

# Laparoscopic and Robotic Kidney Surgery

Commonly asked  
questions

by Dr Gerald Tan

Most people are born with two functioning kidneys. The kidneys are bean-shaped organs situated high in the posterior abdominal cavity, on either side of the vertebral column [Figure 1]. The kidneys are responsible for several vital roles in the human body, such as waste excretion, maintaining the delicate balance of essential salts, acids and water in the bloodstream, regulation of blood pressure and regulation of red blood cell production for oxygen carriage in the bloodstream.

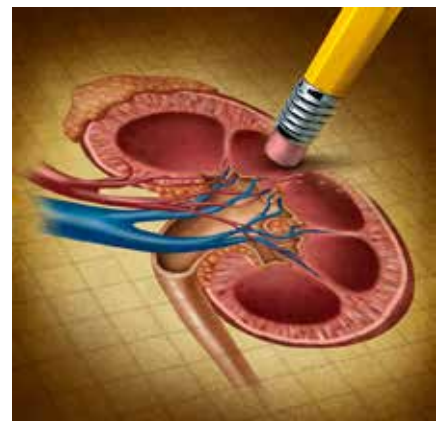
With age, patients may develop diseases that irreversibly damage the functioning cells in the kidneys. Kidney failure may occur in:

- severe or recurrent urinary tract infections
- unrelieved obstruction of urine outflow due to stones, tumours or scarring of the ureters
- prolonged dehydration
- life-threatening conditions causing low blood pressure and impaired blood supply to the kidneys
- traumatic injury to the kidneys from falls, accidents etc.

In patients with obstruction of the urinary tract, the blocked kidney becomes swollen, causing patients to experience loin pain or ache. When these symptoms are persistently ignored, the swollen kidney will start to deteriorate and irreversibly lose its function. On routine health screening, blood tests or ultrasound examination of the abdomen, these patients then discover that their obstructed kidney(s) has become damaged.

## When must patients have their kidneys removed? What are the health consequences of removing the entire kidney?

Patients may need to have their diseased kidneys removed in a variety of scenarios:



**Figure 1.** The kidneys are bean-shaped organs responsible for waste excretion and salt and fluid balance in the body.



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- Kidney cancer
- Severe life-threatening infections of the kidney e.g. emphysematous pyelonephritis
- Non-functioning kidney causing pain or recurrent urinary tract infection
- Traumatic injury to the kidney with ongoing bleeding

Most healthy people are able to survive well with only one functioning kidney. This allows people to donate one of their healthy kidneys to suitable recipients with end-stage kidney failure on dialysis. However, patients with only one functioning kidney must see their doctor regularly to make sure they are keeping their blood pressure and sugar levels in control, to avoid damage to their remaining kidney. Patients who have had one kidney removed or damaged, are at higher risk of developing high blood pressure, heart disease and strokes in the future.<sup>1</sup> As such, urologists nowadays routinely attempt kidney-sparing surgery in patients with early kidney cancers, to maximise preservation of healthy functioning kidney tissue in the affected kidney.

When both kidneys become irreversibly damaged, patients develop end-stage kidney failure. They then require dialysis to remove the waste products from their body. This may be achieved either through haemodialysis with the aid of a dialysis machine, or through continuous peritoneal dialysis.

### What is laparoscopic kidney surgery and what are the risks associated with undergoing such surgery?

Laparoscopic kidney surgery (popularly known as “keyhole surgery”) is a minimally invasive approach, where surgery on the affected kidney is performed through small incisions (< 1.5cm) in the abdominal cavity using specialised instruments and a video camera system, instead of using a large conventional incision [Figure 2]. In most instances, laparoscopic surgery is always preferred as it affords numerous advantages over conventional open kidney surgery – patients have less pain and intraoperative bleeding, shorter hospitalisation, and earlier return to work and normal activities. For open surgery, many patients complain of chronic pain or numbness over the large incision [Figure 3].

However, laparoscopic surgery may not be the best approach in some rare clinical scenarios e.g. patients with very large or locally advanced kidney cancers, patients who are very sick due to severe kidney infection with haemodynamic instability, and unstable patients with life-threatening trauma to the kidneys and abdominal organs causing ongoing bleeding.

### For patients undergoing laparoscopic nephrectomy, what can they reasonably expect from such surgery? Are there any preparations they need to take before undergoing this surgery?

