A novel technique of Nephron Sparing Surgery using HABIB 4X bipolar radio-frequency device: preliminary results

M. Wyczó3kowski¹, K. Juszczak¹2, M. Rzepecki¹, W. Klima¹,
T. Drewniak¹, P. Maciukiewicz¹
¹ Department of Urology, Memorial Rydygier Hospital, Cracow, Poland
² Department of Pathophysiology, Medical College Jagiellonian University, Cracow, Poland

Abstract

Introduction & Purpose: The Nephron Sparing Surgery (NSS) created the necessity of unique techniques development which facilitate the optimal hemostasis of renal parenchyma. In this study the usefulness of HABIB 4X device in NSS was evaluated.

Material & Methods: The open NSS was performed in twelve patients divided into 2 groups: I (n=4) – NSS + HABIB 4X; II (n=8) – NSS + bleeding within the site of tumour controlled with the HABIB 4X, without haemostatic suture ligation.

Results: In all patients from group I the prolonged drainage and wound healing obtained. Additionally, 2 of them developed the urine cutaneo-kidney fistula. The patients from group II revealed no complications and proper wound healing.

Conclusions: Our results showed that open NSS using the HABIB 4X device is related to extensive kidney parenchyma damage and high risk of urine cutaneo-kidney fistula development. The combination of open NSS with standard excision of tumour and haemostasis of the site of resected tumour controlled with the HABIB 4X device provides the rapid bleeding control with supplementary oncological margin.

Key words: nephron sparing surgery, kidney tumour, Habib 4X device.
Introduction

The rapid development of imaging techniques, such as ultrasound and computer tomography induced an increase of number of incidentally diagnosed kidney tumours, especially renal cell carcinomas (RCCs). These tumours are mostly smaller and of lower stage [1]. Therefore, nowadays an increment of NSS (Nephron Sparing Surgery) procedures performed in an open or laparoscopic way is observed [2, 3]. The tendency for organ sparing treatment in case of kidney tumours entailed the necessity of unique techniques development which facilitate the optimal hemostasis of renal parenchyma during such procedures. Prolonged ischemia leads to irreversible damage of nephrons and secondarily to renal dysfunction. In most cases of NSS the renal hilum is clamped causing renal hemodynamic deterioration. Thus, the optimal novel technology is needed to achieve good haemostatic effect without hilar clamping while performing NSS.

The HABIB 4X bipolar radio-frequency device created the novel way of avascular resection of kidney tumours in NSS. The HABIB 4X consists of a 2 x 2 array of needles arranged in a rectangle, uses bipolar radiofrequency (RF) energy for kidney’s parenchyma coagulation in seconds. The device is connected to a special generator which produces the RF power. The generator allows measurement of the generator output, tissue impedance, temperature and time. The RF power setting can be modified according to user experience and the thermal requirement of the individual tissue types [4].

Purpose

The goal of this study was to determine the outcomes of HABIB 4X bipolar radio-frequency device in open Nephron Sparing Surgery procedure in patients with kidney tumours.

Material and Methods

The study was performed in group of twelve patients with kidney tumour qualified to open Nephron Sparing Surgery (NSS) procedure. Mean age was 50 years (range 34–73). Among the twelve kidney tumours removed by NSS procedure, 4 tumours were localised in upper pool, 2 in central area of kidney and 6 in lower pool. Mean size of the tumour was 32 mm in greatest dimension (range 15-55 mm).

The patients were divided into two groups, as follow:

a) Group I (n=4): the patients underwent the open NSS using the handheld HABIB 4X based on the thermoresection leading to an avascular plane circumferentially around the tumour with an adequate margin, and after the complete thermocoagulation a surgical scissors was used to excise the tumour,

b) Group II (n=8): the patients underwent the open NSS with standard excision of tumour with proper resection margin using surgical scissors. Any bleeding within the site of resected tumour was controlled with the handheld HABIB 4X device without haemostatic suture ligation (Fig.1).
We evaluated the operative data (operative and warm ischemic time), intraoperative complications, significant anaemia which required the blood transfusion. Histopathological estimation of resected specimens were evaluated for tumor size and margin status. All patients were followed postoperatively for complications.

