Percutaneous Cryoablation of Solid Renal Masses

Thesis for Complete Fulfilment of Master degree (Msc) in radiodiagnosis Submitted by

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2009

Abstract

Alternatives include nephron-sparing surgical resection, laparoscopic partial nephrectomy, laparoscopic cryoablation, percutaneous radiofrequency (RF) ablation, and percutaneous cryoablation. Although investigators have reported the successful treatment of solid renal tumors with percutaneous RF ablation ***[Farrell&Gervais; 2003]***.

Intraoperative approaches and percutaneous approaches with MR imaging guidance have been described ***[Cestari & Moon; 2004]***.

Key word;

Percutaneous Cryoablation of Solid Renal Masses

Acknowledgements

First of all, I'm grateful to Allah for guiding me to complete this work.

I would like to express my gratitude to all those who gave me the possibility to complete this essay.

I wish to express my warm and sincere thanks to my supervisor ***Prof. Amr Abd El-Fattah Nasef*** for his understanding, encouraging and personal guidance.

I am deeply grateful to ***Dr. Ayman Ismail Kamel and Dr. Ahmed Abd El-Samie Mahmoud*** for their constructive criticism and excellent advice during the preparation of this essay.

I wish to thank my family and my sisters for their help and support.

And most importantly I wish to thank my parents for their love, support and patience. To them I dedicate this work.

Introduction

Percutaneous management of solid renal tumors with radiofrequency ablation and cryoablation has been established as a technically feasible treatment in selected patients allowing for relatively short-term follow-up. ***(Patr´icia JM, 2008)***

These percutaneous techniques are effective in tumor management. The success rate is approximately about 90-100% for radiofrequency ablation and 92-100% for cryoablation. ***(Hendy GN, 2006)***

With increased number of incidentally discovered renal tumors in the general population and the uncertain clinical significance of small renal tumors ***(Frank I, 2003)***, efforts have been directed toward the use of methods that are less invasive than radical nephrectomy for the treatment of small tumors. Alternatives include nephron-sparing surgical resection, laparoscopic partial nephrectomy, laparoscopic cryoablation, percutaneous radiofrequency (RF) ablation, and percutaneous cryoablation.

Although investigators have reported the successful treatment of solid renal tumors with percutaneous RF ablation ***(Varkarakis IM,2005)*** it has two important limitations. First, tumors larger than 3 cm in diameter require multiple precisely targeted and overlapped RF ablations. Second, the RF ablation zone cannot be monitored effectively with computed tomography (CT) or ultrasonography (US). Accurate monitoring is critical importance for the treatment of tumors in the renal pelvis, ureter, or colon. Cryoablation expands the indications for percutaneous renal ablation because larger tumors can be treated with simultaneous operation of multiple cryoprobes, and the ablation margin can be accurately monitored with CT.

A common theme in the radiofrequency ablation literature is difficulty managing larger tumors, typically defined as larger than 3 cm in diameter. Such large tumors often necessitate additional radiofrequency ablation sessions, and technical success rates are lower than those reported for smaller tumors ***(Trotti A, 2003)*** Although the published findings on percutaneous cryoablation are limited, authors ***(Salem R, 2002)*** have tended to treat patients with smaller tumors, usually less than 5 cm, even though cryoablation technology allows simultaneous operation of several cryoprobes to generate large confluent ice balls for tumor treatment.

Given that 80% of surgically resected renal tumors are larger than 3 cm, ***(Gray B 2001)***; it is clear that percutaneous ablation techniques must evolve to allow management of these larger tumors if we are to offer this alternative to a greater number of appropriate patients. Such patients are typically considered at high risk for surgery because of previous renal resection or advanced comorbid medical conditions. For this reason, we reviewed our experience in the percutaneous cryoablative management of renal tumors measuring 3 cm or more in diameter.

On the basis of cryoablation experiences from other centers and our own intraoperative liver cryoablation experience, we incorporated this procedure into our clinical practice. The purpose of our study was to retrospectively determine the safety and effectiveness of percutaneous cryoablation, monitored with CT, for the treatment of solid renal masses ***(Gill IS, 2005)***.

Percutaneous cryoablation with US guidance and CT monitoring is safe and effective for the treatment of solid renal tumors. Longer follow-up should provide further proof of the effectiveness of this technique.

