RESEARCH ARTICLE

Application of Laparospic Ultrasonography in Surgery of Small Renal Cell Carcinoma

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Abstract

Purpose: : To assess the clinic value of application of laparospic ultrasonography (LU) in partial nephrectomy of small renal cell carcinoma. Materials and Methods: From 2007 to 2011, 28 small renal cell carcinoma patients in ou clinic underwent laparoscopic partial nephrectomy with LU. For comparison with preoperative conventional ultrasound and CT, we collected ultrasonic performance of the affected side kidney, renal tumor location, size, echo change, blood supply situation and the relationship with the surrounding tissue. Results: LU could more clearly show the tumor interior structure and blood supply, as well as the relationship with the surrounding tissue. It also can provided doctor assistance with real-time tumor resection, reducing operative complications. Conclusions: LU can clearly show tumor internal structure and blood supply, which is helpful for explicit diagnosis. Moreover, it supplies accurate information for surgeons and assists surgery. Therefore LU has an important guiding value in partial nephrectomy for small renal cell carcinoma.

Keywords: Laparoscopic ultrasonography - small renal cell carcinoma - laparoscopic partial nephrectomy

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Introduction

In recent years, with the development of the ultrasound, CT imaging examination and the enhancement of the attention to the physical examination, the detective rate of the accidental kidney cancer gradually elevates and the tumor volume also becomes smaller (Gardner et al., 2011; Israel and Sliverman, 2011; Kang and Chandarana, 2012). Most scholars define the maximum diameter < 4 cm renal tumors as small renal cell carcinoma (SRCC) (Sanchez et al., 2009). Laparoscopicpartial nephrectomy (LPN) has gradually replaced open surgery, which becomes the standard surgical treatment to SRCC (Andre et al., 2011; Matsuda et al., 2013). With the application of laparoscopic techniques in the urinary system, LU has also gradually valued by the clinical and ultrasonic doctors. In this paper, we took LUS assisted in 28 small renal cell carcinoma patients who received Laparoscopicpartial nephrectomy into application, to discuss the clinic value of diagnosis and surgical treatment.

Materials and Methods

General data

During 2007 to 2011, 28 cases of small renal cell carcinoma were collected, male 20 cases, female 8 cases, aged 29-81 years old, an average of 53.6 years old; left side 18 cases, right side 10 cases. Tumor diameter 1.5 ~ 3.7 cm, an average of 2.4 cm, T1 stage 27 cases, T2 1 patient. All the patients received transabdominal ultrasound, CT imaging examination before the operation, excluding tumor metastasis and tumor emboli in renal vein or the inferior vena cava. Their renal function were all normal.

Inspection instruments

We adopt Aloka 4000 colored ultrasonic diagnostic instrument, UST-5536-7.5 special LUS probe, frequency 4.0 ~ 10.0 MHz, lateral scanning probe of linear array produces rectangular images. We use BK Pro Focus Ultraview ultrasound diagnostic instrument, 8666-RF special LUS probe, frequency 5.0 ~ 10.0 MHz, lateral scanning probe of convex array produces wide fan images. Both probes can pass the 10 mm tocar, s channel. Whole body of probes can be disinfected by low-temperature plasma method.

Operation method

Two ultrasonic doctors achieve LUS together. We collected all the imaging data of patients before surgery. A doctor brushed hands conventionally, wore surgical clothes and operated laparoscopic probe. Another doctor controlled the ultrasonic instrument. When the surgeon fully free the tissue surrounding the kidney, ultrasonic doctors used LUS probe to do the exploration. The exploration includes two parts: first detect the position, depth, size and internal blood supply of renal tumors, and

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also assist the performers to confirm the excision scope and depth. And then LUS was used to completely inspect the artery and vein condition of renal hilum, in order to provide detailed materials including affiliated blood vessel and arterial branches. The whole time for exploration is about 5 ~ 10 min. Ultrasonic doctors quickly took the doppler probe to scan ischemia condition in operation area when performers closed the renal artery, about 1 min. Laparoscopicpartial nephrectomy would be done after confirming no obvious artery blood supply. After tumor resection and hemostasis, we reopened the renal artery, using laparoscopic ultrasound probe to observe blood recovery of the surgical area.

Results

General materials

The 28 cases were all successfully completed, no transit to open surgery. Operation time 105 min (71 ~ 140 min), the average renal artery blocking time is 28 min (22 ~ 50 min). Postoperative pathological results: renal cell carcinoma 25 cases, transparent papillary renal cell carcinoma 1 case, multilocular cystic renal cell carcinoma 2 cases. All the 28 cases received postoperative periodic review, follow-up of 3 ~ 43 months, an average of 16 months, no tumor recurrence.

Images comparison between conventional ultrasound and LU

Conventional ultrasound showed renal tumors of high echo 9 cases, low echo 13 cases, mixed echo 4 cases, cystic lesion 2 cases.18 cases of renal tumors boundary were clear, and 10 cases of renal tumors boundary were not very clear or not clear.

