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**Transcatheter Arterial Embolization with Absolute Ethanol Injection  
for Enlarged Polycystic Kidneys after failed metallic coil embolization**

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## **Abstract**

Kidney enlargement in autosomal dominant polycystic kidney disease (ADPKD) may cause symptoms by compressing the alimentary tract, lungs, and heart. The clinical symptoms may be progressive, remarkably decrease quality of life, and sometimes life-threatening. Although treatment of this disease is often difficult, transcatheter arterial embolization (TAE) with metallic coils has been reported as a renal contraction therapy that is less invasive than surgery. We present a case of ADPKD successfully treated by TAE with absolute ethanol after a previous TAE with metallic coils failed to contract the affected kidneys because of recanalization.

## **Introduction**

Autosomal dominant polycystic kidney disease (ADPKD) is one of the most common monogenic disorders, and globally is one of the most common causes of end-stage kidney disease (1). Several methods have been reported to decrease kidney size (2-6). Aspiration without or with sclerosis of cysts is a less invasive contraction therapy and relieved preoperative symptoms after the treatment (2, 3), however, its effect was transient and high rate recurrence was reported (2), and serious complications with this method include perirenal hemorrhage, arteriovenous fistula formation, and infection (7, 8). Conventional nephrectomy will result in complete cure, but it is associated with high morbidity (11.5%) and mortality rates (5%) (9). Transcatheter arterial embolization (TAE) of the renal artery by metallic coil embolization has recently been reported (7, 8). This method is an effective and less invasive renal contraction therapy. The present report describes a case of successful treatment of ADPKD by renal arterial embolization with absolute ethanol injection after a previous TAE with metallic coils failed to contract the affected kidneys because of recanalization.

## **Case Report**

A 53-year-old woman, who at the age of 31 had been diagnosed with chronic renal failure and ADPKD, was admitted to our hospital for severe abdominal distention and dysphagia. It was difficult for her to wake up the upper part of her body from the dorsal position for gross abdominal swelling, and she could not smoothly take a meal because of transit disorder of the alimentary tract. Both kidneys were becoming enlarged, and chronic renal failure was gradually increasing. She had been receiving hemodialysis since the age of 49. One month after the introduction of hemodialysis, she underwent TAE of the right renal artery with microcoils for enlarged polycystic kidneys at an affiliated hospital. However, the treatment had no effect, and her kidneys continued to enlarge compared to images of computed tomography (CT) performed in the past afterwards. The patient was in good health but her abdomen swelled out greatly, with a maximum circumference of 89 cm, much larger than expected given her height of 141.8 cm.

Laboratory data showed elevated levels of serum creatinine 5.8 mg/dL and uric nitrogen (27 mg/dL). Also revealed were anemia (erythrocytes,  $3.69 \times 10^4$  / $\mu$ L; hemoglobin, 10.3 g/dL; hematocrit, 31.4 %), leucopenia (3,100 / $\mu$ L), a mild increase of g-GTP (48 IU/L), and a mild decrease of cholinesterase (208 IU/L). Other serologic data were within the normal ranges.

Computed tomographic images showed markedly enlarged bilateral polycystic kidneys and multiple liver cysts. The left kidney measured 15.0×12.2×28.0 cm and the right measured 13.2×8.3×22.0 cm. The volumes (using the formula  $\pi/6 \times \text{length} \times \text{width} \times \text{depth}$  as an ellipsoid on CT images) were 2681 ml and 1261 ml in the left and right, respectively. There were no findings of solid tumors in the kidneys or any other malignancy in contrast-enhanced abdominal and pelvic CT images. Both renal parenchymas were enhanced and it represented that there was blood flow in them. The metallic coils that had been inserted in the previous attempt for TAE were observed in the right renal hilum.

The protocol was approved by the institutional review board of our hospital before treatment, and written informed consent was obtained from the patient. TAE was performed in January 2006. Under local anesthesia, a 5F sheath introducer (Super Sheath Introducer; Togo Medikit, Miyazaki, Japan) was percutaneously inserted into the aorta via the right femoral artery by Seldinger's technique. First, the abdominal aortography was performed using a 4F Omniflush catheter (Togo Medikit, Miyazaki). The arteriogram before renal TAE showed bilateral narrowed and stretched renal arteries of polycystic kidney (Figures 1, 2). The selective renal arteriography followed using a 4F Mikaelsson catheter (Create Medic, Kanagawa, Japan). The right renal

arteriogram showed microcoils, placed during the previous TAE, in the proximal ventral and dorsal branches. Both branches, however, were recanalized and their distal branches were visualized (Figure 1). Besides, the right renal capsular artery supplied blood flow to the cyst walls (Figure 1). We planned to use a balloon occlusion catheter to control the blood flow, but the right renal artery became very narrow and the flow was not so fast. We then considered it unnecessary to control blood flow and did not use a balloon occlusion catheter.

