

## Renal Arterial Embolization with Absolute Ethanol

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*Twenty separate infarction procedures with absolute ethanol were performed on eighteen renal tumors in seventeen patients at Department of Radiology, Seoul National University Hospital since 1982. Fifteen were hypernephroma cases and two were angiomyolipoma cases.*

*The indications for renal infarction were the preoperative interruption of renal arterial flow in eight cases of hypernephroma, and primary therapy or palliation of symptoms in seven cases of hypernephroma and two cases of angiomyolipoma.*

*Average 15ml of absolute ethanol was injected for renal arterial embolization at a rate of 1-2 ml/sec via balloon occlusion catheter or superselective administration technique.*

*Though the long-term beneficial effect on survival was not confirmed, transcatheter embolization with absolute ethanol was suggested to be used as indispensable treatment in preoperative and inoperable or symptomatic cases of renal tumor.*

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Key Words: Renal artery, embolization, ethanol, hypernephroma

### INTRODUCTION

**Transcatheter** embolization has been used widely in the management of tumor and bleeding control of kidney with variety of embolizing agents in recent years (Kauffmann et al., 1981; Barry et al., 1981; Doppman et al., 1981; Mazer et al., 1981; Goldstein et al., 1975; Chuang et al., 1981; Freeny et al., 1979; Barth et al., 1977; White et al., 1979; Lalli et al., 1969).

As an agent for artificial infarction, absolute ethanol has several advantages over others. First, being a non-viscous fluid, injection of ethanol into the main renal artery results in diffusion throughout the tumor and renal parenchyme producing vascular injury at the small artery and glomerular level

which leads to tumor ministration of the fluid ethanol is technically easier than particulate material (Frank et al., 1982).

We report our experience on 17 cases of the transcatheter infarction of renal tumor with absolute ethanol together with analysis of its indications, method, postinfarction syndrome, changes in the postembolization angiographic findings, and pathological findings of the nephrectomized kidneys.

### MATERIAL AND METHODS

Since 1982, 20 separate infarction procedures were performed on 18 renal tumors in 17 patients at Department of Radiology, Seoul National University Hospital. Histologically 15 cases were hypernephromas and 2 were angiomyolipomas. Of the 15 hypernephromas, stage A case was 1, stage B, 1, stage C, 8 and stage D, 5.

One of 2 angiomyolipoma cases was bilateral one

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and renal infarctions were performed for right side, in 1981, for left side in 1984.

Of the 17 patients, 8 had renal infarction preoperatively to reduce blood loss and facilitate operation procedures. And these cases include 1 stage A case, 1 stage B case and 6 stage C cases. Remained two stage C and five stage D hypernephroma patients and two angiomyolipoma patients had renal infarction for primary therapy or palliation of symptoms, such as hematuria, mass or pain (Table 1).

**Table 1.** Clinical diagnosis of 17 cases of renal embolization

Hypernephroma		15
Stage A	1	
Stage B	1	
Stage C	8	
Stage D	5	
Angiomyolipoma		2
		17

Before embolization, diagnostic angiography was performed. In 17 separate infarction procedures, absolute ethanol alone was used and in 3 procedures, absolute ethanol with other agents such as Gelfoam (surgical gelatin, Upjohn, Inc.), Ivalon particles (polyvinyl alcohol, Unipoint Lab., High Point, NC) and Gianturco steel coil were used.

And in recent 2 hypernephroma cases, 8cc of Lipiodol Ultra-Fluid (LUF) was mixed with 8cc of ethanol in 1 case and 4cc of LUF alone was infused into renal artery to demonstrate tumor vessels in another 1 case.

To deliver absolute alcohol into renal arteries, we have used balloon occlusion technique and selective or superselective administration technique. But, recently, our preferred technique has been the former using the balloon occlusion catheter. Ethanol is injected manually at rate of 1–2 ml/sec, after inflation of the occlusion balloon in the main renal artery. The occlusion balloon is kept inflated for about 30 sec and then the occlusion balloon is deflated. With aspiration, the residual alcohol within the catheter and the debris were removed. The catheter is then gently flushed with saline, and a test injection is performed with contrast material. Mixing of conventional water soluble contrast material and ethanol was avoided because of precipitation reaction.

One to two ethanol injection per embolization was done and ethanol volume per embolization was 6–20 ml, averaging 15ml (0.25ml/KG).

