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Minocycline hydrochloride as a soft sclerotizing agent for symptomatic simple renal and hepatic cysts

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Abstract. – OBJECTIVE: To present the results of our ten-year case series in simple hepatic and renal cysts sclerosis using minocycline hydrochloride as a sclerotizing agent, evaluating the effectiveness, the safety and the feasibility of this agent for percutaneous sclerotherapy for symptomatic cysts.

PATIENTS AND METHODS: We retrospectively evaluated our archives of patients treated (54 patients with 60 renal cysts, 21 patients with 24 hepatic cysts) for symptomatic abdominal cysts. These patients were treated with ultrasound guided drainage and subsequent minocycline hydrochloride instillation. In large or recurrent cysts, we repeated the treatment for the second time. The patients were evaluated at 6 and 12 months; some patients underwent later, additional examinations and we also reviewed these exams for any eventual long-term relapse.

RESULTS: The percentage of sclerosis success was found to be 100% for hepatic cysts and 86% for renal cysts. We also found that minimal complications were encountered.

CONCLUSIONS: Minocycline hydrochloride has proven to be an effective sclerotizing agent. In our cases, symptoms disappeared in 100% of patients with hepatic cysts and in 93% of patients with renal cysts. It is also a safe sclerotizing agent, as demonstrated by the few complications encountered. Percutaneous sclerosis with Minocycline hydrochloride is a very effective and promising nonsurgical treatment for patients with symptomatic simple cysts, and it can be performed without major complications.

Key Words
Cysts, Interventional, Percutaneous, Kidney, Liver, Sclerosis, Minocycline hydrochloride.

Introduction

Cysts can be located in various abdominal organs, with the most common sites being liver and kidneys. The discovery of abdominal cysts is mostly accidental, occurring during medical imaging of the abdomen for other reasons (like an evaluation for kidney stones or gallstones, or in oncological or trauma patients). Cysts originate from different cell lineages, including nephron epithelial cells in the kidney[1] and ductal epithelial cells in the liver[2]. The variation in their origin also explains the differences in fluids contained within the cysts, and in particular the specific substances secreted by the cyst walls.

Most abdominal cysts are usually asymptomatic. In some cases, however, they can manifest themselves[2,3]. The symptoms are non-specific: the most common symptoms are due to compression of the adjacent structures or organs, bloating, shortness of breath, nausea, vomiting, early satiety, asthenia, obstructive jaundice, hydronephrosis, flank or abdominal pain, hematuria, or hypertension (if they compress renal parenchyma or renal arterioles). In some cases, they can break spontaneously or after abdominal trauma. The treatment is indicated when the cyst becomes symptomatic or when it shows an increase in volume over time, often reaching considerable size. Although it may be suspected that the cause of the symptoms is attributable to a cyst, other possible causes must also be excluded.

Renal Cysts

Simple kidney cysts are benign lesions, most frequently involving the elderly where they are practically always present. In the majority of cases they are acquired, and they tend to grow over time, with a growth trend of approximately 5% per year. The origin of renal cysts is still unclear; however, some authors have suggested that they derive from diverticula of the renal tubules, as the intracystic fluid is much like pre-urine. The differential diagnosis from cystic tumors is based on the Bosniak's classification[4] that predicts the

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risk of malignancy on the basis of certain signs: calcifications, number and thickness of the internal septa, mural nodules with enhancement after contrast medium. Cysts classified as 2F, 3 and 4, which have a higher risk of malignancy, should be managed with radical therapies (such as surgery) and are, therefore, excluded from sclerosing treatments.

Regarding treatment, guidelines on the management of renal cysts (if, when and how to treat them) have not been defined as yet[5]. Up to now, the main indication for the treatment of renal cysts is the presence of symptoms, largely due to the increased volume and the subsequent mass effect. In some cases, this increase in volume causes compression of the adjacent urinary tract, often resulting in partial hydronephrosis. Other indications for treatment are the possible risk of rupture, infection and intracystic hemorrhage. Authors have also reported an association with hypertension, where it is thought that the cysts can cause stretching of the vascular pedicle of the kidney because of its weight, and some cases have been published where cyst decompression lowered blood pressure.

