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Ischemic nephropathy: revascularization or conservative medical treatment?

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SUMMARY

Ischemic nephropathy is recognized as a distinct cause of renal insufficiency and it is defined as a significant reduction in glomerular filtration rate in patients with hemodynamically significant renovascular occlusive disease.

We argue the epidemiologic and clínica¡ manifestations of atherosclerotic renovascular disease, and we evaluate the pronostic agents.

Published studies of the outcome of revascularization for renal-artery stenosis have been excellent, offering a durable patency and functional improvement but they have had numerous limitations. The atherosclerosis is a systemic disease and it provides the general prognosis of patients.

We conclude that ischemic renal disease is a nephropathy of smoker men, with proteinuria excretion similar to nephropathy with unilateral stenosis. The age of patients is the clinical feature that decide the treatment: surgery, angioplasty/stent or medical management.

Comparative analysis of percutaneous transluminal angioplasty and operation for renal revascularization and medically treated patients have proved that the advanced chronic renal insufficiency is associated with an unfavourable response of treatment of the ischemic nephropathy. But, in this nephropathy the revascularization can be the better therapy for selected patients. The revascularization with angioplasty/stent for patients with unilateral renal stenosis and chronic renal insufficiency has a doubtful effectiveness, as the chronic renal failure is result of nephroangiosclerosis.

Key words: ***Ischemic nephropathy. Proteinuria. Revascularization.***

NEFROPATIA ISQUÉMICA: ¿REVASCULARIZACIÓN O TRATAMIENTO MÉDICO CONSERVADOR?

RESUMEN

La nefropatía isquémica es la enfermedad renal que origina insuficiencia renal a través de la reducción de filtrado glomerular, a consecuencia de la alteración significativa del flujo arterial renal principal.

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Se valoran los factores etiopatogénicos de la nefropatía isquémica y de otras nefropatías vasculares como la nefroangiosclerosis. Se revisan también sus factores pronósticos.

La revascularización tendría que ser el mejor tratamiento de la nefropatía isquémica. Sin embargo, cuando las estenosis de las arterias renales son consecuencia de lesiones arteriosclerosas, al incidir esta enfermedad de manera general en todo el organismo, no está tan claro que la revascularización sea la mejor opción terapéutica.

Partiendo de poblaciones seleccionadas, no equiparables entre sí, nos proponemos establecer el mejor tratamiento para cada una de ellas. Hemos podido comprobar que la afectación arteriosclerosa de las arterias renales en nuestro contexto es una enfermedad predominante en pacientes varones con hábito tabáquico, y que el daño parenquimatoso renal atendiendo a la determinación de proteinuria es parecido entre la verdadera nefropatía isquémica y la nefropatía vascular con afectación arterial unilateral.

Nuestros datos muestran que la edad es el único factor determinante de la opción terapéutica a seguir y que el grado de insuficiencia renal crónica en el momento del diagnóstico es índice pronóstico independiente de la nefropatía isquémica. La revascularización renal tiende a ser la mejor opción terapéutica en población seleccionada afecta de nefropatía isquémica. La revascularización renal endovascular, en casos de afectación renal unilateral con insuficiencia renal, ofrece resultados más dudosos de efectividad, ya que dicha insuficiencia renal crónica sería atribuible a la afectación renal intraparenquimatosa.

Palabras clave: ***Nefropatía isquémica. Proteinuria. Revascularización.***

INTRODUCCIÓN

Ischemic nephropathy is a nephropathy that causes renal failure and that is conditioned by a reduction in glomerular filtration in patients with hemodynamically significant occlusive renovascular disease.[1]

There is some controversy about the best treatment option for ischemic nephropathy (IN) when it is due to renal arteries arteriosclerosis since the latter affects the great renal vessels, being part of generalized arteriosclerosis and is concurrent with nephroangiosclerosis of the intraparenchymal arterioles.[2-5] Besides, complications following revascularization are not exceptional and, in a not negligible percentage of patients, renal function may deteriorate.[6]

It seemed that revascularization was the best treatment,[7,8] but in recent years published experiences have demonstrated that conservative medical treatment, in selected populations, may be the best therapeutic option[9,10].

The current clinical challenge is to differentiate, before choosing the treatment, those patients that will improve with revascularization- surgical or endovascular- and those that will have a better course with conservative medical treatment.

The GEDENI (Spanish Group for the Study of Ischemic Nephropathy), following Jacobson's criterion,[1] considered chronic renal failure (CRF) causing nephropathy as the a nephropathy caused by partial, although significant, or total obstruction of the main renal arteries (stenosis greater than 70% of renal arteries lumen), or in the case of single renal patients, of the artery of their single kidney.[11]

In this way, the difference would be made with the true IN of CRF due to vascular nephropathy caused by only intraparenchymal damage (nephroangiosclerosis -NAG-).