Postembolization angiography was performed after 15 minutes after embolization to evaluate the effect of embolization. In cases of unsatisfactory embolization, additional ethanol injection was done.

## RESULT

Of the 20 separate absolute ethanol embolizations, 15 embolization resulted in complete occlusion (Fig. 1,2), and 4 embolizations which were all included in preoperative group, resulted in incomplete occlusion of tumor vessels in immediate post-embolization angiogram. This result is probably due to the fact that the aim of embolization in preoperative group is mainly the reduction of blood loss during operation, so the complete occlusion of tumor is not mandatory (Fig. 3). One embolization of the preoperative group was failed due to arteriovenous fistula and showed no change in surgical pathologic specimen.

Almost all the patients experienced moderate to severe flank pain during the procedure and the postinfarction syndrome after the procedure (Table 2).

**Table 2.** Incidence of postembolization syndrome

Symptoms	Incidence (n = 20)
Flank pain	16
Fever	12
GI symptoms	11
Nausea & vomiting	8
Paralytic ileus	5

Postinfarction syndrome consists of flank pain, fever and gastrointestinal symptoms, such as nausea, vomiting, paralytic ileus and anorexia. Mild to severe flank pain persisted for several days to a week. Fever was low grade in 8 cases and high (above 38°C) in 4 cases. Gastrointestinal symptoms persisted for several days and were generally mild or moderate.

Eight hypernephroma patients underwent radical nephrectomy after embolization. Interval between embolization and operation day was 1 to 21 days, averaging 6.5 days.