Hepatic Cysts

Hepatic cysts include a variable range of focal lesions, ranging from simple cysts to infectious, neoplastic and post-traumatic cysts. Imaging, in the vast majority of cases, allows the differentiation of the various types of cysts and directs the treatment modality. Although there isn't a classification system like the Bosniak[4], the semiologic criteria are similar (essentially the presence of calcification, nodules of the wall or septa). We decided to treat only simple hepatic cysts. Histologically, hepatic cysts come from a malformation of the biliary ducts but usually they do not communicate with the intrahepatic biliary system. The cyst wall is formed of a layer of cuboidal or columnar cells, similar to the epithelial cells of the bile ducts. The frequency of hepatic cysts is very high (approximately 18% of the adult population[6]), with a higher prevalence in females, with cysts often being numerous and small in size.

The finding of hepatic cysts is almost always incidental, mostly due to ultrasound examinations being performed for other reasons (such as the evaluation for kidney stones or cholelithiasis, or in oncological or trauma patients). More rarely, when the cysts are voluminous, the imaging is performed due to the mass effect caused by the cyst and this is especially true in patients with polycystic disease (hepatic or hepatorenal). Sometimes patients may also present with jaundice caused by compression of the bile ducts. Before the sclerosing treatment, a thorough examination with a second-level method, such as contrast-enhanced CT or MRI, is highly recommended in order to rule out parasitic cysts or cystic tumors. A panoramic evaluation is also useful in preoperative planning to better decide the puncture site and the needle path, which must pass through healthy parenchyma, in order to reduce the risk of bleeding.

This study summarizes our experience of more than 12 years in the use of minocycline hydrochloride (Minocin®, Teofarma S.r.l., Valle Salimbene, PV, Italy) for the treatment of simple liver and kidney cysts.

Patients and Methods

Study Participants

We retrospectively evaluated our archive of treated patients (90 patients from 2004 to 2015), and divided it into two groups, from which we isolated those patients with at least 12 months of follow-up data available (Table I). 15 patients were excluded due to the absence of follow-up exams.

Renal cysts: 54 patients (26 women, 28 men, age range 28-73 years) with a total of 60 cysts, all symptomatic cases. This group also includes 5 patients with polycystic kidney disease (or hepatorenal disease) and patients with a large or very large single cyst (7 patients).

Hepatic cysts: 21 patients (13 women, 8 men, age range 31-72 years) with a total of 24 cysts, all symptomatic. While most of these patients had a single cyst, 3 patients had polycystic liver or hepatorenal disease and 3 had a large or very large cyst.

Table I. Summary of patient and cyst details.

	Renal cysts	Hepatic cysts
Patients	54	21
Single cyst	49	18
Polycystic disease	5	3
Total cysts	60	24
Sex (female/male)	26/28	13/8
Age range (years)	28 to 73 (mean 54)	31 to 71 (mean 59)

The diagnosis was made in all cases with an abdominal ultrasound, except in six cases where it was made by contrast-enhanced CT and in five cases that were treated on the basis of MRI findings (made in young patients for radioprotection reasons). This study was performed according to the principles of the World Medical Association Declaration of Helsinki and the patients signed an informed consent.

Sclerosing Treatment

Before treatment, all patients underwent a surgical visit and other tests to confirm that the symptoms were caused by the cyst. Patients were treated on an inpatient basis at our hospital, usually for 2 days and 1 night. They presented to us with hematological and chemical tests (complete blood count, coagulation tests). The sclerosing of cysts was almost always carried out under ultrasound guidance in an angiography suite, always by prior arrangement with surgeons from our center, to ensure coverage in case of major surgical intra-procedural complications, which never occurred.

After antiseptic skin preparation and local anesthesia, we chose in real time both the puncture site and the corresponding needle to use. In most cases we used a thin needle (18-20 G, length 10-20 cm); a thin needle is less traumatic but it slows down the procedure, so for bigger cysts the use of 6F catheters is advisable. Ultrasounds were used continuously to assess: the position of the needle tip, any potential intracystic bleeding and the gradual emptying of the cyst. In the case of suspected communication with the renal excretory system, we performed a cystography to evaluate any possible communication (it was never documented).

