

## Diagnoses and treatments of renal artery stenosis at King Chulalongkorn Memorial Hospital

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- Problem/background** : *Renal artery stenosis (RAS) is a common cause of secondary hypertension; 90 % of the cases are originated from atherosclerosis. Renal angiogram is the standard diagnosis procedure for RAS. However, it is a complicated process which can cause serious complications. Currently, there are several techniques for the diagnosis of RAS such as doppler ultrasound, magnetic resonance angiogram (MRA) and captopril renogram. Common problems in the diagnosis of RAS through the techniques are their accuracy of their diagnostic findings and interpretations. The treatment of RAS is composed of revascularization, percutaneous transluminal renal angioplasty (PTRA) and medical treatment. The appropriate treatment of RAS is debatable.*
- Objective** : *The study aimed to evaluate the diagnostic value of several techniques for the diagnosis of RAS such as doppler ultrasound, magnetic resonance angiogram (MRA) and captopril renogram compare with renal angiogram which is the gold standard. Also the efficacy of the treatment modes were evaluated.*
- Design** : *Descriptive study*
- Setting** : *Department of Medicine, Faculty of Medicine, Chulalongkorn University*
- Materials and Methods** : *This study was conducted on patients who were diagnosed of RAS at King Chulalongkorn Memorial Hospital through clinical evaluations and diagnostic techniques, namely, doppler ultrasound, captopril renogram, MRA and renal angiogram from January 1995 (2538 B.E) to December 2003 (2546 B.E.)(a period of 9 years). The data were obtained by chart review.*

- Results** : *Fifty-five patients who were diagnosed with RAS were recruited; their mean age was  $43.5 \pm 26.8$  years old at the time when they were diagnosed with RAS. Captopril renogram has certain limitation for diagnosis of RAS in the cases with impaired renal function, it produced 30.77 % false positive, 87.5 % sensitivity, and 20 % specificity. The sensitivity of Doppler ultrasound and MRA are 100 %, whereas their specificities are 33.3 % and 60 %, respectively. In 30 cases that were diagnosed of RAS by renal angiogram, 18 cases were treated with PTRA and 12 cases with antihypertensive drugs. The outcome of a 12-month treatment with PTRA, compared to those treated only with medication shows that patients of both groups were able to control their blood pressure at the same level. There was no statistical significant difference detected in MAP, serum creatinine and creatinine clearance after the being treated with the two protocols.*
- Conclusions** : *This study shows that RAS can be found in all age group of patients. Captopril renogram has limitation in patients with impaired renal function and it frequently produced false positive, whereas Doppler ultrasound and MRA had 100 % sensitivity. Patients who were treated with PTRA had their blood pressure and renal function under control within 12 months. After receiving PTRA treatment, there was no statistical significant difference when the patients were compared to those who were treated with antihypertensive drug.*
- Keywords** : *Renal artery stenosis, Doppler ultrasound, Magnetic resonance angiogram (MRA), Captopril renogram, Percutaneous transluminal renal angioplasty (PTRA).*

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**เหตุผลการทำวิจัย** : ภาวะ renal artery stenosis (RAS) เป็นภาวะที่พบได้บ่อยที่สุดของภาวะ secondary hypertension ซึ่งพบว่า 90 % มีสาเหตุจากภาวะ atherosclerosis การวินิจฉัยภาวะ RAS ด้วย renal angiogram ถือเป็นมาตรฐาน อย่างไรก็ตามวิธีนี้เป็นวิธีที่ยุ่งยากและอาจเกิดภาวะแทรกซ้อนจากการวินิจฉัย ปัจจุบันมีการวินิจฉัยด้วยวิธีอื่น ๆ ได้แก่ doppler ultrasound, magnetic resonance angiogram (MRA) และ captopril renogram ปัญหาที่พบบ่อยในการวินิจฉัยภาวะ RAS ด้วยวิธีดังกล่าวคือ ความแม่นยำของการวินิจฉัยและการแปลผล การรักษา RAS ประกอบด้วยการทำ Revascularization, การทำ percutaneous transluminal renal angioplasty (PTRA) และการให้ medical treatment ยังเป็นข้อถกเถียงในแง่วิธีการรักษาที่เหมาะสมแก่ผู้ป่วย RAS