Thus, in those patients with both functional kidneys that might have CRF and significant stenosis of just one renal artery, having ruled out other nephropathies, renal failure would be attributable to nephroangiosclerosis.

In our Center, we established a management protocol that we have applied for the last 11 years, differentiating susceptible patients for revascularization, and the type of revascularization, from those candidate to conservative medical treatment. Management protocol was focused on establishing a clear goal: to define the criteria for establishing the best treatment option of IN. We have revised the outcomes for the last 11 years with the current objectives of: 1) esta-

blishing the epidemiological characteristics that differentiate true IN from vascular nephropathy due to NAG; 2) establishing the best therapeutic option for IN; and 3) establishing the best treatment in those cases with CRF and unilateral renal artery stenosis.

MATERIAL AND METHOD

In order to achieve the outlined goal, we revised the validity of the protocol once designed to establish the criteria for renal revascularization. For that purpose, we reviewed all patients diagnosed with partial (> 70% of the lumen) or total obstruction of renal artery/ies, from 01/01/1992 to 31/12/2002. Patients whose renal arterial flow impairment is attributable, through angiographic criteria, to arteriosclerotic lesions have been selected, ruling out other pathologies such as renal embolism and fibromuscular angiodysplasia. Ischemic nephropathy patients (bilateral or unilateral (if single kidney) obstruction) -IN-group- have been differentiated from those with single renal artery obstruction without significant stenosis of the contralateral artery -URAS group-.

At the time of diagnosis and therapeutic option decision-making, all patients had renal failure: they had plasma creatinine > 1.4 mg/dL or creatinine clearance < 70 mL/min in 24-hour urine sample, or both criteria.

In both groups, the following etiopathogenic factors have been reviewed: gender, age, cigarette smoking, diabetes mellitus, dyslipemia, (high total cholesterol), arterial hypertension (AHT), and obesity. Prognostic factors at the time of diagnosis such as left ventricular hypertrophy; coronary, carotid-cerebral, or peripheral (lower limbs) arteriosclerosis; abdominal aortic artery aneurysm; creatinine; creatinine clearance; proteinuria; vascular calcifications in plane abdominal radiographs; renal diameter less than 7.5 cm by ultrasound; ostium location of obstructive lesion at the time of diagnosis.

Patients' follow-up has been completed until 31/12/2002, or until entering into dialysis or death. At the end of the follow-up period, the rate of cardiovascular complications, chance of death from cardiovascular origin, creatinine, use of antihypertensive drugs as compared to the beginning of treatment chosen according to protocol, and dialysis requirement have been assessed.

Revascularization option has been chosen according to criteria shown in Table 1. Renal function worsening is defined as proven creatinine increase in more than one plasma creatinine level measurement of at least 1 mg/dL, or as 10 mL/min decrease in creatinine clearance, within a time interval of 1-3 months.

Severe generalized arteriosclerotic disease is defined as the one that has presented recent systemic manifestations, susceptible of diagnostic/therapeutic procedures within the last three months. Active ischemic cardiopathy is defined as any acute coronary syndrome occurred within the last 6 months.

The surgical-anesthetic risk is established according to the following criteria: 1) patients with low surgical risk: ASA I (healthy patient) and ASA II (non-complicated diabetes mellitus, controlled AHT, anemia, simple chronic bronchitis, morbid obesity), performance of surgical revascularization; 2) Patients with high surgical risk: ASA III (patient with severe systemic disease: chronic obstructive pulmonary disease, previous myocardial infarction..), performance of endovascular revascularization by means of angioplasty and/or intrarterial stent placement; 3) Patients with excessive surgical risk: ASA IV (patient with disabling disease: congestive heart failure; advanced pulmonary disease…), medical conservative treatment only.

Both in IN and URAS groups a comparison is made between the three treatments performed, chosen according to protocol, that is, surgical revascularization, endovascular revascularization, or medical treatment. Renal function progression is revised comparing creatinine levels and creatinine clearance at the beginning and at the end of study, comparing the three treatments as well.

Bilateral impairment cases belonging to IN-group and unilateral cases belonging to URAS group, but with normal renal function, are also recorded.

STATISTICAL ANALYSIS

Qualitative variables are expressed as number of cases and percentages, and quantitative variables as

Table I. Renal revascularization criteria in patients with renal artery obstruction greater than 70% of the lumen

- Revascularization in case of recent and significant worsening of renal function.
- Revascularization if longitudinal diameter > 7.5 cm by ultrasound or shorter but with adequate cortical width.
- Revascularization in the absence of severe generalized arteriosclerotic disease.
- Revascularization if absence of active coronary heart disease (absence of symptoms for the last months).
- No surgical risk: surgical revascularization.
- Surgical risk: endovascular revascularization by means of angioplasty/stent.
- Excessive surgical and endovascular risk: medical treatment.

means, standard deviation and range. Analysis of these variables is done by groups (unilateral/bilateral) and by treatments.