After emptying approximately half to three-quarters of the cyst fluid, a quantity of minocycline hydrochloride equal to 1 mg per ml of the volume of the native cyst (i.e. cysts of 200 ml were treated with 200 mg of minocycline hydrochloride), dissolved in 20 cc of saline was introduced. The instilled minocycline hydrochloride was left in place and not drained. We never administered more than 600 mg of a sclerosing agent, even in cysts that exceeded 600 ml in volume, to prevent excessive dosage of the drug. Therefore, in some cases, a second treatment was also given. A preventive or post-procedural antibiotic was never given. Some of the aspirated fluid was sent to the laboratory for cytological study and chemical analysis, to confirm the simple benign nature of the cyst. No signs of bacterial or parasitic infections were present in the aspirated fluid.

Patients remained in bed until the next day, with preferential decubitus on the side of the cyst treated, and then they were discharged the following day after a complete blood count and an ultrasound check to rule out abdominal or intracystic bleeding and iatrogenic injuries.

A follow-up ultrasound was performed for all patients after 6 and 12 months. Most of the patient underwent subsequent evaluation (US, CT or MRI) performed for other reasons, and these exams were also used as follow-up. Many patients had up to 10 years of follow-up data, and we decided to use this data as a conclusive assessment of the treatment and to identify cases where the cyst was subsequently reformed.

We considered as a complete radiological response the reduction of the cyst volume of at least 80%, partial success the reduction of up to 50% of the volume, failure the reduction of less than 50% of the volume. We considered as a good clinical response the complete symptoms relief.

Statistical Analysis

For analysis, we divided the cysts into three subcategories based on volume (100-499 ml, 500-1000 ml, and 1000-5000 ml) and calculated the radiological response for each subgroup. Data were analyzed with SPSS (SPSS v22.0, IBM, Chicago, IL, USA). The distribution of the continuous variables was assessed by the Kolmogorov-Smirnov test, which showed a normal distribution of the variables considered. A statistical study (*t*-test for paired samples) was conducted for every subgroup to compare the volume before and after (6 months) sclerotherapy. A *p*-value of less than 0.05 was considered statistically significant.

Results

As shown in Table II, the results of this retrospective study highlight the effectiveness of sclerotherapy with minocycline hydrochloride, with the resolution of the symptoms in almost all patients treated: 100% of hepatic cysts and 93% of renal cysts. We found a significant radiological response in 100% of hepatic cysts and 86% of renal cysts. The effectiveness of this treatment was evident as soon as 6 months post-treatment (Tables III and IV), and remained even up to 10 years later.

Table II. Cyst volume and clinical presentation, and summary of the radiological, clinical and adverse responses of abdominal cysts to Minocycline hydrochloride sclerotherapy.

	Renal cysts	Hepatic cysts
Total number of cysts	60	24
Mean cyst volume (ml) ± SD		
From 100 ml to 500 ml	271.81 ± 103.66	224.7 ± 127.8
From 501 ml to 999 ml	618.33 ± 121.23	557.1 ± 53.45
From 1000 ml to 5000 ml	2200 ± 1557.4	2167 ± 971.3
Clinical presentation		
Mass effect	44 (73%)	21 (87%)
Pain	12 (20%)	2 (8%)
Hemorrhage	4 (7%)	1 (4%)
Radiological response		
Complete	52 (86%)	24 (100%)
Partial	7 (12%)	0 (0%)
Failure	1 (2%)	0 (0%)
From 0 ml to 499 ml	35 cysts	16 cysts
Success	33 (94%)	16 (100%)
Partial success	2 (6%)	0 (0%)
Failure	0 (0%)	0 (0%)
From 500 ml to 999 ml	18 cysts	5 cysts
Success	12 (67%)	5 (100%)
Partial success	5 (27%)	0 (0%)
Failure	1 (6%)	0 (0%)
From 1000 ml to 5000 ml	7 cysts	3 cysts
Success	7 (100%)	3 (100%)
Partial success	0 (0%)	0 (0%)
Failure	0 (0%)	0 (0%)
Clinical response		
Complete	56 (93%)	24 (100%)
Partial	3 (5%)	0 (0%)
Failure	1 (2%)	0 (0%)
Number of adverse events	5	3
Intra-procedural pain	1	0
Hemorrhage	2 (1 intracystic, 1 perirenal)	3 (intracystic hemorrhage)
Fever	2 (lasted less than 24 h)	0

We found a significant statistical reduction of volume before and after sclerotherapy in almost every subgroup.