**วัตถุประสงค์** : การศึกษานี้เพื่อประเมินประสิทธิภาพของการวินิจฉัยภาวะ RAS ด้วย doppler ultrasound, magnetic resonance angiogram (MRA) และ captopril renogram เปรียบเทียบกับ renal angiogram ซึ่งถือเป็นวิธีมาตรฐาน นอกจากนี้ยังมีวัตถุประสงค์เพื่อประเมินประสิทธิภาพของการรักษาภาวะ RAS ด้วยวิธีต่าง ๆ

**รูปแบบการวิจัย** : การศึกษาเชิงพรรณนา

**สถานที่การศึกษา** : ภาควิชาอายุรศาสตร์ คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

**ตัวอย่างและวิธีการศึกษา** : กลุ่มประชากรที่ใช้ในการวิจัย ได้แก่ ผู้ป่วยที่ได้รับการวินิจฉัยว่าเป็น RAS ใน รพ.จุฬาลงกรณ์ ระหว่าง ม.ค. 2538 - ธ.ค. 2546 (ระยะเวลา 9 ปี) โดยอาศัยการ ข้อมูลจากฐานข้อมูลเวชระเบียนผู้ป่วย รพ.จุฬาลงกรณ์ ผลการตรวจที่เกี่ยวข้อง เช่น doppler ultrasound, captopril renogram, MRA และ renal angiogram ตลอดจนวิธีการรักษาและยาที่ผู้ป่วยได้รับ จะได้รับการวิเคราะห์เปรียบเทียบ

- ผลการศึกษา** : ผู้ป่วยที่ได้รับการวินิจฉัยภาวะ RAS จำนวน 55 รายมีอายุเฉลี่ย  $43.5 \pm 26.8$  ปี เมื่อเริ่มได้รับการวินิจฉัยภาวะ RAS พบการกระจายของช่วงอายุผู้ป่วยทุกช่วงอายุ พบว่า *captopril renogram* มีข้อจำกัดในการตรวจวินิจฉัยผู้ป่วย RAS ในรายที่มี *impaired renal function* และมี *false positive* 30.77 % , มีค่า *sensitivity* เท่ากับ 87.5 % และมีค่า *specificity* เท่ากับ 20 % , *Doppler ultrasound* และ *MRA* มีมีค่า *sensitivity* เท่ากับ 100 % ขณะที่ มีค่า *specificity* เท่ากับ 33.3 % และ 60 % ตามลำดับ ผู้ป่วย 30 รายที่ให้การวินิจฉัย RAS จาก *renal angiogram* มีผู้ป่วย 18 รายได้รับการรักษาด้วยการทำ *PTRA* และมีผู้ป่วยจำนวน 12 รายได้รับการรักษาด้วยยาลดความดันโลหิต ผลการรักษา 12 เดือนหลังการทำ *PTRA* เปรียบเทียบกับการใช้ยาอย่างเดียว พบว่า ผู้ป่วยทั้ง 2 กลุ่มสามารถควบคุมความดันโลหิตได้ใกล้เคียงกัน และไม่พบความแตกต่างของการเปลี่ยนแปลงความดันโลหิตเฉลี่ย และไม่พบความแตกต่างของการทำงานของไตหลังการรักษา ด้วยทั้ง 2 วิธีอย่างมีนัยสำคัญทางสถิติ
- สรุป** : ภาวะ RAS เกิด ได้ในผู้ป่วยทุกกลุ่มอายุ *Captopril renogram* มีข้อจำกัดในการวินิจฉัยโรค โดยเฉพาะอย่างยิ่งผู้ป่วยที่มีค่า *serum creatinine* มากกว่า 3 มิลลิกรัมต่อเดซิลิตร พบว่าทั้ง *doppler ultrasound* และ *MRA* มีค่าความไวในการวินิจฉัย เท่ากับ 100 เปอร์เซ็นต์ ผู้ป่วยที่ได้รับการรักษาด้วยวิธี *PTRA* สามารถควบคุมความดันโลหิต และรักษาระดับการทำงานของไตได้เท่ากับผู้ป่วยที่ได้รับการรักษาด้วยการใช้ยา
- คำสำคัญ** : ภาวะเส้นเลือดไตตีบ, *Doppler ultrasound*, *Magnetic resonance angiogram (MRA)*, *Captopril renogram*, *Percutaneous transluminal renal angioplasty (PTRA)*