**Results**

Mean hospitalisation time was 16 days (range: 6–37 days). Mean operative and warm ischemia time was 90 minutes (range: 58–240 min.) and 7.5 minutes (range: 0-12 min.), respectively. The four patients after NSS required the blood transfusion in postoperative period because of anaemia (3 patients – 2 units, 1 patient – 4 units of blood). The histopathological estimation revealed no positive margins in the removed samples.

Our observations revealed that in all four patients after open NSS using the handheld HABIB 4X device ablation without haemostatic suture ligation revealed no complications and proper wound healing till 8th postoperative day (group I).

**Discussion**

In the last decade, the increased prevalence of kidney tumours led to the development and preference for nephron-sparing surgery (NSS) to preserve renal function. Especially, for small incidentally discovered tumours the minimal invasive NSS procedures are advocated [5]. The ablative techniques have some potential advantages, such as decreased morbidity, shorter hospitalisation, an earlier return to normal activities, preservation of renal function, potentially lower costs, and the ability to treat patients who are poor surgical risks. Thus, many ablative techniques of kidney tumour, such as cryoablation, radiofrequency ablation (RFA), high-intensity focused ultrasound (HIFU), microwave thermotherapy (MT), laser interstitial thermotherapy (LITT), chemoablation with or without radiofrequency, and radiosurgery were described [6].

In the literature there are many papers concerning the outcomes of ablative technique using the HABIB 4X bipolar radio-frequency device in NSS. RFA of kidney tumour acts by converting the radiofrequency waves to heat, resulting in thermal tissue damage. High-frequency current flows from the inserted needle electrode to target tumour result in ionic agitation and heat-producing molecular friction, denaturation of proteins, and cell membrane disintegration. These changes take from 4 to 6 minutes at temperatures >50°C and occur almost immediately above 60°C. The vaporization of tissue, resulting in gas formation and inefficient creation of RF lesion mostly occurs in temperature greater than 105°C. Therefore, the RFA is most effective in 50 - 100°C range throughout the tumour [6,7]. Rehman et al. study revealed that bipolar RFA decreases the risk of accidental burns associated with monopolar RFA [8]. RFA of kidney tumours can be performed percutaneously, laparoscopically or in open surgery. The published studies describe the usage of the HABIB 4X device in two ways. Primarily, the RFA creates an plane circumferentially around the tumour with an adequate margin with following tumour extirpation [9, 10]. Secondly, the device’s needles are placed within and also sometimes beyond the tumour with following ablated tissue resection [5].

We performed twelve open NSS procedures using...
HABIB 4X device in patients with kidney tumours. The first 4 patients underwent the RFA to produce an avascular plane after insertion of Habib 4X needles circumferentially around the tumour following the excision of ablated kidney tissue with the tumour. Prolonged drainage (till 9th postoperative day), wound healing and urine fistula creation point that, this way of RFA may lead to expanded damage of kidney parenchyma, and pyelo-caycaleal complex, especially in case of tumours localised centrally or closed to kidney hilum. There is no control on the deepness of needle insertion. Thus, the distance between the wall of pyelo-caycaleal complex and the end of the needle is not estimated, and probably the area of RF ablated tissue involves the wall of pyelo-caycaleal complex leading to its damage and perforation and secondary, to the urine cutaneo-kidney fistula development.

Due to our remarks mentioned above, we modified the RFA technique in NSS. The following 8 patients underwent the open NSS with standard excision of tumour with proper resection margin using surgical scissors. Any bleeding within the site of resected tumour was controlled with the HABIB 4X device without haemostatic suture ligation (Fig.1). This group of patients revealed no complications and proper wound healing till 8th postoperative day. Such a modification enables better control of RFA of bleeding areas of tumour bed. The needles can be inserted in safety distance from the pyelo-caycaleal complex walls and prevent the urine cutaneo-kidney fistula occurrence.