For renal cysts:

- From 0 to 499 ml we found a significant reduction of volume from 271.8 ± 103.6 ml to 36.4 ml ($p < 0.001$)
- From 500 to 999 ml we found a significant reduction of volume from 618.3 ± 121.2 ml to 154 ml ($p < 0.001$)
- From 1000 to 3000 ml we found a significant reduction of volume from 2200 ± 1557.4 to 314 ml ($p < 0.01$)
- For hepatic cysts:
- From 0 to 499 ml we found a significant reduction of volume from 224.7 ± 127.8 ml to 16.3 ml ($p < 0.001$)
- From 500 to 999 we found a significant reduction of volume from 557.1 ± 53.4 ml to 33.3 ml ($p < 0.001$)
- From 1000 to 3000 ml we found a reduction of volume from 2167 ± 971.3 ml to 85 ml, but without a statistical significance

Three cases (all renal cysts) demonstrated a relapse at the first follow-up at 6 months; the first cyst regained 78% of the original volume, the second 61% and the third 45%. The first two of these cysts were treated a second time, with complete success. The third was not retreated due to personal problems of the patient. Furthermore, a patient with a very large cyst (5500 ml) was treated twice because after the first treatment the volume of the cyst was still approximately 1000 ml. At 6 months after the second treatment, the final volume was just 60 ml.

Table III. Renal cyst volume (ml) reduction relative to cyst size pre-minocycline hydrochloride sclerotherapy. The last follow-up range between 24 and 120 months.

	Pretreatment	6 months	12 months	At last follow-up
Renal cysts				
Mean cyst volume (ml) ± SD				
From 100 ml to 500 ml*	271.8 ± 103.6	36.4	25.8	25.4
From 501 ml to 999 ml*	618.3 ± 121.2	154.1	117.5	98.6
From 1000 ml to 5000 ml**	2200 ± 1557.4	314.2	264.2	234.2

* $p < 0.001$; ** $p < 0.01$

We never encountered major complications but only 8 small adverse effects: 4 cases of intracystic bleeding, 1 case of bleeding along the needle tract, 2 cases of post-procedural mild fever (well controlled with paracetamol) and 1 case of intra-procedural pain, which receded after temporary suspension of the treatment.

Discussion

Historically, the treatment of abdominal cysts was the prerogative of surgery[7], first with laparotomy and later with laparoscopy. The first proposed approach was the fenestration of the cyst, a surgical technique that has also been subsequently refined[8,9]. Surgery, however, always presents a small amount of risk (although reduced with laparoscopy), and it is frequently associated with functional consequences for the patient (splenectomy in case of splenic cysts, liver resections in case of deep hepatic cysts that cannot be easily extracted or fenestrated). The risks of general anesthesia must also be considered. Also, the benign nature of abdominal cysts has made feasible those treatments that aim at simply reducing the volume of the cyst, rather than at its complete removal. These methods are much less invasive, less dangerous and less expensive, and, therefore, easily repeatable in the case of failure[10]. Nonetheless, even today, some authors believe the surgical approach to be safer[11,12]. However, several studies have shown that the sclerosing of cysts has a similar efficacy to surgery, with the added advantage of fewer complications and lower costs[13-15].

The first nonsurgical technique proposed was the simple suction of the intracystic fluid[16]. This method, as well documented in the past, was followed by relapses in a high number of cases, making it ineffective. The high rate of recurrence is because the drainage of the cyst does not solve the reason why the cysts born and grow (the walls of the cysts are constituted by a layer of epithelial cells that produce liquid). The percutaneous aspiration was then modified with the instillation of sclerosing agents into the cyst to damage the secretory epithelium of the wall[17].