Renal artery stenosis (RAS) is the most cause of secondary hypertension, 90 % of the cases are caused by atherosclerosis.<sup>(1)</sup> The diagnosis of RAS by renal angiogram is considered as gold standard. However, it is a complicated procedure which can also lead to many complications. Currently, there are a number of techniques available for the diagnosis of RAS, such as doppler ultrasound, magnetic resonance angiogram (MRA) and captopril renogram. Common problems that emerge out of the diagnosis of RAS with these new techniques are their accuracy and interpretation of the results.

Apart from the problems of interpretations of diagnostic findings, searching for the most appropriate treatment for RAS is still being debated. The choices of treatment of RAS include revascularization, percutaneous transluminal renal angioplasty (PTRA) and treatment with medications. Among these, the treatment with PTRA is gaining more popularity because of its efficiency and it causes less complication than surgical revascularization. However, there is no definite conclusion for the treatment of RAS, regarding its efficacy vis-à-vis that of PTRA and medication for the control of blood pressure and their impacts on the renal function. The Dutch Renal Artery Stenosis Intervention Cooperative Study (DRASTIC),<sup>(2)</sup> which was a randomized controlled trial of 106 RAS cases caused by atherosclerosis, found that there was no difference between systolic pressure and diastolic pressure in the group of patients who received PTRA and that treatment with medication after 12 months of retrospective study of the outcomes of the treatments. Another study<sup>(3)</sup> of the outcome of treatment of 215 cases of RAS caused by atherosclerosis with PTRA showed that 35 % of the patients who were

treated with PTRA had improved renal function, assessed by the change of serum creatinine or creatinine clearance, whereas 35 % of the patients displayed no change in their renal function.

This study is designed to investigate patients who were diagnosed with RAS at King Chulalongkorn Memorial Hospital by evaluating the diagnosis method of doppler ultrasound, captopril renogram, MRA and renal angiogram, as well as the efficacy of the treatment with PTRA.

### **Methods and data analysis**

This is a retrospective descriptive study. The study population were patients who were diagnosed of RAS at King Chulalongkorn Memorial Hospital from January 1995 (2538 B.E.) to December 2003 (2546 B.E.) (a period of 9 years), based on their medical records at the hospital database. The diagnostic investigations such as doppler ultrasound, captopril renogram, MRA and renal angiogram as well as the protocol of treatment and the medications were analyzed.

### **Definitions of blood pressure in patients who were older than 18 years old.**

According to the diagnostic criteria of high blood pressure of the Seventh Report of the Joint National Committee (JNC VII),<sup>(4)</sup> normal blood pressure is defined when the level of systolic pressure of the patient is lower than 120 mmHg and the diastolic pressure is lower than 80 mmHg; and, prehypertension is defined when the patient's systolic pressure is between 120-130 mmHg and diastolic pressure between 81-89 mmHg. Stage 1 hypertension is defined when the patient's systolic pressure is between 140-

159 mmHg or diastolic pressure between 90-99 mmHg; and, stage 2 hypertension is defined when the patient's systolic pressure is higher than 160 mmHg or diastolic pressure higher than 100 mmHg.

### Definition of hypertension in patients who were young than or equal to 18 years old

The diagnostic criteria for hypertension in patients who are younger than 18 years old according to the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents, Nation Heart, Lung and Blood Institute, National Institutes of Health (2004),<sup>(5)</sup> normal blood pressure is defined when the patient's systolic pressure and diastolic pressure lower than 90 percentile; prehypertension is defined when the patient's systolic pressure and /or diastolic pressure is between 90-95 percentile, or the patient's blood pressure is higher than 120/80 mmHg. Stage 1 and stage 2 of hypertension are defined when systolic

pressure and /or diastolic pressure is between higher than 95 percentile to 5 mmHg than higher than 99 percentile, and when the systolic and/or diastolic pressure is 5 mmHg higher than 99 percentile, respectively.