Comparison between groups (unilateral/bilateral) and between treatments is done by Chi-squared test or Fisher's exact test when dealing with proportions, and the statistics (Cochran and Mantel-Haenszel) when adjusting for other factors (multivariate), and Student's t test/ANOVA when dealing with means.

Normality assumptions are compared by a normality P-P Plot graph, frequency histogram, and with Kolmogorov-Smirnov comparison.

Comparison of quantitative variables progression such as number of antihypertensive drugs (before and after) and creatinine according to treatment group is done by ANOVA of repeated measurements.

Survival functions by treatment are estimated until starting on dialysis in patients alive by Kaplan-Meier, and a log-rank test is performed for comparison. In all applied tests, significance level is set at 5%.

RESULTS

During 11 years (from 01/01/1992 to 12/31/2002), 144 patients have been diagnosed with renal arteries obstructive disease (significant stenosis and in two cases complete obstruction of the main renal arteries with blood flow through collateral arteries), in our Center that provides health assistance to 400,000 inhabitants. In 49 patients, a bilateral or unilateral in single kidney patients obstruction of arteriosclerotic origin was diagnosed (IN group), whereas there were 36 patients diagnosed with URAS, with significant stenosis (> 70%) or obstruction of a single renal artery without significant obstruction of the contralateral artery. The remaining patients did not have arteriosclerotic obstruction of the renal artery (embolism, fibromuscular dysplasia, etc.) or there was arteriosclerosis with normal renal function (creatinine < 1.4 mg/dL and creatinine clearance > 70 mL/min).

IN-group comprised 38 men and 11 women, with a mean age of 69.3 years (40-84); mean age for males was 68.3 years and for females 74.2 years. URAS group comprised 35 men with a mean age of 66.8 years (51-91) and a 77 years old woman. Global mean age for males was 67.5 y. and for women 75.6 y.. Mean follow-up for IN-group was 34.2 months and for URAS group 35.2 months.

Table II shows the most remarkable clinical and epidemiological characteristics for both groups, without any significant differences between groups. We highlight constant cigarette smoking in men, which was inexistent in women. There is also no significant predominance of hypercholesterolemia in IN-group. Creatinine average at the time of diagnosis was essentially the same in both groups (2.3714 mg/dL for IN group and 2.3750 mg/dL for URAS group), while creatinine clearance was, respectively, 34.12 and 32.45 mL/min. In IN group, 4 patients with plasma creatinine < 1.4 mg/dL but with creatinine clearance repeatedly < 70 mL/min have been included; in URAS group, 6 patients with these same characteristics have been included.

We do highlight the fact that bilateral obstruction with normal renal function is rare (just one case out of 50; 2%), whereas it is more frequent in the case of unilateral obstruction (8 out of 44; 22.2%).

Systemic extension of arteriosclerosis or AHT control did not show significant differences between both groups. Deaths from a cardiovascular origin tended to be more frequent in cases of true ischemic nephropathy than in the cases of only unilateral disease, although a statistical significance was not reached.

The remaining etiopathogenic or prognostic factors shown in Table 3 did not show any kind of sta-

Table II. Remarkable characteristics

Ischemic nephropathy group: 49 patients (38 males; 11 females) **Mean age: 69.6 y**	**Unilateral renal artery stenosis group: 36 patients (35 males; 1 female)** **Mean age: 67.1 y**
• Cigarette smoking: 94.2% M; 0% F	• Cigarette smoking: 91.7% M; 0% F
• Dyslipemia: 63.3%	• Dyslipemia: 47.2%
• Coronary heart disease: 46.9%	• Coronary heart disease: 38.8%
• CVA: 36.7%	• CVA: 27.8%
• Peripheral arteriopathy: 65.3%	• Peripheral arteriopathy: 72.2%
• Initial creatinine: 2.37 mg/dL > final: 2.91 mg/dL	• Initial creatinine: 2.37 mg/dL > final: 3.11 mg/dL
• AHT control: antihypertensive drugs intake at the beginning = 2.06 >> final = 2.14	• AHT control: antihypertensive drugs intake at the beginning = 1.75 >> final = 2.00
• Cardiovascular deaths: 24.5%	• Cardiovascular deaths: 19.4%
• Bilateral involvement with normal renal function: 1 (2%)	• Bilateral involvement with normal renal function: 8 (22.2%)
M: males; F: females; CVA: cerebral vascular attack; AHT: arterial hypertension.	M: males; F: females; CVA: cerebral vascular attack; AHT: arterial hypertension.

tistically significant difference between both groups. Referred proteinuria is an average of patients' proteinuria. Ostium location in the case of ischemic nephropathy has been considered if at least one of both arteries presented stenosis at that level. Vascular calcifications considered have been those present at plane abdominal radiographs. The notified renal diameter is the longitudinal one shown with renal ultrasound. Additional renal survival detailed in the Table does not show a statistical significance either.