Aim of work

The aim of this study is to To retrospectively determine the safety and effectiveness of percutaneous cryoablation, monitored with computed tomography (CT), for the treatment of solid renal masses.

List of figures

List of tables

Table of contents

GROSS ANATOMY

OF

THE KIDNEY

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The urinary system consists of two kidneys, two ureters, the urinary bladder, and the urethra. Tubules in the kidneys are intertwined with vascular networks of the circulatory system to enable the production of urine **(fig. 1)** ***[Van De Graaff et al., 2001]***.

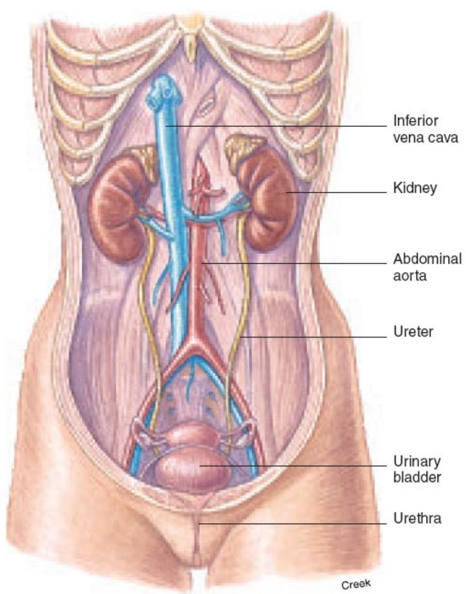

Figure 1 The organs of the urinary system are the two kidneys, two ureters, urinary bladder, and urethra **[Quoted from: Van De Graaff, 2001].**

The kidneys are two bean-shaped organs lying on the retroperitoneal space on either side of the vertebral column in the most posterior part of the abdominal cavity. They lie posterior to the lower portion of the liver on the right and posterior to the lower spleen on the left. The lower ribcage thus forms a protective enclosure for kidneys ***[Bontrager and Lampignano, 2005]***.

The kidneys are reddish brown in colour and positioned against the posterior wall of the abdominal cavity between the levels of the twelfth thoracic and the third lumbar vertebrae. The lateral border of each kidney is convex, whereas the medial border is strongly concave. The right kidney is usually 1.5 to 2.0 cm lower than the left because of the large area occupied by the liver on the right side ***[Van De Graaff et al., 2001]***.

The average adult kidney is fairly small, weighting about 150 grams. The measurements are 10 to 12 cm long, 5 to 7.5 cm wide, and 2.5 cm thick. The left kidney is a little longer but narrower than the right ***[Bontrager and Lampignano, 2005]***.

Gross Structure of the Kidney: (fig. 2)

The kidney has a thin capsule, easily removed, composed of collagen-rich tissue with some elastic and smooth muscle fibers. In renal disease it may become adherent ***[Standring et al., 2005]***.

A coronal section of the kidney shows two distinct regions and a major cavity. The outer renal cortex, in contact with the renal capsule, is reddish brown and granular in appearance because of its many capillaries. The deeper renal medulla is darker, and the presence of microscopic tubules and blood vessels gives it a striped appearance ***[Van De Graaff et al., 2001]***.

Extensions of the cortex centrally as columns (of Bertin) separate the medulla into pyramids whose apices, jutting into the calyces, are called the papillae ***[Ryan et al., 2004]***.

The renal pyramids are primarily a collection of tubules that converge at an opening at the renal papilla (apex) and drain into the minor calyx. Calyces appear as hollowed, flattened tubes. Minor calyces unite to form two to three major calyces. The major calyces unite to form the renal pelvis, which appears in the shape of a larger flattened funnel ***[Bontrager and Lampignano, 2005]***.

The hilum of the kidney lies medially, that of the left at L1 vertebral level and that of the right slightly lower at L1/L2 level, owing to the bulk of the liver above. At the hilum, the pelvis lies posteriorly, the vein anteriorly and the artery in between. The artery may branch early and a posterior arterial branch may enter the pelvis posterior the pelvis. Lymph vessels and nerves also enter at the hilum ***[Ryan et al., 2004]***.