Review of the surgical pathologic specimens in 8

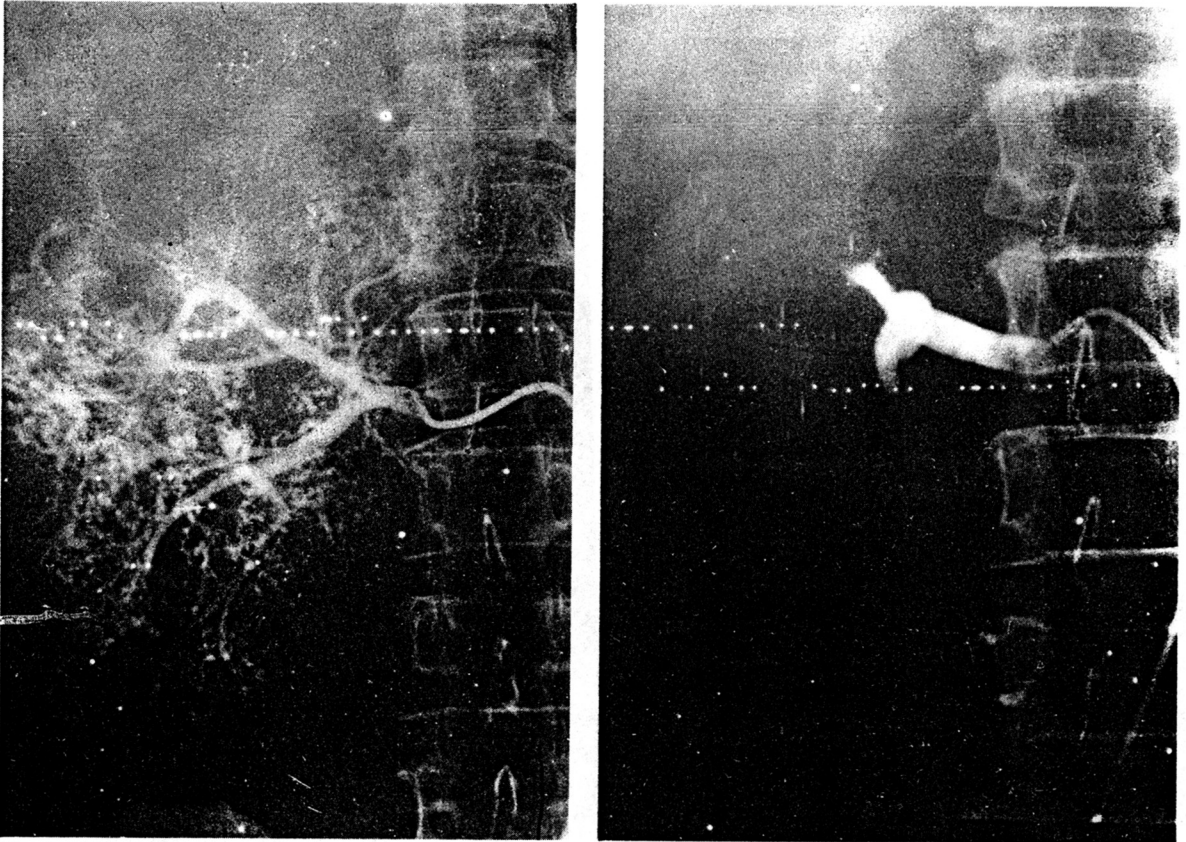


Fig. 1. M 47. Hypernephroma of right kidney, Stage D.

A) Selective right renal arteriography shows multiple neovasculatures in the entire right kidney.

B) Using occlusion balloon catheter, a total 16 cc of alcohol was injected. Both segmental arteries are completely occluded.

cases revealed endothelial denudation, medial necrosis with organized thrombus in renal artery, and variable extent of ischemic necrosis in tumor. Normal renal parenchyme was noted in seven cases, except one case of failed embolization. Peripheral part of renal artery was more severely damaged than proximal one.

Of the 8 radical nephrectomized hypernephroma patients, 5 patients remain alive well for four months to one year and 2 patients have been treated with anti-cancer drug and remain alive for seven to ten months. One patient was lost for follow up.

Palliative therapy group of 7 hypernephroma patients have been followed up and 4 patients are alive. For 2 months to 2 years with improvement of symptoms, 1 patient expired after six months, 2 patients are in serious condition due to metastatic lesion.

Life threatening hematuria from the huge an-

giomyolipoma was controlled by superselective infusion of absolute ethanol. Hematuria decreased after first ethanol embolization and stopped after second embolization which was performed 15 days after first embolization. During the 20 months of follow up, no gross hematuria recurred and mass size markedly decreased.

Another angiomyolipoma patient who had complete occlusion of tumor vessel by ethanol embolization has been well for six months.

## DISCUSSION

Indications for therapeutic renal artery occlusion include: 1) control of hemorrhage from benign or malignant tumor, vascular malformation, or trauma; 2) control of pain due to malignant tumor; 3) reduction of tumor bulk preoperatively or as palliation; 4) decreasing tumor vascularity to lower operative