When analyzing the data (Tables III and IV), the reduction in size of the cyst was significant as early as 6 months after treatment, while the variation in size between successive follow-up time points was minimal, and there were no cases of cyst enlargement. These results are very important because they allow a reduction in the number of the follow-up exams and demonstrate that 6 months are sufficient to assess the outcome of the treatment.

Table IV. Hepatic cyst volume (ml) reduction relative to cyst size pre-minocycline hydrochloride sclerotherapy. The last follow-up range between 24 and 120 months.

	Pretreatment	6 months	12 months	At last follow-up*
Hepatic cysts				
Mean cyst volume (ml) ± SD				
From 100 ml to 500 ml*	224.7 ± 127.8	16.3	12.4	10.9
From 501 ml to 999 ml*	557.1 ± 53.4	33.3	30	28.3
From 1000 ml to 5000 ml**	2167 ± 971.3	85	50	50

* $p < 0.001$; ** not statistically significant

We also note that even larger cysts showed a great reduction in volume (Tables II, III and IV), although we never exceeded 600 mg of sclerosing agent, preferring to repeat sclerotherapy if the volume reduction had proven to be insufficient. However, the safety of minocycline hydrochloride (highlighted by the low number of complications) and the absence of peri-procedural difficulties, may allow a higher dose administration. This option is usually needed in patients with polycystic disease where the high number of cysts may require the treatment of up to 5-6 lesions in the same session.

As evidenced by the review of the literature and as confirmed by our case load, this treatment modality allows the possibility of repetition in cases of partial success or failure of the initial treatment[5]. We have treated two patients twice, both times achieving a complete response. However, if the symptoms resolve, patients may also feel satisfied with the first treatment only, without repeating the procedure.

Regarding the effectiveness of the treatment, we had symptoms disappearing in 100% of the hepatic cysts and in 93% of renal cysts. Specifically, for renal cysts, we had a symptom relief rate of 93.7%, while other authors had relief rates ranging from 89.7%[18] to 100%[19]. Furthermore, for hepatic cysts we had a symptom relief rate of 100%, in line with other reports[20].

Comparing data with other authors experiences, we had an 86% radiological success rate for renal cysts, slightly better than other authors who have used minocycline hydrochloride (Ohkawa et al[21] reported a 77% of radiological success) and 100% for hepatic cists, in line with literature[22].

Currently, in literature, there are no clear indications on which substance must be used as sclerosing agent. At least 10 substances have been used[5], including tetracycline, 3% polidocanol, povidone-iodine, and 50% acetic acid, with variable and not always satisfying results. Up to now, the most frequently sclerosing agent used is ethyl alcohol, which has various drawbacks. Ethanol has a variable concentration, ranging between 95% and 99%, and it is administered in a high volume (but never greater than the pretreatment cyst volume). It also induces the necrosis of the cells of the cyst wall in 1-3 minutes. Notably, peri-procedural complications are frequent. In addition to the immediate burning pain and fever (common to all techniques of sclerotherapy), the increase of blood alcohol concentration is frequent as ethanol can filter through the wall of the cyst and end up in the bloodstream. In some cases, these values are particularly high, with patients receiving alcohol poisoning[5]. However, it takes between 4 and 12 hours to overcome the capsule of the cyst and to spread into the adjacent tissue, thus giving the operator more than adequate time for its removal[5]. This effect depends on the total amount of alcohol injected (depending on the volume of the treated cysts) and the time the alcohol is left in the cyst. Other complications are due to the leakage of ethanol along the route of the needle or in the renal calyces, with local inflammation and sometimes fibrosis[23].

Most publications do not indicate the presence of peri-procedural complications, but when they were reported, the rate was quite variable, ranging from 0%[24,25] to 30%[26]. In our case (Table II), their frequency was minimal (9.5%)

Given that minocycline hydrochloride is as effective as alcohol, possible complications of minocycline hydrochloride are less serious than those of alcohol. For example, a recent case report showed the effects of alcohol extravasated in the urinary tract in a patient where the cyst communication with renal pelvis had not been properly excluded.