The functional subunit of the kidney is the nephron and consists of a glomerulus in the cortex and a tubule in the medulla. This drains to a collecting duct which empties into the calyx at the tip of the medulla. The kidney has approximately 1 million nephrons ***[Ryan et al., 2004]***.

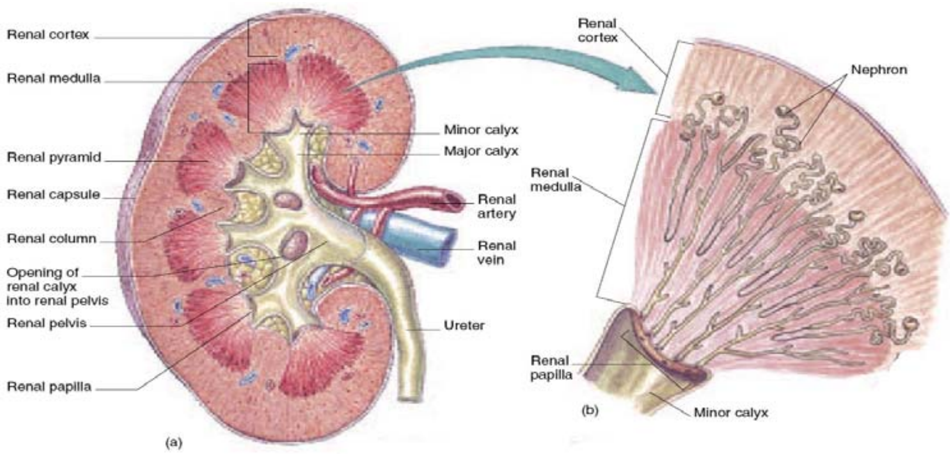

Figure 2 The internal structures of a kidney. **(a)** A coronal section showing the structure of the renal cortex, renal medulla, and renal pelvis. **(b)** A diagrammatic magnification of a renal pyramid to depict the renal tubules **[Quoted from: Van De Graaff *et al.*, 2001].**

<u>Vascular Supply and Lymphatic Drainage:</u> (fig. 3)

Large blood vessels are needed to handle the vast quantities of blood flowing through the kidneys daily. At rest, about 25% of the blood pumped from the heart with each beat passes through the kidneys ***[Bontrager and Lampignano, 2005]***.

The renal arteries normally arise from the aorta at L1/L2 level. The right renal artery is longer and lower than the left and passes posterior to the IVC ***[Ryan et al., 2004]***.

Accessory renal arteries are common (30% of individuals), and usually arise from the aorta above or below main renal artery and follow it to the renal hilum ***[Standring et al., 2005]***.

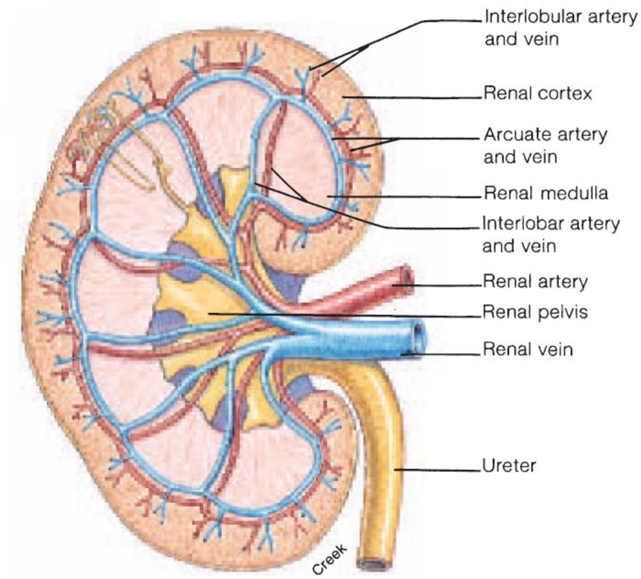

Figure 3 The principal arteries and veins of a kidney **[Quoted from: Van De Graaff, 2001]**.

Both renal arteries usually have two divisions: one passes posterior to the renal pelvis and supplies the posterior upper part of the kidney; or the another anterior branch supplies the upper anterior kidney; a branch of the anterior division passes inferiorly and supplies the entire lower part of the kidney ***[Ryan et al., 2004]***.