### Statistical analysis

The statistical analysis of the relationships of different variants was done by software statistical package from the Social Science Version 10.0 (SPSS, Inc. Chicago, IL, USA). The level of significance was considered at  $P < 0.05$ .

### Results

#### Demographic data of the study population

##### (Table 1)

Fifty-five patients were diagnosed with RAS in a period of nine years from January 1995 to December 2003. The average age of the patients when they were diagnosed with RAS was  $43.5 \pm 26.8$  years

**Table 1.** Characteristics of the study population (Number of patients = 55).

	Number of patient	Percent of patients
Male patients	33	60.0 %
Female patients	22	40.0 %
Age of patient when RAS was diagnosed		
0-20 yrs	13	23.6 %
21-40 yrs	13	23.6 %
41->60 yrs	7	12.7 %
> 61 yrs	22	40.1 %
Hypertension		
Normal	3	5.5 %
Prehypertension	6	10.9 %
Stage 1 hypertension	9	16.4 %
Stage 2 hypertension	37	67.3 %

old. The percentage of patients who were younger than 20 years old, between 21-40 years old, between 41-60 years old and older than 60 years old were 23.6 %, 23.6 %, 12.7 % and 40.0 %, respectively. Most patients (67.3 %) had their blood pressure higher than 160/100 mmHg (hypertension stage 2); 5.5 % of the patients (3 cases) had RAS without hypertension. These three cases were diagnosed with RAS by accidental finding with the coronary angiogram (CAG).

### Clinical symptoms and signs of RAS (Fig. 1)

The majority of the patients (50.9 %) were suspicious of RAS based on their clinical symptoms of hypertension in the age group lower than 35 years old; 5.45 % of the patients were found with the symptoms of malignant hypertension such as hypertensive encephalopathy (3.63 %) and aortic

dissection (1.82 %); 5.45 % of the patients had flash pulmonary edema; 7.27 % of the patients had azotemia after receiving angiotensin converting enzyme inhibitor (ACEI); 10.90 % of the patients had unexplained progressive azotemia; and, 5.45 % of the patients were found after the investigation of uncontrolled hypertension. Abdominal bruit was detected in 10.90 % of the patients during their physical examination; 7.27 % of the patients had disparity of kidney size more than 1.5 cm detected by ultrasound; hypokalemia was found in 10.90 % of the patients. Some patients had more than one clinical manifestation, e.g., six cases had hypertension in the young together with hypokalemia, three cases had hypertension in the young which was found with flash pulmonary edema; two cases had hypertension in the young found with hypertensive encephalopathy.