To control pain, we began a continual intravenous fentanyl infusion at a rate of 25µg per hour before TAE. A coaxial catheter was inserted into the right renal artery and renal capsular artery successively should be used, depending on your intent. Absolute ethanol was then injected via the coaxial catheter into each artery, and both arteries were embolized. The method of ethanol injection was as follows: a test injection of the contrast material was performed at a rate of 0.1 to 0.3 ml per second to confirm the absence of reflux. The contrast material was injected until the cyst walls were enhanced, and the same amount of ethanol was manually injected at the same rate. After 5 minutes, we evaluated whether or not the targeted arteries were completely embolized by test arteriography through a manual injection of contrast medium. If embolization was not complete, ethanol injections were repeated in the same way. The total amount of ethanol

injected to the right renal capsular artery was 2.7 ml, and that injected to the right renal artery was 5.6 ml (Figure 1). Then we occluded the left renal artery by a 5F balloon occlusion catheter (Selecon MP catheter; Clinical Supply, Gifu, Japan) with a balloon diameter of 9 mm) using absolute ethanol injection. The total amount of ethanol injected to the left renal artery was 10 ml (Figure 2).

After the operation, the patient had abdominal and low back pain, but both were reduced by drip intravenous administration of nonsteroidal anti-inflammatory drugs added to the previously infused fentanyl. After the TAE, she had fever (up to 38C), nausea, and anorexia. The fever resolved and the nausea and anorexia gradually improved from the third day after the TAE. She recovered and left our hospital on the 7th day after the operation.

After her discharge, progressive anemia was found (erythrocytes,  $5.9 \times 10^4 / \mu\text{L}$ ) at a dialysis hospital, and edema was aggravated in both legs. Red cell concentrates mannitol adenine phosphate (RC-MAP) was infused (6U), and the dosage of erythropoietin during dialysis was increased from 1500 U to 3000 U. Afterward, the anemia improved. Her dry weight fell from 42.7 kg to 41.5 kg as a result of the procedure. The anemia continued to improve and the edema was reduced.

Her general condition also improved. The bilateral kidney size (left/right)

decreased to 77.9%/72.2%, 57.9/68.0%, 50.0%/67.1%, and 46.0%/57.0% of the pretherapeutic value at 3, 6, 9, and 12 months after TAE, respectively (Table, Figure 3). The abdominal maximum circumference was reduced from 89 cm to 79 cm at 12 months after TAE. Some abdominal swelling remained because of the enlargement of the polycystic liver, but the degree of distension was much less than that prior to embolization, and the dysphagia disappeared. There were no recurrent symptoms or complications at 12 months after the treatment.

## **Discussion**

In this case we successfully treated symptomatic bilateral polycystic kidney by TAE with absolute ethanol. Prior to the operation, we consulted with experienced doctors in the department of urology about other treatment options: needle aspiration of the cysts without or with injection of sclerosing agents, cyst fenestration or decompression, and surgical nephrectomy. Needle aspiration demonstrated transient therapeutic effect and high rate recurrence (2, 3). In cyst fenestration or decompression, complications such as upper urinary collecting system injury, urinary tract infection, bleeding, incisional hernia, and small bowel obstruction have been reported (4, 5). Surgical nephrectomy is usually performed assuming kidney transplantation and

associated with high morbidity and mortality rates (9). Thus, we thought TAE was the most feasible therapy and finally chose it of the bilateral renal arteries.

Ubara et al. evaluated TAE's effectiveness in ADPKD patients (7, 8). They reported that the decrease rate of kidney volume at 12 months after TAE was  $53.1 \pm 11.6\%$  of the pretherapeutic value. In our case, bilateral kidney size (left/right) decreased to 46.0%/57.0% at 12 months after TAE, and this result is equal to that of them. They used metallic coils as the embolic agent, and placed them into the main trunk or branches of the bilateral renal arteries. They used 16 to 56 platinum microcoils per patient (mean,  $31.2 \pm 11.2$  coils) in 40 patients, who were also treated with a gelatin sponge (group 3). In this case, TAE with metallic coils had been performed previously, but recanalization occurred and there was no therapeutic effect. Recanalization after TAE and additional coils placements in the more proximal portions of the renal arteries were reported, however, the targeted renal arteries could not be completely obstructed because the proximal renal arteries had been obstructed and additional coils could not be inserted safely and fully (7). Our case is similar to their cases in that the proximal renal arteries were embolized and recanalized, but we were able to occlude distal arteries because we used absolute ethanol as a liquid embolic agent that can go through the recanalized arteries (Figure 1). Ethanol injection will be useful in such cases where

additional coil TAE is impossible or ineffective.