Average follow-up period for IN-group was 34.2 months (2-120) during which time, out of 49 diagnosed patients, 6 were submitted to surgical revascularization, 25 to angioplasty/stent placement and 18 were medically treated only. Table 4 shows that the degree of renal failure at the time of diagnosis is a prognostic index independent from other factors. The same table also shows the remarkable characteristics of the three adopted treatment subgroups. Mean age of each of the subgroups is different and clearly statistically significant. Besides renal function prognosis, this datum is the only one that differentiates them, as shown in Figure 1. Arterial hypertension management with antihypertensive drugs in the three treatments groups is shown in Figure 2.

Average follow-up time for URAS group was 35.2 months (2.-132), during which out of 36 diagnosed patients, 5 were submitted to surgical revascularization, 10 to angioplasty/stent placement and 21 were medically treated only. Shown in Table 5, and similarly to what happens in IN group, the degree of renal failure at the time of diagnosis might influence the disease prognosis (the cutoff point for creatinine clearance has been set at 34.12 mL/min, the same as for IN group, and similar to the mean for that group, 32.45 mL/min), although in this case, it is not the same way since patients treated one way or the other are not comparable (multivariate analysis).

Also are shown characteristics of the subgroups selected by adopted treatment. There are no significant differences between them. Figures 3 and 4 show, as for IN-group, a trend to a better prognosis for patients treated with revascularization as compared to those treated with only pharmacological medical conservative treatment.

Table III. Etiopathogenic and prognostic factors and overall survival for ischemic nephropathy group and unilateral renal artery stenosis group

	IN Group	URAS Group
* Diabetes mellitus (%)	26.5	19.4
* Obesity (%)	30.6	27.8
* High blood pressure (%)	92	88
* Left ventricular hypertrophy (%)	46.9	44.4
* Proteinuria	0.72 g/24 h	0.80 g/24 h
* Aortic artery aneurysm (%)	18.4	25
* Ostium location (%)	49	50
* Vascular calcifications (%)	75	77
* Renal diameter < 7.5 cm (%)	20	16.6
* Overall survival (%)	53	55.5

IN: ischemic nephropathy; URAS: unilateral renal artery stenosis; %: percentage of cases in each group.

DISCUSSION

Renal arteries arteriosclerosis is often accompanied by the same arteriosclerotic lesions in other in extrarenal vessels; and vice versa, there are atherosclerotic lesions in renal arteries when there exists coronary disease and peripheral arteriopathy.[12-16] Intraparenchymal renal vessels are affected, as well, leading to nephroangiosclerosis.[2-5,17-19] These two concepts may condition prognosis in ischemic nephropathy, independently of treatment performed: general patient's prognosis will be determined by systemic involvement from the disease and the degree of intraparenchymal renal impairment.[16,18,19] When

Table IV. The degree of renal failure at the time of diagnosis is an independent prognostic factor. The most remarkable characteristics are shown for each group according to adopted treatment in patients with ischemic nephropathy

Initial Creat.	n	Dialysis
> 2.3 mg/dl	16	6 (37.5%)*
< 2.3 mg/dl	33	3 (9.1%)*

* $p < 0.05$

Creat. Clearance	n	Dialysis
< 34 cc/min	25	7 (28%)**
> 34 cc/min	24	2 (8.3%)**

**p = 0.068

Treatment	Medical	Angioplasty/stent	Surgical
Number	18	25	6
Mean age (years)	71.38	70.96	58.5*
CHD + CVA	66.6%	56%	0%
Follow-up (months)	27.7	36.5	43.3
Creatinine initial > final	2.15 > 3.08	2.48 > 2.78	2.55 > 2.98**
Antihypertensive drugs Initial > final	1.66 > 2.16	2.36 > 2.20	2.00 > 1.83
Survival/Dialysis	50%/22.2%	52%/12%	66%/16.6%
Cardiovascular deaths	22.2% (4/5)	28% (7/10)	16.6% (1/1)

*$p < 0.01$. **$p < 0.05$.