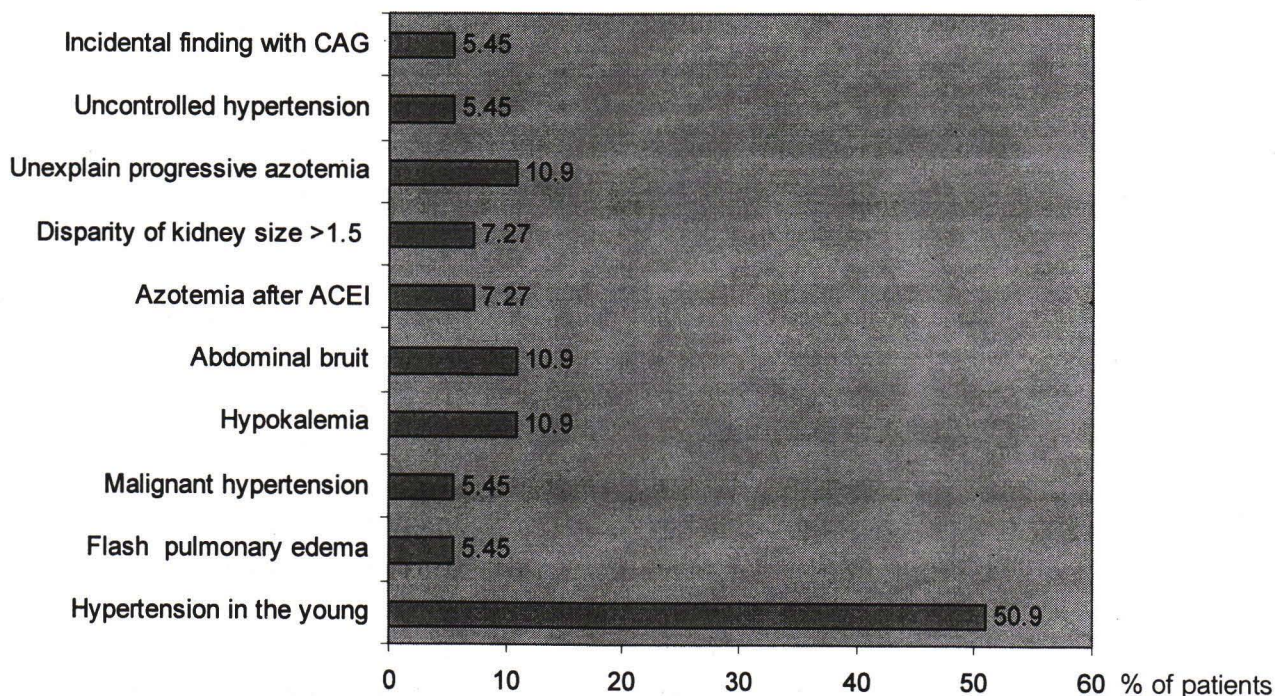


Figure 1. Clinical manifestations of patients with RAS (N =55).



### Comparison of diagnostic results in patient with RAS (Table 2)

The data showed that 30.90 %, 32.73 %, 40.00 % and 76.36 % of the RAS patients received Doppler ultrasound, Captopril renogram, MRA and renal angiogram, respectively. The majority of the patients (60.00 %) were diagnosed from more than

one technique; 12.73 % of the patients were diagnosed with more than two techniques; 7.27 % of the patients were diagnosed with all the four techniques. Most patients received renal angiogram which was regarded as the gold standard for diagnosis. Patients who were diagnosed with RAS were those who were positive by at least one techniques.

**Table 2.** Diagnostic methods of RAS in 55 patients.

No. patient	Age	Captopril				Clinical manifestations of patient
		Doppler U/S <sup>a</sup>	renogram <sup>b</sup>	MRA <sup>a</sup>	Angiogram <sup>a</sup>	
1	6.4	+	+	not done	+	Hypertension in the young
2	7	not done	not done	+	+	Hypertension in the young
3	52	not done	not done	not done	+	CAG with renal angiogram
4	69	+	not done	not done	+	Hypertension with abdominal bruit
5	44	not done	inconclusive	not done	-	Disparity of kidney size more than 1.5 cm
6	12	not done	+	not done	+	Hypertension in the young
7	84	not done	not done	+	+	Deterioration of renal function
8	22	not done	inconclusive	not done	+	Hypertension in the young with hypokalemia
9	21	not done	+	Not done	+	Hypertension in the young
10	34	not done	+	not done	+	Hypertension in the young
11	43	not done	+	not done	-	Hypertension in the young
12	10	+	+	+	+	Hypertension in the young
13	35	not done	inconclusive	not done	+	Hypertension in the young with antiphospholipid syndrome associated SLE
14	39	+	inconclusive	+	+	Hypertension in the young with Malignant hypertension
15	80	not done	not done	+	not done	Hypertension with ischemic bowel
16	4	+	not done	not done	+	Hypertension in the young
17	1.3	not done	not done	+	not done	Hypertension in the young
18	4	not done	+	not done	+	Hypertension in the young with hypokalemia
19	61	+	not done	not done	not done	Azotemia after ACEI
20	4.9	not done	not done	not done	+	CAG with renal angiogram
21	58	not done	not done	not done	+	Hypertension in the young
22	73	not done	not done	+	not done	Hypertension with hypokalemia
23	66	+	+	not done	-	Hypertension
24	69	not done	not done	not done	+	Hypertension with abdominal bruit
25	77	not done	not done	+	not done	Disparity of kidney size more than 1.5 cms with hypokalemia with azotemia after ACEI



Table 2. Continuous.