The RFA technique seems to be more suitable for patients with advanced age and comorbidity, multiple bilateral RCC (e.g. in Von Hippel - Lindau disease), and RCC in a solitary kidney, compared to open NSS. Tumours greater than 5cm, hilar and central localized tumours are not suitable for RFA. The only absolute contraindication is an irreversible coagulopathy. RFA has also been used in patients with intractable haematuria due to RCC and tumour recurrence in the nephrectomy bed [6].

Compared to open NSS with standard excision of the tumour, the RFA circumferentially around the tumour using HABIB 4X have some disadvantages. Mainly, the area of ablation is much more extensive, as well as the quantity of damaged (prior intact) renal parenchyma surrounding the tumour enclosed within avascular rim is much bigger (Fig. 2). The damage of surrounding tissue is caused by coagulative necrosis characterized by membrane disruption, protein denaturation, and vascular thrombosis [8].

Secondarily, the precise control of the distance between the pyelo-caycaleal complex walls and HABIB 4X needles tips is questionable. Our modification of thermoablation in NSS provides the more precise bleeding control within excised tumour bed with accompanying haemostatic suture ligation withdrawn, as well as the decrement of the ablated tissue area. This manoeuvre enables the reduction of normal kidney parenchyma damage caused by haemostatic sutures (Fig. 3), what becomes more important in case of patient with only one sufficient kidney or with chronic renal insufficiency.

Additionally, our modification of RFA using HABIB 4X seems to be useful for NSS in case of bigger tumours greater than 5cm, as well as hilar and central localized tumours, especially for the optimal
Some published data concerning the neoplasms recurrence after RFA therapy, using different types of RF devices, raise concerns about the oncological efficacy of this technique and makes a cogent argument for the need for further refinements and close follow-up [6]. Michaels et al. [11] treated 15 patients with a total of 20 tumors with RFA through an open surgical approach immediately before partial nephrectomy. The pathological estimation of specimens obtained that the RFA did not result in total tumor destruction. Also Rendon et al. [12] have found the viable residual tumour (approximately 5% of the tumour volume) in partial or radical nephrectomy specimens of patients treated with previous RFA. Likewise Brausi et al. [13] detected neoplasms cells in the bed of tumour specimens in patients treated with open RFA immediately before partial or radical nephrectomy. Therefore Aron et al. [6] recommend scheduled needle biopsy of the tumour bed to confirm complete tumour destruction after RFA procedure.

Additionally, the influence of RFA on renal function was established by Aron et al. [6]. In 68 patients with renal tumour after percutaneously RFA the renal insufficiency occurred in 26%.

All data mentioned above indicate that the elaborated distinct maneuver using RFA device can become the optional technique for local hemostasis control, reduction of kidney parenchyma damage and post-operative complication in nephron sparing surgery, especially in for patients with limited kidney function, multifocal tumours, as well as centrally and hilar tumours.

**Conclusions**

Our results showed that open nephron sparing surgery using the handheld HABIB 4X device based on the thermoresection leading to an avascular plane circumferentially around the tumour with an adequate margin is related to extensive kidney parenchyma damage and a high risk of urine cutaneo-kidney fistula development.

The combination of open nephron sparing surgery with standard excision of tumour with haemostasis of the site of resected tumour controlled with the handheld HABIB 4X device provides the rapid bleeding control with supplementary oncological margin, which seems to be more precise in comparison to the NSS technique with haemostatic suture ligation. The time to achieve the proper haemostasis is shorter in case of HABIB 4X device and provide the withdrawal of kidney hilar clamping.

**References**


**Conflict of interest:** None declared.