There are no previous reports of ADPKD treated by TAE with ethanol injection, and the safety of this procedure is unknown. But TAE with ethanol injection for various renal diseases has been reported; renal arteriovenous malformation (10, 11), renal angiomyolipoma (12) and renal ablation (13-15). These reports prove that renal vascular embolization with ethanol is a safe and effective technique. Embolization with absolute ethanol injection was demonstrated to cause complete cellular death with total vascular occlusion through the combination of vascular thrombosis, sludging of erythrocytes and endothelial damage (14), and induced necrosis of perivascular areas, thereby avoiding late revascularization by collaterals (16). Furthermore, ethanol would embolize the peripheral arteries through the recanalized arteries in which coils had been placed. However, the most significant complication is reflux of injected ethanol into nontargeted areas because of its radiolucency. There are reports of colonic infarction (17) and spinal cord infarction (18). A meticulous search for adrenal, gonadal, and phrenic branches of the renal arteries is needed prior to embolization (13), and strict attention is required for ethanol injection. As our experience in the right renal artery, use of a balloon catheter may prevent these complications (13). Use of ethanol emulsified with radiopaque agent such as iodized oil may also be helpful (11).

This report suggests that TAE with absolute ethanol may be a reasonable renal contraction therapy for ADPKD that deserves further evaluation.

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| Volume (ml)                 | After the Treatment |             |            |             |             |
|-----------------------------|---------------------|-------------|------------|-------------|-------------|
|                             | Pre                 | 3m          | 6m         | 9m          | 12m         |
| Left Kidney                 | 2681                | 2089        | 1551       | 1335        | 1234        |
| Right kidney                | 1261                | 910         | 858        | 846         | 719         |
| Reduction rate (Left/Right) | 100%/100%           | 77.9%/72.2% | 57.9/68.0% | 50.0%/67.1% | 46.0%/57.0% |

Table. Changes of the volume of the kidneys

## Legends

Figure 1. (a) The right renal arteriogram before transcatheter arterial embolization (TAE) shows narrowed and stretched renal arteries and developed renal capsular artery (arrowheads). (b) Platinum coils are placed in the right renal artery (white arrows), however, recanalization is shown on the selective right renal angiogram. (c) After the TAE using absolute ethanol, the right renal artery and renal capsular artery are occluded.

Figure 2. (a) The left renal arteriogram before transcatheter arterial embolization (TAE) shows narrowed and stretched renal arteries. (b) After the TAE, the left renal artery is occluded.

Figure 3. (a) Computed tomography (CT) images before transcatheter arterial embolization (TAE) show the grossly enlarged polycystic kidneys and liver. (b) CT images at 12 months after TAE show that both the bilateral kidneys markedly decrease. The size of the bilateral kidneys (left/right) is decreased to 46.0%/57.0% of the pretherapeutic value. No apparent change in cysts of the liver was observed.



a.



b.



c.

Figure 1. (a) The right renal arteriogram before transcatheter arterial embolization (TAE) shows narrowed and stretched renal arteries and developed renal capsular artery (arrowheads). (b) Platinum coils are placed in the right renal artery (white arrows), however, recanalization is shown on the selective right renal angiogram. (c) After the TAE using absolute ethanol, the right renal artery and renal capsular artery are occluded.



a.

b.

Figure 2. (a) The left renal arteriogram before transcatheter arterial embolization (TAE) shows narrowed and stretched renal arteries. (b) After the TAE, the left renal artery is occluded.



a.



b.

Figure 3. (a) Computed tomography (CT) images before transcatheter arterial embolization (TAE) show the grossly enlarged polycystic kidneys and liver. (b) CT images at 12 months after TAE show that both the bilateral kidneys markedly decrease. The size of the bilateral kidneys (left/right) is decreased to 46.0%/57.0% of the pretherapeutic value. No apparent change in cysts of the liver was observed.