No. patient	Age	Doppler U/S <sup>a</sup>	Captopril renogram <sup>b</sup>	MRA <sup>a</sup>	Angiogram <sup>a</sup>	Clinical manifestations of patient
26	9	not done	+	+	-	Hypertension in the young
27	55	-	not done	+	-	Disparity of kidney size more than 1.5 cms
28	36	not done	not done	+	not done	Hypertension in the young with malignant hypertension
29	22	+	not done	not done	+	Hypertension in the young
30	70	not done	not done	+	not done	Hypertension
31	61	not done	not done	+	not done	Azotemia with ACEI
32	28	not done	not done	+	renal A-V fistula	Hypertension in the young with malignant hypertension
33	13	-	not done	not done	not done	Hypertension in the young
34	2	+	not done	+	Not done	Hypertension in the young
35	81	not done	not done	not done	+	Hypertension with deterioration of renal function
36	35	not done	+	not done	+	Hypertension in the young with hypokalemia
37	64	+	+	not done	not done	Hypertension with abdominal bruit
38	12	+	not done	not done	+	Hypertension in the young
39	62	not done	not done	+	+	CAG with renal angiogram
40	63	not done	not done	not done	+	CAG with renal angiogram and deterioration of renal function
41	28	not done	+	Not done	-	Hypertension in the young
42	80	not done	not done	+	+	Hypertension with abdominal bruit
43	64	not done	not done	+	-	Hypertension
44	81	not done	not done	not done	+	Hypertension with deterioration of renal function
45	37	not done	not done	not done	+	Hypertension in the young
46	5	not done	+	not done	-	Hypertension in the young with hypokalemia
47	68	not done	+	not done	-	Hypertension with azotemia after ACEI
48	74	+	not done	not done	not done	Disparity of kidney size more than 1.5 cms
49	64	not done	not done	not done	+	CAG with renal angiogram
50	57	not done	not done	+	-	Hypertension with deterioration of renal function
51	2.3	inconclusive	-	not done	+	Hypertension in the young
52	69	not done	not done	+	+	Hypertension with abdominal bruit
53	78	+	not done	not done	+	Hypertension with abdominal bruit
54	26	not done	not done	+	not done	Hypertension in the young
55	28	+	-	-	-	Hypertension in the young

a = positive diagnosis, as stenosis of either renal artery or both arteries more than 75 %

b= positive diagnosis, as renin dependent renal function, before and after Captopril was given to the patient

Regarding the diagnostic value of MRA, doppler ultrasound and captopril renogram when renal angiogram was the gold standard (Table 3), 17 cases received Captopril renogram and renal angiogram; 4 cases had inconclusive results due to impaired renal function (serum creatinine > 3 mg %). The data showed that captopril renogram had 87.5 % sensitivity, and 20 % specificity. Among the twelve cases who had Doppler ultrasound and renal angiogram, doppler ultrasound was not able to be concluded whether the patient had RAS in one case. Doppler ultrasound yielded false positive result in two cases. And no false negative was detected from Doppler ultrasound. The sensitivity of the test is 100 % and 33.3 % specificity. Among the twelve cases that received MRA and renal angiogram, MRA gave false positive in two cases; no false negative was detected from MRA, the sensitivity of which is 100 % and 60 % specificity.

### Characteristics of RAS patients who were younger than 35 years old (hypertension in the young) and those who were older than 35 years old.