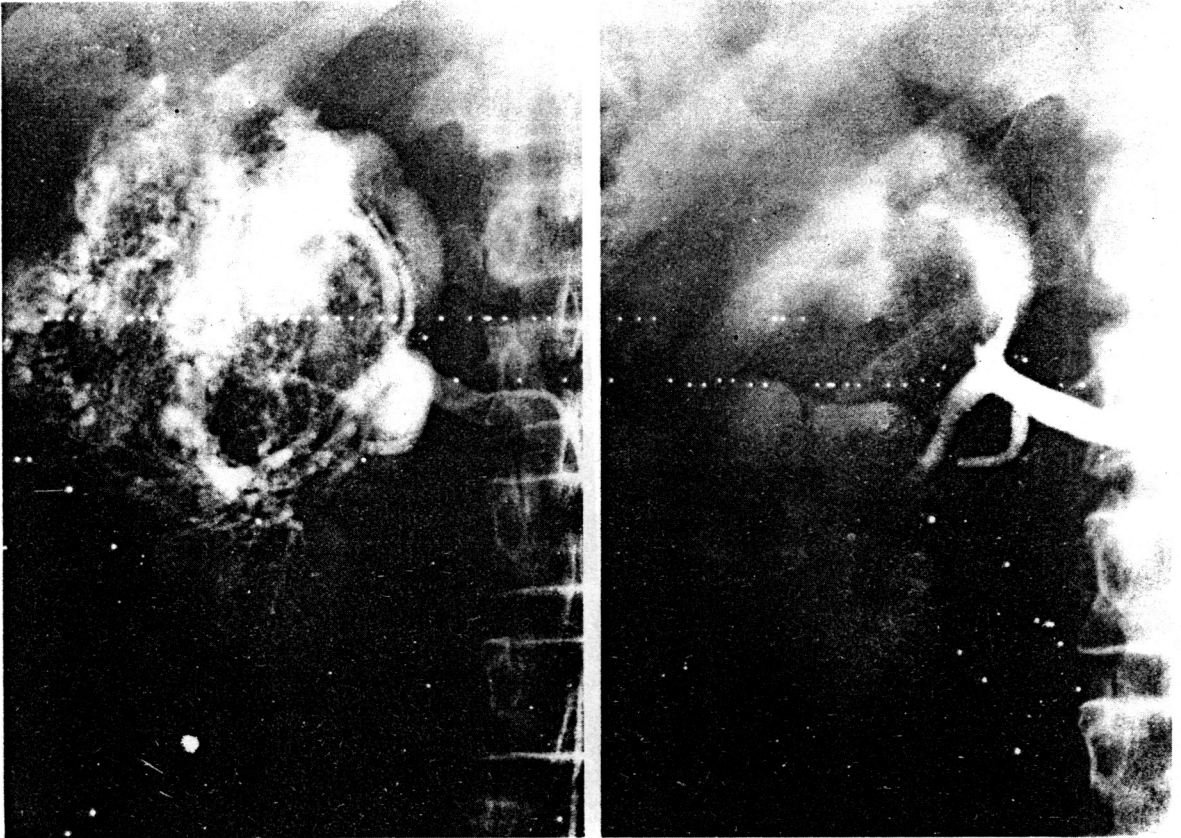


Fig. 2. M 60. Hypernephroma of right kidney with IVC involvement, Stage D.

A) Relatively well-defined hypervascular mass is revealed in pre-embolization arteriography.

B) A total 17cc of ethanol was injected through the balloon catheter, inducing complete occlusion of segmental arteries.

blood loss and 5) transforming a vascular neoplasm into an ischemic one in an attempt to stimulate an immune response (Ellman *et al.*, 1981; Bernardins *et al.*, 1981).

Variety of embolizing agents have been used such as gelatin foam sponge, stainless steel coil, isobutyl-2-cyanoacrylate, ethanol, autologous tissue and blood clot, ferromagnetic material, and detachable balloons (Kauffmann *et al.*, 1981; Barry *et al.*, 1981; Deppman *et al.*, 1981; Mazer *et al.*, 1981; Goldstein *et al.*, 1975; Chuang *et al.*, 1981; Freeny *et al.*, 1979; Barth *et al.*, 1977; White *et al.*, 1979; Lalli *et al.*, 1969). Among them, absolute ethanol has several advantages over others: 1) complete tissue necrosis with arterial occlusion, 2) permanent arterial occlusion, 3) less danger of accidental embolization of nontarget organs, 4) milder postinfarction syndrome, 5) no infection related to the procedures, and 6) simplicity of the procedure (Ellman *et*

*al.*, 1981).

Techniques for delivery of absolute ethanol to renal artery include the balloon occlusion technique and superselective technique. The balloon occlusion catheter serves several purposes: the balloon interrupts renal blood flow, markedly prolonging contact time of the ethanol with the endothelium; the balloon inhibits reflux of ethanol into the aorta and the balloon allows effective infarction with injection at the main renal artery without the necessity for selective segmental injection. Thus, the balloon occlusion technique is simple to use and reduces the time required to perform the procedure (Rabe *et al.*, 1981).

The mechanism of action of ethanol has been proposed to be a combination of perivascular necrosis, sludging of erythrocyte in small arteries and glomeruli, small artery spasm and endothelial damage and sloughing leading to occlusion (Ellman *et*