Laparoscopic radical nephrectomy is usually performed for patients with moderate to large kidney cancers (> 4cm in size). Such patients will



**Figure 3. Patient with laparoscopic incisions compared to conventional open kidney surgery scar.**

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**Figure 2. Laparoscopic kidney surgery being performed through small incisions made in the abdomen with specialised instruments and a video camera system.**

need preoperative blood tests and ECG to assess their fitness for surgery and general anaesthesia. The day before surgery, patients may be asked to take medications to cleanse their intestines and to fast for six hours before surgery.

For most experienced surgeons, laparoscopic nephrectomy usually takes two to four hours, depending on how technically challenging the local anatomy of the affected kidney is. The surgeon will mobilise the affected kidney free from its surrounding structures such as the overlying bowel, liver or spleen, and identify the ureter and the main blood vessels supplying the kidney, which are then divided using clips or staples to minimise bleeding. The affected kidney is then removed through a 6cm-7cm incision in the lower abdomen, and a surgical drain is left in the abdomen for one to two days to monitor for possible bleeding after the surgery.<sup>2</sup>

In most instances where surgery has proceeded smoothly, patients will be asked to walk on the first day after surgery, and may be discharged from hospital two to three days after surgery, after removal of the drain. They will usually be allowed to return to work and resume normal activities two weeks after surgery.

### How is kidney cancer detected?

Cancer of the kidney refers to the uncontrolled growth of abnormal cells within the kidneys. Early stage 1 renal cell cancers, defined as less than 7cm in size, are usually diagnosed incidentally, when patients undergo routine ultrasound or CT scans for health screening or other unrelated symptoms. In its early stages, kidney cancer usually does not cause any symptoms. As it progresses, it may cause visible blood in the urine, back pain and weight loss. While some renal cell

cancers are detected only after they have grown quite big, two-thirds of all kidney cancers are usually diagnosed before they spread (metastasise) to the other organs such as the lung and the bony skeleton, through the bloodstream or the lymph vessels. The diagnosis of cancerous change is made based on the presence of features on the CT or MRI scan of the kidneys. When these tumours are surgically removed, 20% of such tumours will turn out to be benign, and do not need further follow-up.<sup>3</sup>

### What is the best treatment for early stage kidney cancer?

Surgical removal of Stage 1 kidney tumours, whilst sparing the rest of the unaffected kidney, has now been established as the current international standard of care advocated by the European Association of Urology and American Urological Association.<sup>3,4</sup> Such nephron-sparing surgery (NSS) is now preferred to radical nephrectomy, where the entire kidney is removed. Several large-scale studies have found that patients who undergo nephron-sparing surgery live longer and have a significantly lower risk of developing hypertension, ischaemic heart disease or strokes over the long term compared to patients who had their entire kidney removed. In patients who have only one functioning kidney which undergoes cancerous change, NSS is the only means that offers such patients the possibility of avoiding renal failure and the need for lifelong dialysis.

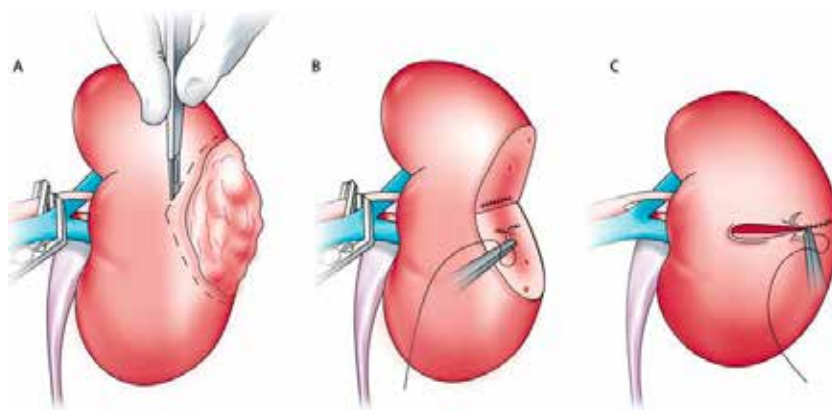
### Are there any risks associated with nephron-sparing surgery compared to removing the whole kidney?