Color doppler showed: palpable blood flow 17 cases, no obvious blood flow 11 cases. LUS showed: renal tumors echo is more clear than the transabdominal ultrasound, including high echo 6 cases, low echo 10 cases, mixed echo (low echo with no echo) 10 cases, pouch or solid change 2 cases. All the 28 patients showed clear boundary.26 solid tumor cases showed peripheral hypoechoic, 2 cases of cystic lesion was no obvious low echo but clear boundary. Color doppler showed: The signals of obvious blood flow can be detected in all the 28 patients, tumors, in which 26 cases can be seen cycle blood flow surrounding low echo halo, 2 cystic neoplasm cases were no cycle blood flow surrounding them, but the thickening place of bursa wall and sac division can be detected the arterial blood signals (Table 1).

Images comparison between CT and LU

CT scan showed that 21 in 28 cases presented low density shadow, and it can be obviously improved after enhancement.5 cases showed uneven density shadow, also uneven after enhancement. 2 cases presented inhomogeneous thick-walled cystic lesion, edge unclear. After enhancement the nidus presented rather obvious aggrandizement, which appeared inhomogeneous thick-walled ring, and intradural mild aggrandizement. So it is considered as the cyst with concurrent infection and to be identified with cystadenocarcinoma. LUS showed:

Table 1. Comparing the Feature between Transabdominal Ultrasound and Laparoscopic Ultrasound

Ultrasound findings	Transabdominal ultrasound	Intraoperative Laparoscopic Ultrasound
Boundary		
Clear	18	28
Not Clear	10	0
Peripheral Hypoechoic Halo		
Yes	8	26
No	20	2
Internal Echo		
High Echo	9	6
Low Echo	13	10
Mixed Echo	4	10
Cystic Lesion	2	2
Blood Supply Level		
No Blood Supply	11	0
Poor Blood Supply	12	7
Multiple Blood Supply	5	21
Surround Blood Flow or Not		
yes	7	26
no	21	2

16 cases of solid echo.10 cases of mixed echo, in which irregular no echo can be seen, confirmed by operation as liquefied necrosis or bleeding.2 cases of solid lumps. Blood flow signals can be seen in all the 28 cases of cancer. Just 2 cases among them, arterial blood can be detected in the thickening place of bursa wall and sac division, RI0.7, considered the possibility of kidney cancer during the operation.

Other

By laparoscopic doppler ultrasound, we found blood supply to the tumor area from accessory renal arteries, so as to avoid the intraoperative hemorrhage.

Discussion

In 1982, Fukuda et al. (1982) were the first doctors to apply ultrasonic technology into laparoscopic surgery to make assessment of liver tumors. Since then, LUS has been gradually applied to laparoscopic surgery, in order to reduce the risk of surgery and complications (Kang et al., 2012; Gwinn et al., 2013; Hotston and Keeley, 2013).

LUS technology is a intraoperative scanning technology used under laparoscope. For LUS probe directly located on viscera surface, it avoids the interference of abdominal organizations, and eliminates the interference problems of traditional transabdominal ultrasound. So compared to conventional ultrasound, LUS has higher resolution and detection rate, and give a better show of tumor internal situation (Yu et al., 2010). 28 cases of conventional ultrasound showed renal tumors clear boundary 18 cases, tumor boundary not clear 10 cases. Echogenicity showed low echo 13 cases, high echo 9 cases, mixed (low echo with a little no echo) 4 cases, cystic lesion 2 cases. While in LUS group all the cases indicates a clear border. Echogenicity showed low echo 10 cases, high echo 6 cases, mixed echo 10 cases

which were confirmed as liquefied necrosis and bleeding during the operation. Through LUS 2 cases of patients with cystic lesion were verified as pouch or solid change, thickening wall, much space in sac division. So LUS can more clearly show the tumor boundary. It is obviously better than traditional transabdominal ultrasound on the demonstration of tumor interior slight structure, especially tumor interior small liquefication necrosis area. Secondly, the conventional ultrasound is hard to detect low-speed flow signals, so sometimes it is more difficult to definitude diagnosis SRCC only depending on the echo nature. The conventional ultrasound was taken into application in this group of 28 patients, only 17 cases can be seen different amount of annular or wire rod colored blood flow in peripheral and internal of the tumors. 11 cases can not be seen detectable and significant blood flow signals, in which 5 cases were hyperechoic and difficult to identify with renal hamartoma. 2 cystic lesion cases showed no echo within a little space, no obvious blood flow, and were difficult to identify with cyst with separation. But intraoperative LUS detection showed:obvious blood flow signals were all detected in the tumors of 28 patients. Especailly in 2 cystic lesion cases, rather obvious artery spectrum can be explored in the thickening place of bursa wall and sac division. Thus, LUS is more available than traditional transabdominal ultrasound on the exploration of blood flow situation of SRCC. So it can provide reliable basis for diagnosis of benign tumor or malignancy (Table 1).