Minocycline hydrochloride can be used as sclerotizing agent because of the extremely low pH of the solution that causes a reaction of the wall cells with fibrosis and adhesions of the walls[27]. We found this sclerotizing agent most effective on hepatic cysts than renal cysts probably due to the difference of the epithelial cells lining the cysts. An advantage of minocycline hydrochloride is that it can be left in place with a prolonged effect on the secreting epithelium of the cyst. Minocycline hydrochloride can also be used at multiple sites simultaneously. Among our patients we treated eight cases with renal or hepatic polycystosis (five with hepatic cysts, three with renal cysts), treating more cysts simultaneously, with minimal discomfort of the patient. Follow-up controls have been more difficult (in these patients the kidney and liver were completely subverted by numerous cysts), but the therapeutic effect was demonstrated by the decrease of the organ size and the decrease of the mass-feeling sensation of patients.

The subsequent follow-up of these patients must be performed by physicians experienced in the post-treatment evaluation. This is highlighted by one case of sclerotized renal cyst being mistaken for a kidney tumor (it happened at our in-

stitution, but it is also reported in the literature[10]), while another case report showed the occurrence of a tumor in a treated cyst[28].

This work is a retrospective evaluation of more than 10 years of treatment. Therefore, one limitation is that the data presented may be affected by the technique learning curve of the various operators. However, with refinement of the technique, we could reduce the appearance of complications even further. Also, another shortcoming of the study is its retrospective nature; thus, a prospective study should also be performed to determine the optimal dose of Minocycline hydrochloride to be administered.

Conclusions

The data presented demonstrate that minocycline hydrochloride is a safe and valid sclerosing agent, which is also effective for the treatment of large cysts. In particular, it seems that minocycline hydrochloride is highly effective in hepatic cysts.

This technique is less aggressive and better tolerated than surgical therapy (even laparoscopy) and alcohol sclerotherapy. Our data suggest that sclerosis can be the first choice treatment for renal and hepatic cysts for its simplicity and its capability to obtain collapse and durable sclerosis.

Conflict of Interests

The Authors declare that they have no conflict of interests.

