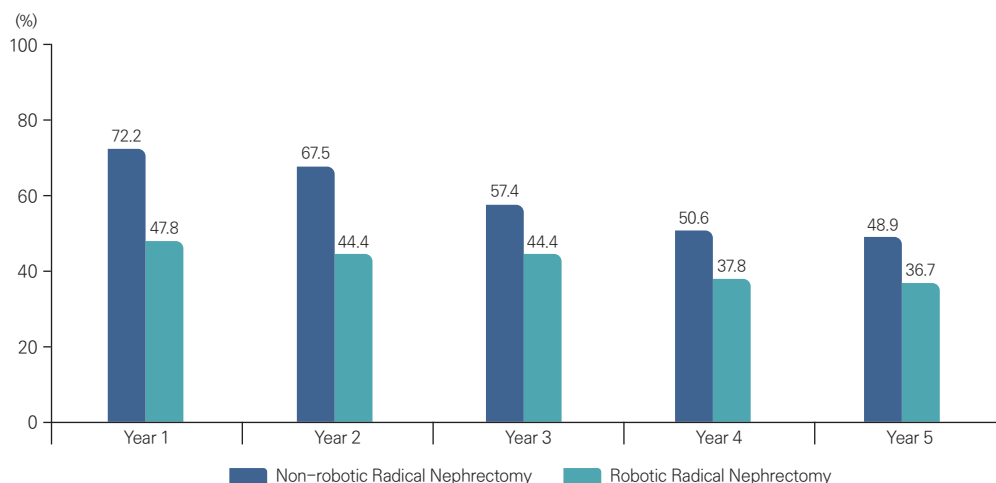
Definitions

- ◆ **Non-robotic radical nephrectomy:** Radical nephrectomy including open surgery and laparoscopy without the use of robot.
- ◆ **Robotic radical nephrectomy:** Radical nephrectomy performed using a robot.
- ◆ **Glomerular filtration rate (GFR):** It is defined as the level of plasma at which the kidney can filter a particular substance within a given period of time. GFR is regarded as an index that best reflects the renal function.
- ◆ **Chronic kidney disease:** A case where GFR falls below 60.



Result

May 1, 2003 – December 31, 2022



Interpretation

- ◆ If a non-robotic radical nephrectomy is performed, it is more likely that the patients will progress to chronic kidney disease.

Data source SNUBH EMR (Electronic Medical Record)

Relevant Research 1) Lesley A.Inker, Brad C.Astor, et al "KDOQI US Commentary on the 2012 KDIGO Clinical Practice Guideline for the Evaluation and Management of CKD" 『AJKD』 2014;63: pp. 713-735.
 2) Joong Seo Ahn, Hyung Joon Kim, et al "Predictive Preoperative Factors for Renal Insufficiency in Patients Followed for More Than 5 Years After Radical Nephrectomy" 『KJU』 2013;54: pp. 303-310.
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Postoperative Chronic Kidney Disease: Non-Robotic vs Robotic Partial Nephrectomy

The annual rate of patients with normal renal function who progress to chronic kidney disease within 5 years after kidney cancer surgery



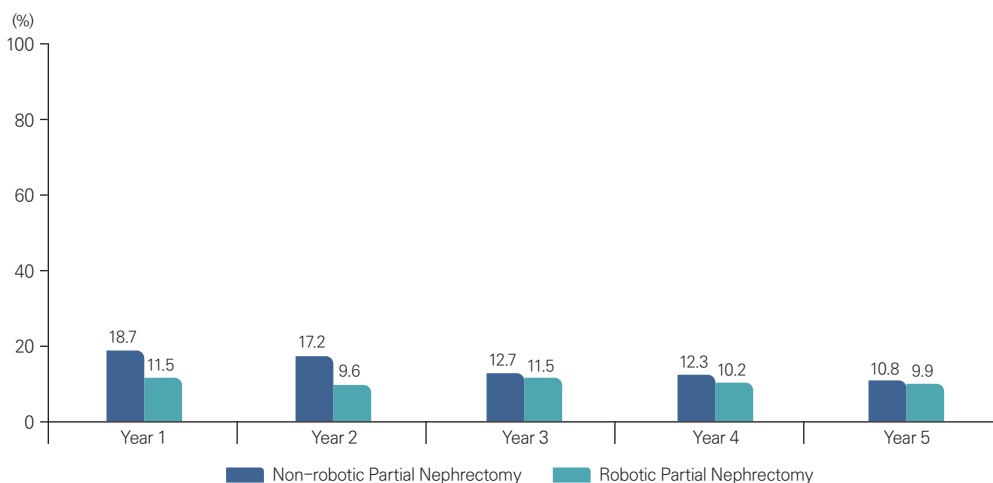
Definitions

- ◆ **Non-robotic partial nephrectomy:** Partial nephrectomy including open surgery and laparoscopy without the use of robot.
- ◆ **Robotic partial nephrectomy:** Partial nephrectomy performed using a robot.
- ◆ **Glomerular filtration rate (GFR):** It is defined as the level of plasma at which the kidney can filter a particular substance within a given period of time. GFR is regarded as an index that best reflects the renal function.
- ◆ **Chronic kidney disease:** A case where GFR falls below 60.



Result

May 1, 2003 – December 31, 2022



Interpretation

- ◆ Partial nephrectomy, regardless of being robotic or non-robotic, was shown to have led to fewer cases of chronic kidney disease compared to radical nephrectomy. And robotic surgery was shown to have led to fewer cases of chronic kidney disease compared to non-robotic surgery.

Data source SNUBH EMR (Electronic Medical Record)

- Relevant Research**
- 1) Lesley A.Inker, Brad C.Astor, et al "KDOQI US Commentary on the 2012 KDIGO Clinical Practice Guideline for the Evaluation and Management of CKD" 『AJKD』 2014;63: pp. 713-735.
 - 2) Joong Seo Ahn, Hyung Joon Kim, et al "Predictive Preoperative Factors for Renal Insufficiency in Patients Followed for More Than 5 Years After Radical Nephrectomy" 『KJU』 2013;54: pp. 303-310.
 - 3) Luigi Tarantini, Giulia Barbati, et al. "Clinical implications of the CKD epidemiology collaboration (CKD-EPI) equation compared with the modification of diet in renal disease (MDRD) study equation for the estimation of renal dysfunction in patients with cardiovascular disease". 『IMJ』 2015;10: pp. 955-963.