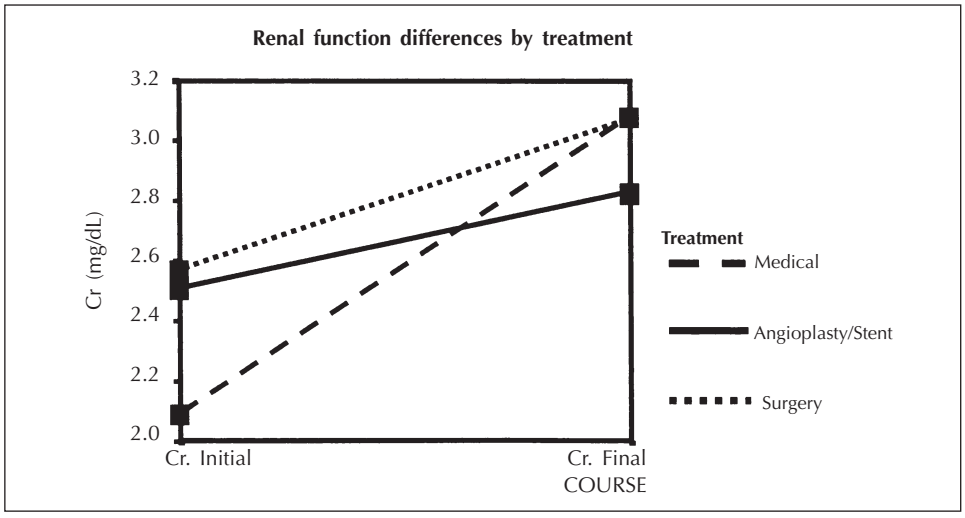

Fig. 1.—Renal function course depending on performed treatment in patients with ischemic nephropathy, bilateral involvement or unilateral involvement in single kidney patients. Cr.: creatinine.

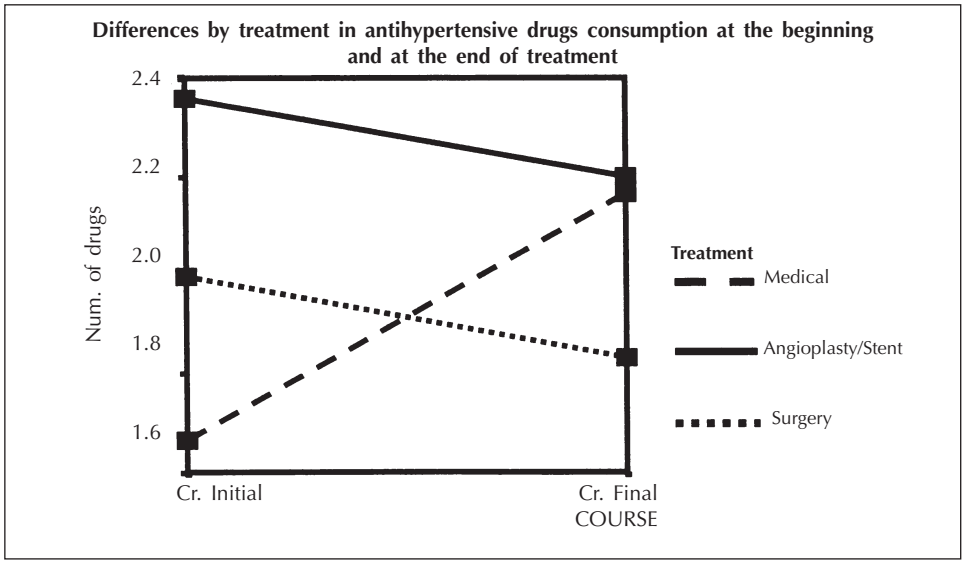

Fig. 2.—Arterial hypertension control depending on adopted treatment throughout the follow-up period, by antihypertensive treatment in patients diagnosed with ischemic nephropathy.

deciding what therapeutic option to choose, these prognostic factors will have to be taken into account. In that sense, the designed protocol to establish the need for renal revascularization essentially deals with the following two issues: 1) generalization of arteriosclerotic disease; 2) degree of severe parenchymal involvement. Revascularization is done when there is progressive renal function worsening (likely existence of viable tissue) and it is not performed when renal shapes are smaller than 7.5 cm in longitudinal diameter (likely existence of non viable tissue).

Then, from different and not comparable selected populations, we won't be able to conclude whether surgical or endovascular revascularization is better than medical conservative treatment. Our aim will be to conclude on the best treatment with populations previously selected as per protocol.

We have not found significant etiopathogenic differences between IN and URAS groups. This corroborates that we are dealing with the same disease, having the same accidental fact of one or two renal arteries involvement. IN my have particular prognostic connotations by having main renal flow impairment of both kidneys or of the only kidney in single kidney patients;[12,17] however, overall survival has not remarkable differences between both groups.

Speaking about etiopathogenic factors, we just would like to highlight that in our setting renal arteries arteriosclerosis is, for the time being, a disea-

Table V. In unilateral involvement, since selected treatment is not comparable in each therapeutic option (multivariate analysis), we cannot affirm that the degree of renal failure at the time of diagnosis is an independent prognostic factor. The most remarkable characteristics are shown for each subgroup according to performed treatment

Initial Creat.	n	Dialysis
> 2.3 mg/dl	16	7 (43.8)*
< 2.3 mg/dl	20	0 (0%)*

* $p < 0.01$.