Nephron-sparing surgery is a technically more difficult operation than simply removing the entire kidney. As it involves removing the tumour from the kidney, there may be bleeding from the raw surfaces of the remaining kidney defect, or urine leakage around the kidney, which may result in postoperative infection and prolonged hospital stays. Thankfully, such complications are not common, the large majority of patients have an uneventful recovery, and NSS cancer outcomes are similar to radical nephrectomy.

### How is nephron-sparing surgery performed?

Nephron-sparing surgery involves five main steps:

1. identify the tumour in the affected kidney
2. clamp the blood vessels supplying the kidney to minimise bleeding



**Figure 4.** Steps of nephron-sparing surgery for early kidney cancer.

3. remove the tumour with a 1cm rim of healthy tissue around it to avoid leaving cancer cells behind
4. close the defect left in the kidney tissue
5. remove the clamps from the blood vessels and check for bleeding before closing up **[Figure 4]**.

NSS may be performed through three approaches:

- traditional open surgery which involves a 15cm-20cm incision in the abdomen or flank
- laparoscopic surgery which is performed through small incisions in the abdomen
- robotic surgery using the da Vinci® surgical robot to remove the tumour and sew up the resulting defect in the affected kidney.

### Can nephron-sparing surgery be safely performed using a minimally invasive approach? How is robotic surgery changing the way surgeons perform this complex kind of laparoscopic surgery?

In experienced hands, nephron-sparing surgery (known as partial nephrectomy) can be safely performed using the laparoscopic approach. The surgical challenge faced by surgeons performing laparoscopic partial nephrectomy lies in minimising the clamp time on the vessels supplying the affected kidney. The longer the clamp time needed for excising the tumour and closing up the defect, the longer the kidney nephrons are starved of oxygen (known as warm ischaemia). Warm ischaemic clamp times of more than 30 minutes have been found to be associated with irreversible loss of kidney function.

Robotic surgery refers to the use of a robotic surgical platform known as the da Vinci® Surgical System to perform minimally invasive surgery through small incisions. This innovative technology comprises a surgical cart that is docked next to the operating table to small ports placed through incisions < 1cm in the patient's abdomen. Robotic wristed instruments are then passed through these small ports into the abdomen, which are controlled by the surgeon sitting at the operating console some distance away from the operating table. A binocular camera lens affords the surgeon a three-dimensional view of the operating field, which can be magnified up to 12 times. The surgeon then manipulates the camera lens and the various robotic instruments at the console using the hand controls and pedals. These specially designed wristed instruments afford the surgeon excellent precision and dexterity of surgical movement.

Using this technique, surgeons are able to see better, cut the tumour out and sew the kidney up much faster than if they used conventional laparoscopic instruments. As such, robotic partial nephrectomy results in much shorter ischaemia clamp time on the kidney vessels and fewer postoperative complications. Several published studies now validate the superior results achieved with the robotic approach over laparoscopic and open surgery.<sup>5,6</sup> The former is becoming widely adopted across the world

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as the preferred surgical approach where such technology is available.

### Is robotic nephron-sparing surgery safe for large and/or difficult tumours which require total removal?

With urologists increasingly adopting robotic nephron-sparing surgery as their preferred mode of treatment, many centres have reported impressive outcomes for robotic NSS in dealing with such challenging cancers.<sup>7</sup> Complex cancers previously deemed too difficult for NSS to be performed safely, are no longer daunting for experienced robotic surgeons as the repertoire of surgical techniques for handling such scenarios continues to evolve.

### What kind of outcomes can we expect with successful nephron-sparing surgery for early kidney cancers?

Stage 1 kidney cancers carry a very good prognosis if they are removed early without having positive margins. In such patients, there is an 85%-90% chance that at ten years after surgery, there will be no cancer recurrence. In healthy patients who have undergone successful nephron-sparing

surgery of the affected kidney, their long-term quality of health is almost comparable to a patient of similar age with two healthy kidneys. Moreover, there is a 20% chance that such suspected kidney cancers will turn out to be benign lesions. Kidney-sparing surgery has now become the standard of care for such early cancers. Where the surgical expertise is available, nephron-sparing surgery using the da Vinci® robot has been found to deliver the best surgical outcomes in terms of minimising blood loss, warm ischaemia clamp times, and postoperative complications such as urine leaks. In this age of technological advances, patients should no longer have to lose their entire kidneys for such early tumours, particularly if these turn out to be benign on final analysis. **MG**



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