Thirty patients who had RAS confirmed by renal angiogram were analyzed (Table 4). They were subsequently divided into two groups according to their age: firstly, the patients who were younger and equal or older than 35 years old (group 1 and group 2 respectively). There are 53.3 % (group 1) and 46.6 % (group 2) of cases in each group. The mean age of group 1 and group 2 was  $15.26 \pm 10.60$  years old and  $58.50 \pm 9.00$  years old, respectively. There was no statistically significant difference in the mean arterial pressure (MAP) between two groups of patients (MAP=  $122 \pm 33$  vs.  $109 \pm 10$  mmHg). In those whose hypertension was detected when they were younger than 35 years old had better renal function than

**Table 3.** Comparison of the diagnostic results of RAS by captopril renogram, doppler ultrasound, and MRA with renal angiogram.

	Renal angiogram positive <sup>a</sup>	Renal angiogram negative <sup>a</sup>
<b>Captopril renogram<sup>b</sup></b>		
positive	7	4
negative	1	1
cannot be concluded	3	1
<b>Doppler ultrasound<sup>a</sup></b>		
positive	8	2
negative	0	1
cannot be concluded	1	0
<b>MRA<sup>a</sup></b>		
positive	7	2
negative	0	3

a = positive diagnosis, as stenosis of either renal artery or both arteries more than 75 %

b= positive diagnosis, as renin dependent renal function, before and after Captopril was given to the patient

those who were older than or equal to 35 years old. Their mean serum creatinine (SCr) was  $1.21 \pm 1.17$  mg % vs.  $2.08 \pm 1.17$  mg % ( $P=0.001$ ); and mean creatinine clearance (CCr) was equal to  $71.4 \pm 26.45$  ml/min vs.  $26.20 \pm 15.23$  ml/min ( $P = 0.001$ ).

In most cases of RAS in whom hypertension was detected at the age lower than 35 years old, they were associated with the following diseases, Takayasu

(25 % of the cases), SLE with antiphospholipid syndrome (6.25 % of the cases). In the group of patients in whom hypertension was found at the age older than or equal to 35 years old, most patients suffered from conditions related to atherosclerosis, i.e., severe hypercholesterolemia, cardiovascular disease, diabetes and cerebrovascular disease at the following 85.7 %, 64.29 %, 21.4 % and 21.4 %, respectively.

**Table 4.** Characteristics of patients with RAS whose age were lower than 35 years old and more than or equal to 35 years old.

	Under 35 yrs N = 16 (53.3%)	Older than or equal to 35 yrs N = 14 (46.6%)	P value
Mean age (year $\pm$ SD)	$15.26 \pm 10.6$	$58.50 \pm 9.00$	< 0.001
Severity of hypertension ( mmHg )			
● normal	0	0	
● prehypertension	1 (6.25)	1 (7.14%)	
● hypertension grade I	2 (12.5)	3 (21.4%)	
● hypertension grade II	13 (81.25)	10 (71.4%)	
● mean MAP	$122 \pm 33$	$109 \pm 10$	0.181
Mean serum Cr $\pm$ SD (mg %)	$1.21 \pm 1.17$	$2.08 \pm 1.17$	0.001
Mean CCr $\pm$ SD (ml/min)	$71.4 \pm 26.45$	$26.20 \pm 15.23$	0.001
Underlying disease			
● Coronary artery disease	1 (5.9 %)	9 (64.29 %)	
● Diabetes mellitus	0 (0 %)	3 (21.4 %)	
● Dyslipidemia	1 (5.9 %)	12 (85.7 %)	
● CVA	0 (0 %)	3 (21.4 %)	
● Takayasu	4 (25 %)	-	
● SLE with APS	1 (6.25 %)	-	
● Fibromuscular dysplasia	-	1 (14.28 %)	

### Outcomes of RAS treatments

Among 30 cases of RAS which were diagnosed by renal angiogram, eighteen were treated with PTRAs and 12 cases were treated with antihypertensive drug (Table 5). There were no statistical differences of mean arterial pressure (MAP) between patients who had PTRAs or medications after 12 months of treatment (MAP =  $91 \pm 10$  mmHg in PTRAs group vs.  $87 \pm 12$  mmHg in medication group respectively P=0.862). There was no difference of change of MAP compared between patients who received PTRAs and received medications (change of MAP =  $23 \pm 47$  mmHg in PTRAs group and  $30 \pm 48$  mmHg in medication group).