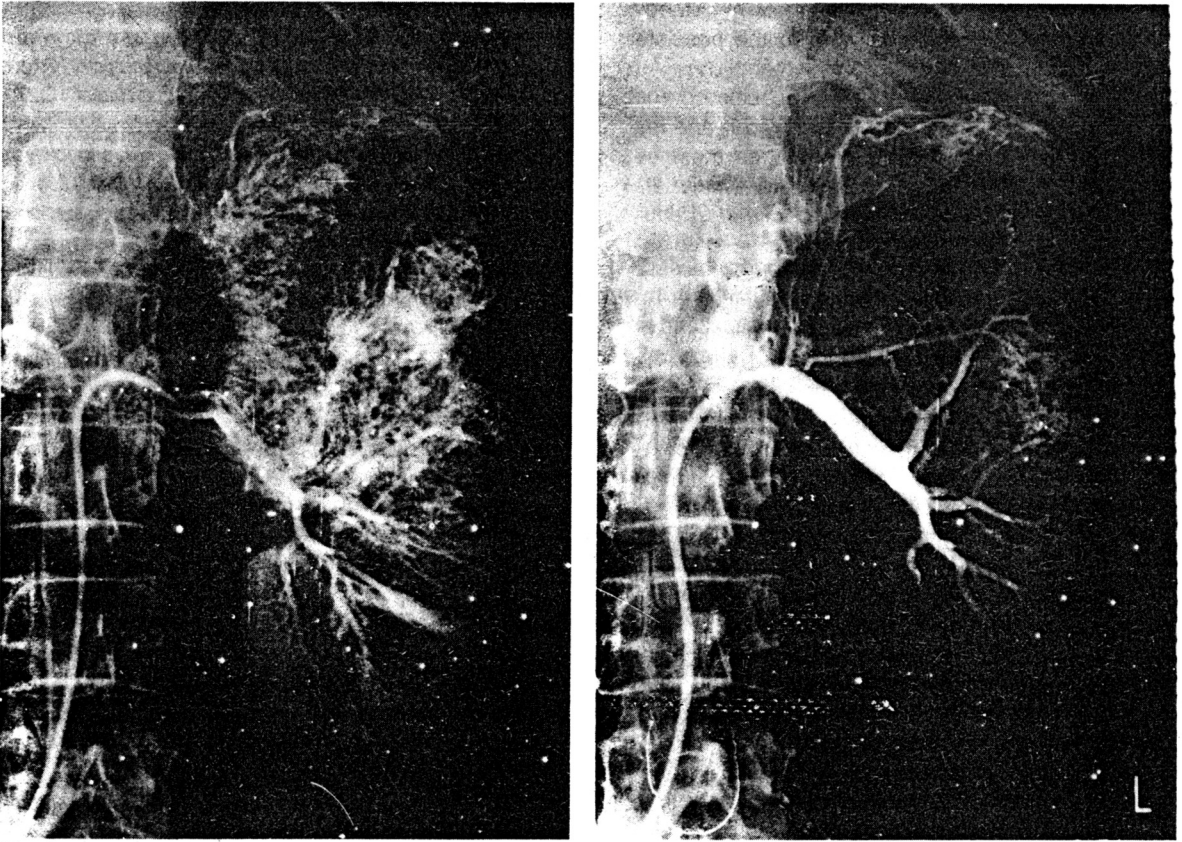


Fig. 3. F 50. Hypernephroma of left kidney, Stage C.

- A) Pre-operative evaluation with selective arteriography showed hypervascular mass of upper portion of left kidney. 'Thread and streaks' are noted in the renal vein, due to tumor thrombi.
- B) Mixture of 7cc ethanol and 4cc Lipiodol caused occlusion of interlobar arteries. Some residual Lipiodol density is remained in the tumor.

al., 1981).

The immediate effect of rapid (1–5 ml/sec) injection of absolute ethanol into a normal renal artery is tissue toxicity leading to necrosis in the perivascular areas. This is associated with sludging of erythrocytes in small arteries and glomeruli and spasm in these small arteries. The angiographic correlate of this sludging and vessel spasm is a slowed flow rate in the renal vessels. Endothelium is damaged and sloughs over a period of hours, resulting in occlusion of the damaged vessels, which may not be complete for several days.

When the ethanol is injected very slowly (0.1 ml/sec), endothelial damage may occur, but there is little direct tissue toxicity produced. With slow injection, ethanol interacts with blood at the catheter tip to produce in situ emboli which are made of clumps

of damaged erythrocytes and denatured protein. In situ emboli are trapped in capillaries and consequently result in acute renal arterial occlusion. It is possible that this slow injection technique may be preferred in treatment of benign conditions, such as occlusion of arteriovenous malformations, in which permanent arterial occlusion with minimal tissue damage is desired (Ellman et al., 1981; Ellman et al., 1984).

Ellman et al. (1981) described the upper limit of volume of ethanol used in renal arterial embolization, 1 ml/0.9 KG of body weight at a rate of 2 ml/sec.

It is known that mixing of contrast material with absolute ethanol produces the precipitate-like material (Rabe et al., 1982). In one of our cases, mixture of ethanol and LUF was used and complete oc-

clusion of renal artery with staining of hypernephroma was obtained, which opened the possible way of opacification of non-opaque ethanol.

