

(Embol)

:

1

2 3

가 가
Polyvinylacetate(PVAc) 가 Embol
45% 55%
가 15 , 0.8(0.5 - 0.9) cc
Embol 5
5 3 3 (I), 2 (II),
4 (III)
1 DMSA
3 1, 3, 5, 7, 14 BUN,
Creatinine, Sodium(Na), Potassium(K)
: Embol
5
14 , (interlobar artery) 1
가
I III 1
가
I II
III 가 3
, III 가 . I
, II III
III
: Embol
가

가 (4),
, (6). 가
가
(1 - 5). , 가 ,

1
2
3

가 (7, 8).
(radiolucency)

2001 5 3 2001 10 8

: (Embol)
 (9 - 11). 가 15 . 가
 (10 mg/ml, ,) 3 cc
 Rompun(xylazine 23.3 mg/cc, Bayer Korea Ltd., Seoul)
 가 (acetic acid), 1 cc 가
 Polyvinyl acetate, Ethibloc Rompun 1.5 cc, 0.5 cc 가
 (12 - 15). 가
 Park (16) Embol 21G 0.018 -
 in (hair wire) 4F micropuncture
 sheath(COOK, Bloomington, U.S.A.)
 . sheath 0.016 - in (guide wire)
 3F (Fastracker; Boston scientific,
 Watertown, U.S.A.)
 Embol
 가 가 . 30%
 0.2 cc
 Embol
 polyvinyl acetate(PVAc)
 (Polysciences, Warrington, PA) 가 5
 Park (16) Embol
 . PVAc sheath
 PVAc vinyl acetate(VAc)
 vinyl alcohol(VA) 가 가 5 3 3 (I), 2
 VA VAc (II), 4 (III)
 VAc VA
 VA 10%
 가 . Embol 20
 g PVAc 172 ml 18.3 ml hematoxylin - eosin
 , 22% VAc가 가 VA 78%
 가 .
 48
 2
 12 g 44 ml . 3
 Ultravist 370(Schering, Berlin, Germany) 3 , 2 , 4 DMSA
 56 ml , 0.8 μ m , 3 1, 3, 5, 7, 14
 가 BUN,
 (autoclave) Creatinine, Sodium (Na), Potassium (K)
 Embol - 78 - 12 PVAc
 가 ,
 190 mg I/ml
 (radioopacity) . Embol
 /
 가 가 .
 (Fig. 1A). 15 13
 2
 Embol 0.8(0.5 - 0.9)cc . Embol
 가
 2 kg

7
K
meg/l
Embolic
14
(interlobar artery)
(nephrogram)
1
(recanalization)
(collaterals)
DMSA

BUN, Cratinine, Na,
19 mg/dl, 0.6 mg/dl, 143 meg/l, 4.4
가
(Table 1).
(Fig. 1B), 1
(Fig. 1C).
(recanalization)
(collaterals)
DMSA

가
가
I II

Table 1. Mean Value of Blood Chemistry Before and After the Procedure in Three Rabbits

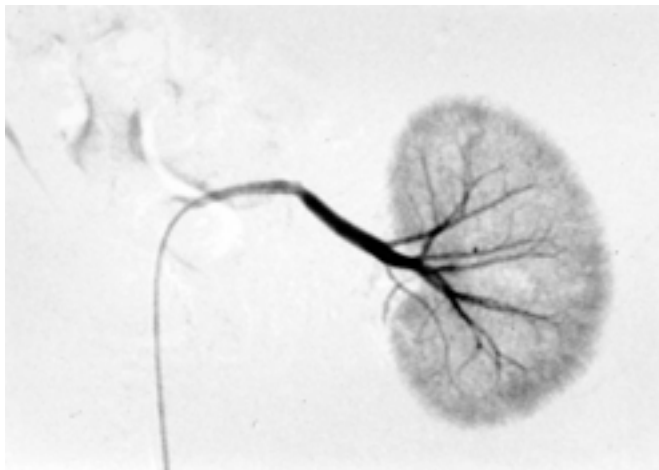
	pre	1 d	3 d	5 d	7 d	14 d
BUN(mg/dl)	21	26	23	23	21	23
Creatinine(mg/dl)	0.6	1.1	0.9	0.8	1.0	0.8
Na(meg/l)	143	143	142	143	142	142
K(meg/l)	4.5	4.5	4.9	4.9	4.8	4.7

Note. - d = day(s), pre = pre-embolization.