The difference of serum creatinine (SCr) before treatment ( $1.97 \pm 0.31$  vs.  $0.94 \pm 0.42$  mmHg, P= 0.03) was detected between the two groups, but there was no difference of SCr after treatment ( $2.74 \pm 0.52$  mmHg vs.  $0.95 \pm 0.34$  mmHg; P= 0.052). Also, there was no difference of in the change of SCr after treatment. No difference of

creatinine clearance (CCr) between the two groups of patients, both before ( $49.14 \pm 12.46$  ml/min vs.  $70.89 \pm 19.55$  ml/min; P= 0.083) and after treatment ( $51.87 \pm 14.42$  ml/min vs.  $81.93 \pm 22.13$  ml/min; P=0.746). Patients who were treated with drugs had increased CCr more than those treated with PTRAs ( $0.50 \pm 7.07$  ml/min vs.  $4.63 \pm 27.04$  ml/min; P=0.025).

### Discussion

RAS is the most common condition of secondary hypertension. Generally, secondary hypertension is considered in the differential diagnosis of hypertension in the young. This study shows that RAS can be found in all age group of patients. Clinical signs which can lead to RAS include hypertension in the young, flash pulmonary edema, malignant hypertension, hypokalemia, abdominal bruit, azotemia after ACEI, disparity of kidney size more than 1.5 cm, unexplained progressive azotemia and uncontrolled hypertension.

**Table 5.** Comparison of MAP and renal function between PTRAs and medication treatment.

	PTRAs N=18	Medications N=12	P value
SCr (mg %)			
● pre treatment	$1.97 \pm 0.31$	$0.94 \pm 0.42$	0.030
● after 12 months	$2.74 \pm 0.52$	$0.95 \pm 0.34$	0.052
● change of SCr	$0.71 \pm 2.08$	$0.06 \pm 0.25$	0.164
CCr (ml/min)			
● pre treatment	$49.14 \pm 12.46$	$70.89 \pm 19.55$	0.083
● after 12 months	$51.87 \pm 14.42$	$81.93 \pm 22.13$	0.746
● change of CCr	$0.50 \pm 7.07$	$4.63 \pm 27.04$	0.025
MAP (mmHg)			
● pre treatment	$114 \pm 12$	$118 \pm 15$	0.049
● after 12 months	$91 \pm 10$	$87 \pm 12$	0.862
● change of CCr	$23 \pm 47$	$30 \pm 48$	0.933

The analysis of the diagnosis of RAS by non-invasive investigation has found that captopril had limitation in patients with impaired renal function and it frequently produced false positive, whereas Doppler ultrasound and MRA had 100 %sensitivity, with its specificity of 33.3 % and 60 %, respectively. Data from other previous studies showed that <sup>(6)</sup> the sensitivity and specificity of Doppler ultrasound was 84-98 % and 62-99 %, respectively. On the other hand, its sensitivity and specificity of MRA were 91 %-100 % and 76-94 %, respectively. This disparity can be due to the operator factor.

The study has found that the pathogenesis of RAS was different between patients who were younger than 35 years old vis-I-vis those who were older than 35 years old. RAS in patients who were younger than 35 years old mostly caused by Takayasu, whereas in patients who were equal or older than 35 years old mostly caused by atherosclerosis. In the group of patients in whom hypertension was found when they were younger than 35, their mean serum Cr and mean CCr were better than those in whom hypertension was found when they were older than 35 with statistical significance (P=0.001).

This study has found that patients who were treated with PTRAs had their blood pressure and renal function under control within 12 months. After receiving PTRAs treatment, there was no statistical significant difference when the patients were compared to those who were treated with antihypertensive drug. Study<sup>(7-8)</sup> showed that PTRAs can cause several complications, such as aortic dissection, atheroembolic shower, cholesterol embolization, arterial occlusion, and radiocontrast induced nephropathy. Considering that PTRAs and medications had the same efficacy for blood

pressure control and restoration of renal function, the medications treatment should be the priority for the treatment of RAS especially in patients who had atherosclerosis.

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