References

1) Terada N, Ichioka K, Matsuta Y, Okubo K, Yoshimura K, Arai Y. The natural history of simple renal cysts. J Urol 2002; 167: 21-23.
2) Lantinga M A, Gevers T JA, Drenth J PH. Evaluation of hepatic cystic lesions. World J Gastroenterol 2013; 19: 3543-3554.
3) Terada N, Arai Y, Kinukawa N, Terai A. The 10-year natural history of simple renal cysts. Urology 2008; 71: 7-11.
4) Bosniak MA. The current radiological approach to renal cysts. Radiology 1986; 158: 1-10.
5) Skolarikos A, Laguna MP, de la Rosette JJ. Conservative and radiological management of simple renal cysts: a comprehensive review. BJU Int 2012; 110: 170-178.
6) Carrim ZI, Murchison JT. The prevalence of simple renal and hepatic cysts detected by spiral computed tomography. Clin Radiol 2003; 58: 626-629.
7) Lin TY, Chen CC, Wang SM. Treatment of non parasitic cystic disease of the liver: a new approach to therapy with polycystic liver. Ann Surg 1968; 168: 921-927.
8) Edwards JD, Eckhauser FE, Knol JA, Strodel WE, Appelman HD. Optimizing surgical management of symptomatic solitary hepatic cysts. Am Surg 1987; 53: 510-514.
9) Lai EC, Wong J. Symptomatic non parasitic cysts of the liver. World J Surg 1990; 14: 452-456.
10) Hanna RM, Dahniya MH. Aspiration and sclerotherapy of symptomatic simple renal cysts: value of two injections of a sclerosing agent. AJR Am J Roentgenol 1996; 167: 781-783.
11) Gadelmoula M, KurKar A, Shalaby M M. The laparoscopic management of symptomatic renal cysts: A single-centre experience. Arab J Urol 2014; 12: 173-177.
12) Koutlidis N, Joyeux L, Méjean N, Sapin E. Management of simple renal cyst in children: French multicenter experience of 36 cases and review of the literature. J Pediatr Urol 2015; 11: 113-117.
13) Moorthy K, Mihssin N, Houghton PWJ. The management of simple hepatic cysts: sclerotherapy or laparoscopic fenestration. Ann R Coll Surg Engl 2001; 83: 409-414.
14) Gasparini D, Sponza M, Valotto C, Marzio A, Luciani LG, Zattoni F. Renal cysts: can percutaneous ethanol injections be considered an alternative to surgery? Urol Int 2003; 71: 197-200.
15) Furuta T, Yoshida Y, Saku M, Honda H, Muranaka T, Oshiumi Y, Kanematsu T, Sugimachi K. Treatment of symptomatic non-parasitic liver cysts - surgical versus alcohol injection therapy. HPB Surgery 1990; 2: 269-277.
16) Dean AL. Treatment of solitary cyst of the kidney by aspiration. Trans Am Assoc Genitourin Surg 1939; 32: 91-95.
17) Bean WJ. Renal cysts: treatment with alcohol. Radiology 1981; 138: 329-331.
18) Kilinc M, Tufan O, Guven S, Odev K, Gurbuz R. Percutaneous injection sclerotherapy with tetracycline hydrochloride in simple renal cysts. Int Urol Nephrol 2008; 40: 609-613.
19) Kwon SH, Oh JH, Seo TS, Park HC. Efficacy of single-session percutaneous drainage and 50% acetic acid sclerotherapy for treatment of simple renal cysts. Cardiovasc Intervent Radiol 2007; 30: 1227-1233.
20) Akhan O, Islim F, Balci S, Erbahceci A, Akpinar B, Ciftci T, Akinci D. Percutaneous treatment of simple hepatic cysts: the long-term results of PAIR and catheterization techniques as single-session procedures. Cardiovasc Intervent Radiol 2016; 39: 902-908.
21) Ohkawa M, Tokunaga S, Orito M, Shimamura M, Hirano S, Okasho A, Kosaka S. Percutaneous injection sclerotherapy with minocycline hydrochloride for simple renal cysts. Int Urol Nephrol 1993; 25: 37-43.
22) Yoshida H1, Onda M, Tajiri T Arima Y, Mamada Y, Taniai N, Akimaru K. Long-term results of multiple minocycline hydrochloride injections for the treatment of symptomatic solitary hepatic cyst. J Gastroenterol Hepatol 2003; 18: 595-598.

23) Kwak J, Lee SH, Chung HH, Je BK, Yeom SK, Sung DJ. Isolated calyx mistaken for a cyst: inappropriately performed catheter-directed sclerotherapy and safe removal of the catheter after selective embolization. Cardiovasc Intervent Radiol 2015; 38: 242-246.
24) Phelan M, Zajko A, Hrebinko RL. Preliminary results of percutaneous treatment of renal cysts with povidone- iodine sclerosis. Urology 1999; 53: 816-817.
25) Madeb R, Feldman PA, Knopf J Rub R, Erturk E, Yachia D. Povidone iodine sclerotherapy is ineffective as the treatment of symptomatic renal cysts. J Endourol 2006; 20: 402-404.
26) Choi YD, Ham WS, Kim WT Cho KS, Lee JH, Cho SY, Seo JW, Jin OH. Clinical experience of single-session percutaneous aspiration and OK-432 sclerotherapy for treatment of simple renal cysts: 1-year follow-up. J Endourol 2009; 23: 1001-1006.
27) Ohkawa M, Tokunaga S, Orito M, Shimamura M, Hirano S, Okasho A, Kosaka S. Percutaneous injection sclerotherapy with minocycline hydrochloride for simple renal cysts. Int Urol Nephrol 1993; 25: 37-43.
28) Hashimoto Y, Imai A, Tokui N Sasaki A, Saitoh H, Koie T, Ohyama C. Unexpected outcome after sclerotherapy of simple renal cyst. BMC Nephrol 2012; 13: 63.