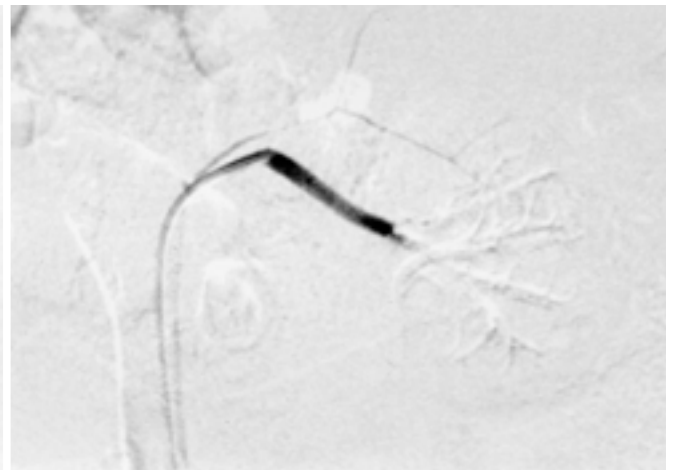
Table 2. Volume Changes of the Kidney after Renal Artery Embolization with Embol

Group	Mean Volume Ratio*
I	1.13
II	0.79
III	0.64

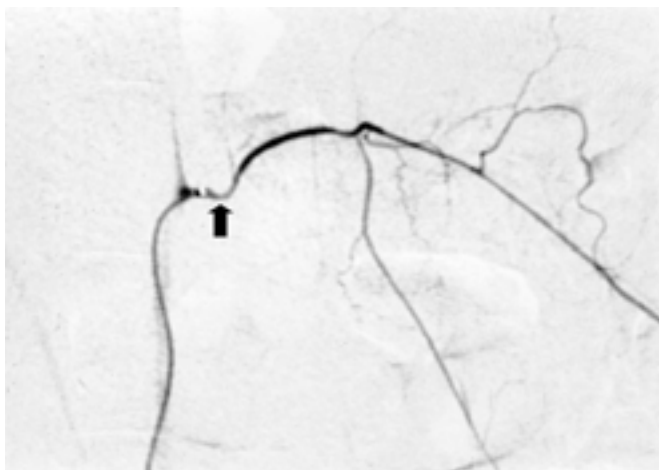
* Volume ratio = volume of the embolized kidney/volume of the normal kidney



A



B



C

Fig. 1. Radiograph of renal artery embolization with Embol.
A. Selective renal arteriogram shows single left renal artery with normal nephrogram.
B. Post-embolization angiogram at 5 minutes shows a complete occlusion of renal artery.
C. Post-embolization angiogram at 4 weeks demonstrates complete occlusion of left renal artery (arrow). Prominent capsular artery and its branches are seen proximal to the occluded left renal artery. There is no evidence of collateral vessels in the renal bed.

III

가

(Table 2).