CT plays an important role in diagnosis of SRCC, especially multilayer spiral CT which has high accuracy to diagnose early renal cell carcinoma and can display tumor of diameter of 0.5 ~ 1 cm. 28 patients were all received preoperative CT examination, 26 patients with a diagnosis of SRCC. 21 cases presented low density shadow, and it can be obviously improved after enhancement. 5 cases showed uneven density shadow, also uneven after enhancement. However, there are certain limitations on the diagnosis of renal tumors for CT. For example: 1) renal cell carcinoma is generally not required to identify with simple cyst, but CT is often difficult to distinguish a complex renal cyst accompanied with bleeding or infection; 2) CT easily misdiagnoses angiomyolipomas which contains less fat ingredient as kidney cancer; 3) when blood supply of the tumor is low or internal cystic changes make blood sinus relatively reduce, it is difficult to identify with small benign renal tumors (Quaia et al., 2008; Hindman et al., 2012; Kang et al., 2012; Rebonato et al., 2012). In this group 2 cases presented inhomogeneous thick-walled cystic lesion, edge unclear. After enhancement the nidus presented rather obvious aggrandizement, which appeared inhomogeneous thick-walled ring, and intradural mild aggrandizement. So it is considered as the cyst with concurrent infection and to be identified with cystadenocarcinoma. And ultrasound, especially LUS is more sensitive than CT on the diagnosis of tumors conbined with internal cystic changes. The LUS exploration showed a mixed echo (low echo with a little no echo) which was confirmed as liquefied necrosis and bleeding of 10 cases, better than CT. During the operation LUS exploration for 2 cystic tumors cases showed cystic and solid tumor, irregular thickening wall, intracapsular grid separator. Colored doppler indicated:arterial blood can be detected in the thickening place of bursa wall and sac division, RI0.7, considered the possibility of kidney cancer during the operation. Postoperative pathological reported multilocular cystic renal cell carcinoma.

There is no histological envelope for renal cell carcinoma, but often the presence of pseudocapsule. Pseudocapsule is the membranous structure formed because of expansive growth of renal cell carcinoma which compresses the surrounding renal parenchyma.

Pathologically, the composition of pseudocapsule is mainly fibrous tissue and compressive intensive renal parenchyma. Pseudocapsule is the key feature of renal cell carcinoma, which is helpful for the diagnosis of renal cell carcinoma. The presence of pseudocapsule of small renal cell carcinoma indicates clinically partial nephrectomy or tumor enucleation (Larygakis and Guzzo, 2012; Taili et al., 2012). The complete resection of pseudocapsule indicates the whole resection of tumor and the better prognosis. The ultrasound of pseudocapsule showed high or low echo boundary surrounding the tumors, peripheral half ring or ring, short arc, line colored flow signals (Liu et al., 2010). Ascenti (Ascenti et al., 2004) considered peripheral hypoechoic halo as the diagnostic criteria for pseudocapsule. The traditional transabdominal ultrasound on the diagnosis of tumor pseudocapsule has limitations. The smaller the tumor is, the lower the rate of showing false envelope is. In this group conventional ultrasound showed clear boundary 18 cases, which can be explored hypoechoic halo 8 cases (8/28, 28%); 10 cases (10/28, 35%) of renal tumor boundary were not clear. LUS presented: all the tumor boundaries of 28 cases were clear. 26 patients with solid tumors can be explored peripheral hypoechoic halo and visible circle blood flow. Hypoechoic halo was confirmed as tumor pseudocapsule after the operation. Thus in the aspect of showing the pseudocapsule of small renal cell carcinoma, LUS is more superior than transabdominal ultrasound. It is of great help for the diagnosis of renal cell carcinoma and helping the surgeon completely to resect the tumor.

The most challenging skills in the laparoscopic operation are the vascular discrimination and separation. Especially there is more risk when the renal hilum blood vessel changes (Perlmutter et al., 2009). LUS can do the intraoperative exploration of the renal hilum vessels for real-time, to help the doctors fast and accurately locate the renal arteries and veins, which also can excluse the blood vessel variation. Through LUS, 5 cases in the group can still be explored artery blood flow in the tumor or surrounding the renal parenchyma after occlusion of renal arteries. And then, we expanded the LUS scanning scope, confirmed the presence of variant arteries, thus avoided the major bleeding during the surgery, increased the safety of operation, which got recognition by operation doctors. With the development of laparoscopic technique, partial resection of renal tumors is gradually taken into extensive application. Because LUS has small volume, can provide real-time images, through which the tumor location, size, range, quality and blood supply can be accurately evaluated, providing important information for

doctors and making up the insufficiency of laparoscopic operation, so it will plays an more and more important role in laparoscopic partial nephrectomy.

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