Ellman *et al.* (1981) suggested specific criteria indicating adequate renal ablation: 1) All arteries smaller than major segmental branches must be occluded. 2) Stagnation of flow in patent major arteries must be observed. 3) Extravasation of contrast material into the renal parenchyma must be observed. And Ellman *et al.* (1981) considered a second attempt at tissue ablation with ethanol to be contraindicated due to the possible rapid leakage of ethanol into surrounding tissue. But Rabe *et al.* (1982) have different view and have found balloon occlusion of the main renal artery with ethanol injection be effective with no need for selective segmental injection and consider total occlusion of the main renal artery as their end point. And they insisted that repeated ethanol embolization is not contraindicated.

With embolic occlusion of the renal arteries, flank pain, fever, nausea, vomiting, anorexia, paralytic ileus have been described as postembolization syndrome. Compared to other agent, postembolization symptoms after ethanol embolization are milder and last for fewer days (Ellman *et al.*, 1981).

Reports about rare complications of this procedure include abscess formation in infarcted area, perinephric abscess, infarction of left colon due to reflux of ethanol into the inferior mesenteric artery (Cos *et al.*, 1982).

Giuliani *et al.* (1981) have opinion that preoperative embolization of the renal tumor should be performed twenty-four hours before the operation, to reduce a possible damage to the patient's general condition.

Though the beneficial effect on survival was not documented with long-term follow-up in the cases of inoperable hypernephroma, preoperative interruption of renal arterial flow with absolute ethanol was reported to make the radical nephrectomy easy in the handling of renal vascular pedicle and dissection of kidney and reduce the operation time (Moon *et al.*, 1983).

## REFERENCES

Barry JW, Bookstein JJ, Alksne JF: *Ferromagnetic emboli-*

*zation. Radiology 138:431-349, 1981.*

Barth KH, Strandberg JD, White RI: *Long term follow-up of transcatheter embolization with autologous clot, Oxycel and Gelfoam in domestic swine. Invest Radiol 12:273-280, 1977.*

Bernardino M, Chuang VP, Wallace S: *Therapeutically infarcted tumor: CT findings. AJR 136:527-530, 1981.*

Chuang VP, Soo CS, Wallace S: *Ivalon embolization in abdominal neoplasms. AJR 136:729-733, 1981.*

Cos GG, Lee KR, Price HI: *Colonic infarction following Ethanol embolization of renal-cell carcinoma. Radiology 145:343-345, 1982.*

Doppman JL, Popovsky M, Girtan M: *The use of iodinated contrast agents to ablate organs: experimental studies and histopathology. Radiology 138:333-340, 1981.*

Ellman BA, Parkhill BJ, Curry TS: *Ablation of renal tumor with absolute ethanol; A new technique. Radiology 141:619-626, 1981.*

Ellman BA, Parkhill BJ, Marcus PB: *Renal ablation with absolute Ethanol: Mechanism of action. Invest Radiol 19:416-423, 1984.*

Freeny PC, Bush WH, Kidd R: *Transcatheter occlusive therapy of genitourinary abnormalities using isobutyl 2-cyanoacrylate (Bucrylate). AJR 133:647-656, 1979.*

Giuliani L, Carmignani G, Belgrans E: *Usefulness of preoperative transcatheter embolization in kidney tumors. Urology 17:431-434, 1981.*

Goldstein HM, Medellin H, Beydoun MT: *Transcatheter embolization of renal cell carcinoma. AJR 123:557-562, 1975.*

Kauffmann GW, Rassweiler J, Richter G: *Capillary embolization with Ethibloc: new embolization concept tested in dog kidneys. AJR 137:1163-1168, 1981.*

Lalli AF, Peterson N, Bookstein JJ: *Roentgen guided infarctions of kidneys and lungs. Radiology 93:434-435, 1969.*

Mazer MJ, Baltaxe HA, Wolf GL: *Therapeutic embolization of the renal artery with Gianturco coils: limitations and technical pitfalls. Radiology 138:37-46, 1981.*

Moon WC, Park JH, Han MC: *The role of arterial embolization with Ethanol in renal tumors. The Korean Journal of Urology 24:987-994, 1983.*

Rabe FE, Yune HY, Richmond BD: *Renal tumor infarction with absolute ethanol. AJR 139:1139-1144, 1982.*

White RI, Kaufman SL, Barth KH: *Embolotherapy with detachable silicone balloons. Radiology 131:619-627, 1977.*