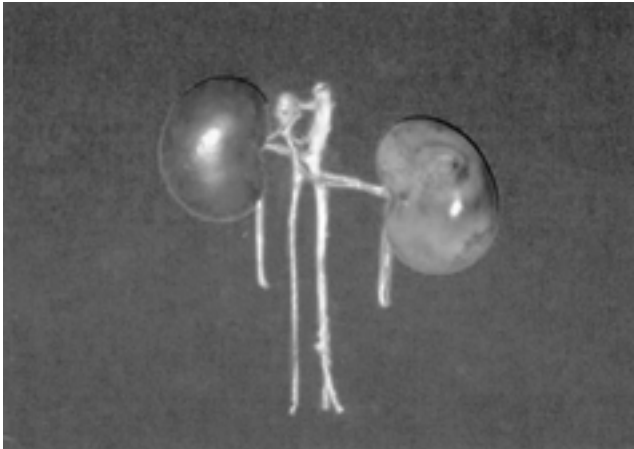
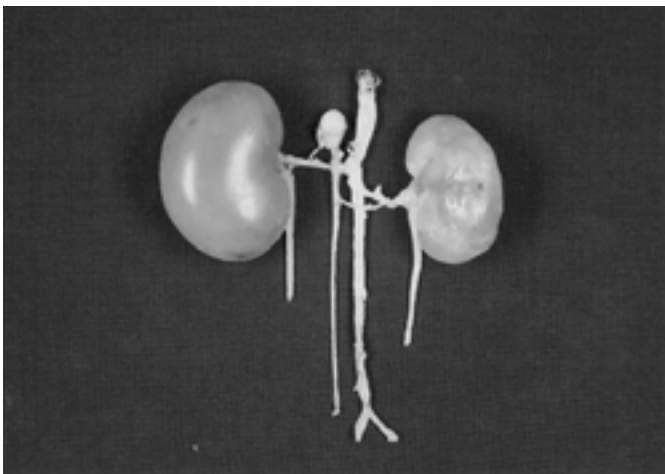
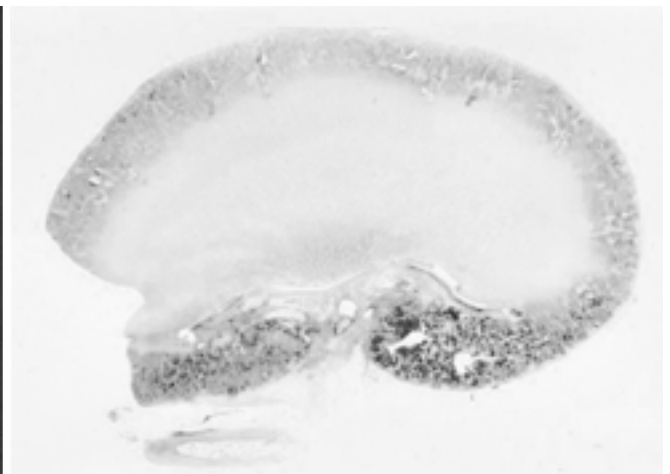


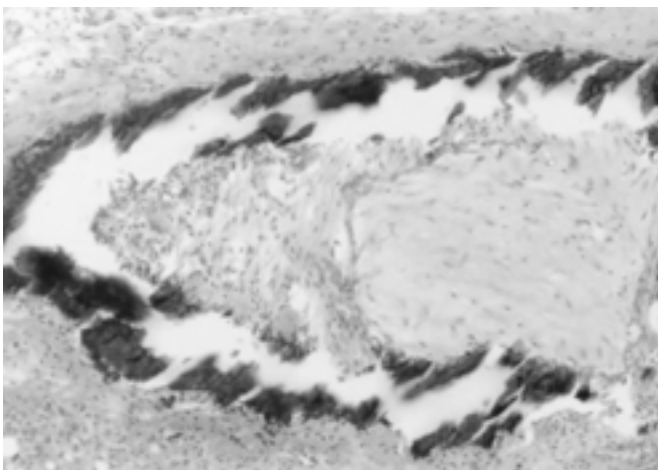
Fig. 2. Gross photograph of kidney of the rabbit in group I shows normal color and texture of right kidney and slightly enlarged and pale appearance of left kidney. Scattered areas of depression and necrotic foci are visible in the embolized kidney.



A



B



C

Fig. 3. Photograph of gross and microscopic findings of embolized kidney of the rabbit in group III.

A. Gross photograph of both kidneys shows marked shrinkage of embolized left kidney. Marked surface irregularity and anemic color changes are evident when compared with that of normal right kidney.

B. Microscopic section of the embolized kidney shows completely necrotic cortical region with extensive basophilic calcifications. (H & E, 1:1)

C. Renal artery is severely damaged and contains completely organized thrombus. Irregular calcifications along the arterial wall as well as along the thrombus are evident. (H & E, $\times 400$)

(Fig. 3C).

가

. Histoacryl

(monomer)

()

(polymerization)가

가

, Embol

가

. Embol

/

가

(water envi-

ronment)

가

가

가

Embol

가

. Embol

PVAc

가

VAc

VA

PVAc가

56%

Embol 45%

1900

가

PVAc가

100 mg l/ml

Embol

190 mg l/ml

PVAc

0.8 cc Embol
, 4

가 , , Coil, Polyvinyl alcohol(Ivalon),
Cyanoacrylate, (4, 5, 7, 8, 17-21).
가 , , coil

(17).

가

. I

III

1

. Ivalon,

(spasm)

Cyanoacrylate,

Embol

Ivalon

가

Cyanoacrylate

가

(4, 22).

Cyanoacrylate

가

가

Embol

가

(7, 8).

(9-11).

lipiodol

4

(occlusion balloon catheter)

가

(1, 23).

Embol Su (22)

PVAc

가

(Embol)

(7). Embol 40%

Embol

(16).