Creat. Clearance	n	Dialysis
< 34 cc/min	20	7 (35%)**
> 34 cc/min	16	0 (0%)**

**p = 0.01.

Treatment	Medical	Angioplasty/Stent	Surgical
Number	21	10	5
Mean age (years)	70.3	67.5	66.2
CHD + CVA	57.1%	50%	0%
Follow-up (months)	31.8	33.7	52.2
Creatinine initial > final	2.74 > 3.75	2.15 > 3.57	1.26 > 1.36
Antihypertensive drugs initial > final	1.71 > 2.00	1.90 > 2.40	1.60 > 1.20
Survival/Dialysis	47.6%/19%	60%/30%	80%/0%
Cardiovascular deaths	28.5% (6/7)	10% (1/1)	0% (0/1)

se of male smokers patients. It has been present in 14% of women, and none of them had a history of cigarette smoking. Female incidence of diabetes mellitus, arterial hypertension or dyslipemias was not higher than in men; age really was remarkably different: women had renal arteriosclerosis but with higher age average (67.5 vs. 75.6 y.).

Possible prognostic indices have not offered significant differences between both groups either, although IN is associated with a greater number of complications and deaths from cardiovascular origin, but without any significant difference. Theoretically, IN-group is affected by more advanced systemic arteriosclerosis; its coronary and carotid-cerebral disease incidence is higher than for URAS group (83.6% vs. 66.6%, respectively). However, and surprisingly, peripheral arteriopathy (65.3% vs. 72.2%) and abdominal aortic artery aneurysm (18.4% vs. 25%) are more common in the latter group. In short, our data interpretation is that all involvement is only one, i.e. arteriosclerosis, and that bilateral and unilateral involvement is circumstantial. With this regard, there are groups that find a more spread sclerotic vascular impairment in the IN group.[12,16-19]

An issue that we would like to highlight is proteinuria. In vascular nephropathy there is proteinuria more or less constantly.[5,18,20] Some authors advocate the role of proteinuria as a vascular nephropathy prognostic index, similarly to what occurs in other types of nephropathy such as diabetic nephropathy.[18] There are even reports of proteinuria in the nephrotic range attributable to renin-angiotensin system,[21] nephroangiosclerosis,[22] segmentary and focal glomerulosclerosis associated to renovascular disease[23,24] and/or manifested after revascularization.[25] In our case, proteinuria average in both groups does not reach 1 gr/24 hours at the time of diagnosis. It would be expected that it would be higher in URAS group considering that intraparenchy-

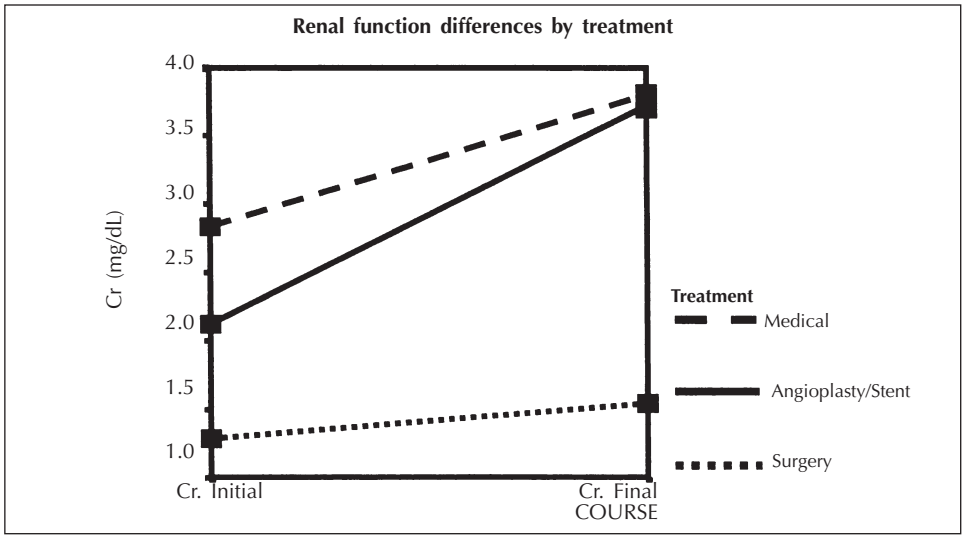

Fig. 3.—Renal function course depending on performed treatment in the group of unilateral renal artery stenosis. Cr.: creatinine.

