Abstract

Background The objective of this study was to evaluate the clinical application value of in situ hypothermic perfusion of kidneys during retroperitoneal laparoscopic partial nephrectomy (RLPN).

Methods We used in situ hypothermic perfusion of kidneys during RLPN in 12 patients with renal tumour. Renal arterial-catheterisation for temporary balloon occlusion of renal artery was used. Hypothermic ischaemia was achieved by continuous perfusion of Ringer’s solution at 4°C through the renal artery. The collecting system was repaired by 4/0 Dixon and renal reconstruction was performed by 1/0 Dixon. We compared data between the RLPN group and open partial nephrectomy (OPN) group.

Results All RLPN operations were successfully completed. Ten of their pathological results were renal cell carcinoma, while two were reninoma and harmatoma respectively. Entry to the collecting system in two patients was repaired intraoperatively. No additional vascular repair was done. There were no significant postoperative complications. The renal function of the kidney was well preserved postoperatively. Neither local recurrence nor distant metastasis was found during the follow-up. There was a statistically significant difference in mean operative time and mean hypothermic ischaemia time between two groups. No difference was noted in mean tumour diameter, intraoperative blood loss, and preoperative and postoperative creatinine clearance rate.

Conclusions The technique of incorporating hypothermic ischaemia via arterial perfusion into RLPN is feasible and safe, which expands the armamentarium of the urologist with the help of radiologists. It is of high clinical applied value, especially for the more complex nephron-sparing surgery.

Keywords Nephron-sparing surgery · In situ hypothermic perfusion · Laparoscopy · Kidney neoplasms

Introduction

Due to encouraging reports about local tumor recurrence and overall survival in nephron sparing surgery (NSS), there is a trend toward more aggressive NSS than radical nephrectomy [1]. However, ischaemia/reperfusion injury (IRI) to the renal parenchyma is one of the major concerns after NSS. Renal function appears to have a high impact on non-cancer-related mortality [2]. Especially when applying NSS to a growing number of patients with a considerably high prevalence of preoperative latent or apparent chronic renal insufficiency, postoperative renal function has to be taken into serious account when considering any treatment [3]. Hypothermia is commonly used to protect the kidneys from IRI. However, intracorporeal renal cooling is technically difficult in laparoscopic surgery. There is an urgent need for a reliable, simple, quick technique to achieve renal hypothermia during retroperitoneoscopic partial nephrectomy (LPN) [4].

In situ perfusion of central organs enables organ-conserving operations to be performed under total ischaemia with almost complete protection of renal function [5] and has been successfully applied in open NSS [6]. Laparoscopic surgery itself and especially reconstructive surgery is challenging. Since the retroperitoneal laparoscopic approach has become the most frequently selected approach among urologists in China, we present our experience with LPN with in situ hypothermic perfusion of kidneys and evaluate the clinical application value of the technique.
Methods

We have successfully adopted this technique for our open partial nephrectomy (OPN) from February 2003 to February 2005. The clinical data of 19 cases were reviewed retrospectively. On the basis of the previous experience, we used in situ hypothermic perfusion of kidneys during LPN in 12 patients with renal tumour from March 2009 to March 2011 in PeKing Union Medical College Hospital (see Table 1). One surgeon (Dr Han Zhong Li) performed all the procedures. All patients provided informed written consent, including information on procedural benefits and risks. The indication for cold ischaemia was the anticipation of a long ischaemia time (i.e., central infiltrating or hilar tumours). Mean tumour diameter was 3.4 cm (range 2.3–5.6 cm) (Fig. 1). Metastatic evaluations were all negative. Interventional radiologists were consulted preoperatively. Informed consent was obtained for the procedures of arterial balloon catheterisation and LPN.

On the morning of the operative day, the patient was sent to the Department of Medical Imaging and a balloon angiocatheter was passed into the main renal artery through a femoral puncture. Renal arterial catheterisation for temporary balloon occlusion of renal artery was used. We used a 5 Fr. balloon catheter (AI07126, Arrow International Inc., USA) as a perfusion catheter. The soft rubber of the balloon at the tip of the catheter enables a secure fixation in the artery. Continuous renal artery perfusion of 4°C Ringer’s solution began through the catheter under high pressure (50–70 cm H2O) to achieve low temperature in situ kidney. The steady-state perfusion rate was about 25 ml/min. The balloon of the catheter was inflated with 0.6–1 ml saline to block the renal artery temporarily 10 min later, just before a partial nephrectomy was carried out (Fig. 2). The kidney tumour was removed by partial nephrectomy with in situ hypothermic perfusion. The perfusate was drained into the circulatory system via the renal vein. The water within the balloon was extracted once suture repair of the collecting system and renal parenchymal repair was accomplished.

Tumour excision was performed in a bloodless field with a biopsy taken from the tumour bed. The collecting system was repaired by 4/0 Dixon and renal reconstruction was performed by 1/0 Dixon. We sometimes use haemostasis gauze on top of the raw surface of kidney. Estimated creatinine clearance was calculated with Cockcroft Gault formula. The balloon was deflated and the renal artery perfusion was terminated after obtaining adequate haemostasis. Postoperative specimen evaluation was carried out by one pathologist. Renal function was assessed using the standard Cockcroft formula: creatinine clearance time (CCT)males=\((140–\text{age})\times\text{body weight}/(\text{Pcr}\times72)\); CCTfemale=\((140–\text{age})\times\text{body weight}/(\text{Pcr}\times85)\).

We compared all the data of the two groups. Statistical analysis was performed using SPSS commercial software. A paired t-test was performed for parameter comparisons with statistical significance considered at \(p<0.05\).

Results

All operations were successfully completed without conversion to open surgery. Table 2 lists the data of all the