3
2 4

가

Embol

가

Embol

Embol

가

. Kaufmann (14)

, Embol

Ekelund (8)

27

가

52

가

2

가

4

가

. Kaufmann (24)

가

(dystrophic calcification)가

(25). Ekelund

가

가

가

Polyvinyl acetate(PVAc)

Peregrin

(13)

95%

. Su (22)

50%

가

Embol

가 40%

(13, 22),

(giant cell)

BUN, Creatinine, Na, K

(BUN: 13.1 - 29.5 mg/dl, Creatinine: 0.5 - 2.65 mg/dl,

Na: 138 - 155 meq/l, K: 3.70 - 6.80 meq/l) (26).

1. Park JH, Kim SH, Han JK, Chung JW, Han MC. Transcatheter arterial embolization of unresectable renal cell carcinoma with a mixture of ethanol and iodized oil. *Cardiovasc Intervent Radiol* 1994;17:323-327
2. Kauffmann GW, Richter GM, Rohrbach R, Wenz W. Prolonged survival following palliative renal tumor embolization by capillary occlusion. *Cardiovasc Intervent Radiol* 1989;12:22-28
3. 4
1994;31:49-53
4. Wallace S, Chuang VP, Swanson D, et al. Embolization of renal cell carcinoma. *Radiology* 1981;138:563-570
5. Ellman BA, Parkhill BJ, Curry TS, Marcus PB, Peters PC. Ablation of renal tumors with absolute ethanol: a new technique. *Radiology* 1981;141:619-626
6. Sanchez FW, Vujic I, Ayres RI, Curry NS, Gobien RP. Hemorrhagic renal angiomyolipoma: superselective renal arterial embolization for preservation of renal function. *Cardiovasc Intervent Radiol* 1985;8:39-42
7. Ellman BA, Green CE, Eigenbrodt E, Garriott JC, Curry TS. Renal infarction with absolute ethanol. *Invest Radiol* 1980;15:318-322
8. Ekelund L, Jonsson N, Treugut H. Transcatheter obliteration of the renal artery by ethanol injection: experimental results. *Cardiovasc Intervent Radiol* 1981;4:1-7
9. Cox GG, Lee KR, Price HI, Gunter K, Noble MJ, Mebust WK. Colonic infarction following ethanol embolization of renal-cell carcinoma. *Radiology* 1982;145:343-345
10. Teertstra HJ, Winter WA, Frensdorf EL. Ethanol embolization of a renal tumor, complicated by colonic infarction. *Diagn Imaging Clin Med* 1984;53:250-254
11. Twomey BP, Wilkins RA, Mee AD. Skin necrosis: a complication of alcohol infarction of a hypernephroma. *Cardiovasc Intervent Radiol* 1985;8:202-203
12. 50% 가
1998;38:1021-1026
13. Peregrin JH, Kaspar M, Haco M, Vanecek R, Belan A. New occlusive agent for therapeutic embolization tested in dogs. *Cardiovasc Intervent Radiol* 1984;7:97-101
14. Kauffmann GW, Rassweiler J, Richter G, Hauenstein KH, Rohrbach R, Friedburg H. Capillary embolization with Ethibloc: new embolization concept tested in dog kidneys. *AJR Am J Roentgenol* 1981;137:1163-1168
15. Peregrin JH, Zabka J, Stribrna J, Boruvka V, Martinek V. Long-term control of hypertension and the predictive value of peripheral plasma renin activity after ablation of end stage kidneys with a new embolic agent. *Cardiovasc Intervent Radiol* 1993;16:355-360
16. Park S, Yoon HK, Lee N, et al. Portal vein embolization with use of a new liquid embolic material: An experimental study. *J Vasc Interv Radiol* 1999;10:339-345
17. Barth KH, Strandberg JD, White RI. Long term follow-up of transcatheter embolization with autologous clot, Oxygel and Gelfoam