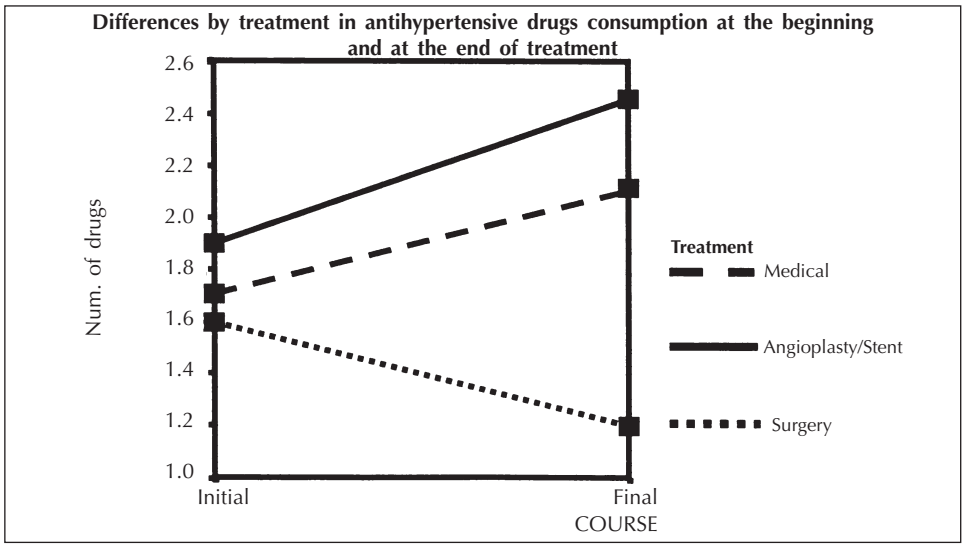

Fig. 4.—Arterial hypertension control depending by consumption of antihypertensive drugs depending on adopted treatment in patients with unilateral renal artery stenosis.

mal damage due to nephroangiosclerosis could be more severe. However, it has been similar, which favors the thought that all is the same disease and that the degree of intrarenal damage in IN-group could be similar to the one in URAS group.[18,19]

Although parenchymal involvement may be determinant on IN prognosis, vascular involvement of the main renal artery plays an important role in renal function impairment: we have found just one patient with significant blood flow impairment in both renal arteries with normal renal function (2%), whereas incidence of normal renal function in patients with significant stenosis of one renal artery is more frequent (22.2%).

Renal revascularization improves renal function in most of the cases in which this condition presents as progressive renal failure, usually accompanied by AHT,[1,2,6-11] and in cases of disease presentation with acute renal failure.[26,27] Thus, the goal of revascularizing must be in view when diagnosing an ischemic nephropathy. Besides, the diagnosis of ischemic vascular nephropathy is not infrequent among patients treated permanently with dialysis for end-stage chronic renal failure,[28-31] and the former condition will lead to more frequent and severe cardiovascular complications within the dialyzed population if compared to other nephropathies, with the exception of diabetic nephropathy. Also for this reason, early diagnosis and treatment are advisable,[32,33] especially knowing that arteriosclerotic stenosis is progressive and entails the risk for renal atrophy.[34,35]

However, for the last few years, these concepts are changing in arteriosclerotic disease. There are positive experiences with only conservative medical treatment with antihypertensive drugs, blood-thinners and statins[9,10,36-40] that is always done jointly with revascularization. Some authors, such as SC Textor,[36] who in 1998 already claimed not to be excessively enthusiastic with renal revascularization because of potential complications and the financial burden, currently are even less enthusiastic because of the same potential efficacy with conservative medical treatment.[4,40]

In this setting, our experience is a valid one to confirm that revascularization must be, even today, the therapeutic goal for ischemic nephropathy. Even in patients with unilateral arterial involvement with contralateral preserved artery, there is a tendency for revascularization as the best therapeutic option. However, in this group, in our experience, there are no evident differences between medical treatment and endovascular revascularization. The degree of renal function worsening and blood pressure control are very similar. In URAS group, endovascular revascularization offers a longer survival, but the need for dialysis during the follow-up is also higher. These results point to treatment advisory always in an individualized manner. We must consider that in both groups, the longest follow-up occurs in patients treated with revascularization, especially those surgically treated. Thus, it may be deduced that in revascularized patients mortality is lower, entry into a dialysis program occurs later, especially in IN-group, depending on the time of follow-up, and renal function and blood pressure are better controlled.

The obtained data with regards to better renal function and blood pressure control are in agreement with those published by others,[7,8,31,41] and disagree from others.[37,38,42-44] Tuttle *et al*[41] and van de Ven *et al*[45] refer a better prognosis after renal revasculari-

zation with stent placement and lesions localized at the ostium. We have not individualized this issue.

However, in cases of unilateral stenosis, the French group of Plouin *et al*,[46] not enthusiastic with revascularization, obtains an immediate benefit after revascularization of the stenotic kidney, with an additional benefit on the non-stenotic contralateral kidney within 6 months of revascularization. In our case, we observed that only with surgical revascularization, and there are few patients.