- in domestic swine. *Invest Radiol* 1977;12:273-280
18. Chuang VP, Wallace S. Arterial infusiion and occlusion in cancer patients. *Semin Roentgenol* 1981;16:13-25
 19. Mazer MJ, Baltaxe HA, Wolf GL. Therapeutic embolization of the renal artery with Gianturco coils: limitations and technical pitfalls. *Radiology* 1981;138:37-46
 20. Freeny PC, Buch WH, Kidd R. Transcatheter occlusive therapy of genitourinary abnormalities using isobutyl 2-cyanoacrylate. *AJR Am J Roentgenol* 1979;133:647-656
 21. Chuang VP, Soo CS, Wallace S. Ivalon embolization in abdominal neoplasms. *AJR Am J Roentgenol* 1981;136:729-733
 22. Su CC, Takahashi A, Yoshimoto T, Sugawara T. Histopathologic studies of a new liquid embolization method using estrogen-alcohol and polyvinyl acetate. *Surg Neurol* 1991;36:4-11
 23. Park JH, Jeon SC, Kang HS, IM JG, Han MC, Kim CW. Transcatheter renal arterial embolization with the mixture of ethanol and iodized oil (Lipiodol). *Invest Radiol* 1986;21:577-580
 24. Kauffmann GW, Rohrbach R, Rassweiler J, Richter G. Experimental basis of arterial occlusion. In: *Percutaneous biopsy and therapeutic vascular occlusion*. Stuttgart: Thieme, 1980:101-104
 25. Woolf N. *Ischaemia and infarction*. In: McGee JO, Isaacson PG, Wright NA. *Oxford textbook of pathology*. New York: Oxford University Press, 1992:524-530
 26. Mitruka BM, Rawnsley HM. *Clinical, biochemical, and hematological reference values in normal experimental animals and normal humans*. 2nd ed. New York: Maason Publishing, 1981;215-219

A New Liquid Embolic Agent(Embol) for Transcatheter Renal Artery Embolization: An Experimental Study in Rabbit¹

Gyoo Sik Jung, M.D., Ji Ho Ko, M.D., Hyun Chul Kim, M.D., Sang Hee Lee, M.D.,
Kyung Seung Oh, M.D., Jin Do Huh, M.D., Young Duk Joh, M.D., Bang Hur, M.D.², Sangsoo Park, Ph.D.³

¹Department of Diagnostic Radiology, Kosin Medical College

²Department of Pathology, Kosin Medical College

³Department of Biomedical Engineering, Seoul Health College

Purpose: To evaluate the effectiveness and safety of a new liquid embolic agent in renal arterial embolization in the rabbit, and its clinical applicability.

Materials and Methods: A new embolic agent, Embol, was obtained by partial hydrolysis of polyvinyl acetate and dissolved in a mixture of 45% ethanol and 55% non-ionic contrast medium. Its radioopacity was therefore good. An average of 0.8 cc(0.5 - 0.9 cc) of Embol was used to embolize the renal artery of one kidney in 15 rabbits. The immediate effect of this was examined angiographically 5 minutes after the procedure. To permit histologic examination, five rabbits in each group were sacrificed 3 days (I), 2 weeks (II), and 4 weeks (III) after embolization: prior to embolization and prior to sacrifice, one rabbit in each group underwent renal scanning, and prior to sacrifice all underwent follow-up angiography. In three rabbits, blood urea nitrogen (BUN), creatinine, sodium(Na), and potassium(K) levels were measured before and 1, 3, 5, 7 and 14 days after embolization.

Results: Embol was easy to use and its radiopacity was good. Five minutes after embolization, angiography showed that total occlusion of the main renal or interlobar artery had been achieved in all rabbits. Serum BUN, creatinine, Na and K levels were within normal limits. Follow-up angiogram obtained in each group showed persistent occlusion of the renal artery in all but one rabbit in group I and one in group III. Renal scans revealed no evidence of radionuclide uptake in embolized kidneys, which were slightly enlarged in group I but became gradually smaller in groups II and III. In all animals, histologic examination showed diffuse coagulation necrosis of the embolized kidneys and in group III the cortex of these was extensively calcified. In group I the renal artery showed an apparently fresh occluding thrombosis, and in groups II and III a completely organized thrombosis was present. In group III this was calcified.

Conclusion: Because of its good radioopacity, Embol is easy to control, and is effective for renal artery embolization. As a permanent embolic agent, it appears suitable for clinical applications.

Index words : Animals

Arteries, therapeutic blockade

Kidneys, interventional procedure

Address reprint requests to : Gyoo Sik Jung, M.D., Department of Diagnostic Radiology, Kosin Medical College.
34, Amnam-Dong, Seo-Ku, Pusan, 602-702 Korea
Tel. 82-51-990-6337 Fax. 82-51-255-2764 E-mail: gsjung@medikorea.net