We highlight the fact that renal failure degree at the time of diagnosis significantly, and independently from other factors, influences the disease prognosis. Therefore, in agreement with other authors, we confirm that early diagnosis must improve patients' perspectives.[4,8,12,18,30,40,47,48] We must revascularize potentially viable renal parenchyma,[40] which implies an early diagnosis or a recent deterioration of renal function.[48] In this regard, Muray' s study demonstrates that a rapid renal function worsening may be a good prognostic factor for endovascular revascularization with angioplasty.[48]

In clinical situations such as CRF made worse by the use of antihypertensive drugs, especially ACE inhibitors or ACE receptor antagonists,[49,50] or by occurrence of repeated episodes of acute lung edema in the presence of CRF of unknown origin, or severe AHT, etc.,[51] it is essential to evaluate renal artery flow by means of the radiographic examinations with the highest diagnostic profitability in each center.[52,53] The surgery and interventional radiology teams should have enough experience, with acceptable morbidity and mortality ranges.[69,7,9] We will then choose the therapeutic option according to center.[54] In this sense, surgical revascularization is more costly but may be more definitive,[55] and in our experience it is indicated in young patients with a low surgical risk. This experience may be extrapolated to other centers similarly equipped, but it ought to be corroborated with a higher number of patients and a longer follow-up period.

Within each group, populations are not homogenous with regards to therapeutic orientation, so that we cannot draw unequivocal conclusions, although our results advise revascularization whenever the patient's global clinical condition allows for it and whenever there is sufficient renal parenchyma susceptible of revascularization. Renal function and blood pressure control are better stabilized.

We are able to conclude that: 1) arteriosclerotic involvement of renal arteries in our setting is a disease predominantly seen in male, smoker patients; 2) parenchymal renal damage according to proteinuria levels is similar between true ischemic nephropathy and nephropathy with unilateral involvement; 3) in ischemic nephropathy, the degree of chronic renal failure at the time of diagnosis is a disease-independent prognostic factor; 4) age is the only statistically significant factor, which may determine one or the other therapeutic option in both groups; 5) renal revascularization is the best therapeutic option in a selected population suffering from ischemic nephropathy; 6) renal revascularization in the setting of unilateral involvement requires a more individualized treatment.

REFERENCES

1. Jacobson HR: Ischemic renal disease: an overlooked clinical entity? *Kidney Int* 34: 729-743, 1988.
2. Greco BA, Breyer JA: Atherosclerotic ischemic renal disease. *Am J Kid Dis* 29: 167-187, 1997.
3. Conlon PJ, O'Riordan E, Kalra PA: New insights into the epidemiologic and clinical manifestations of atherosclerotic renovascular disease. A*m J Kid Dis* 35: 573-587, 2000.
4. Safian RD, Textor SC: Renal-artery stenosis. *N Engl J Med* 344: 431-442, 2001.
5. Marin R, Gorostidi M, Pobes A: Hipertensión arterial y enfermedad vascular renal: nefroangiosclerosis. *Nefrología* XXII, (Supl. 1): 36-45, 2002.
6. Martin LG, Rundback JH, Sacks D, Cardella JF, Rees CR, Metsumoto AH, Meranze SG, Schwartzberg MS, Silverstein MI, Lewis CA: Quality improvement guidelines for angiography, angioplasty, and stent placement in the diagnosis and treatment of renal artery stenosis in adults. *J Vasc Interv Radiol* 13: 1069-1083, 2002.
7. Erdoes LS, Berman SS, Hunter GC, Mills JL: Comparative analysis of percutaneous transluminal angioplasty and operation for renal revascularization. *Am J Kid Dis* 27: 496-503, 1996.
8. Paulsen D, Klow NE, Rogstad B, Leivestad T, Lien B, Vatne K, Fauchald P: Preservation of renal function by percutaneous transluminal angioplasty in ischaemic renal disease. *Nephrol Dial Transplant* 14: 1454-1461, 1999.
9. Radermacher J, Brunkhorst R: Diagnosis and treatment of renovascular stenosis -a cost- benefit analysis. *Nephrol Dial Transplant* 13: 2761-2767, 1998.
10. Ives NJ, Wheatley K, Stowe RL, Krijnen P, Plouin PF, van Jaarsveld BC, Gray R: Continuing uncertainty about the value of percutaneous revascularization in atherosclerotic renovascular disease: a meta-analysis of randomized trials. *Nephrol Dial Transplant* 18: 298-304, 2003.
11. Alcázar JM y Grupo de estudio de la Nefropatía isquémica. *Nefrología* XX, (Supl. 1): 64, 2000.
12. Hansen KJ: Prevalence of ischemic nephropathy in the atherosclerotic population. Am J Kid Dis 24: 615-621, 1994.
13. Missouris CG, Papavassiliou MB, Khaw K, Hall T, Belli AM, Buckenham T, MacGregor GA: High prevalence of carotid artery disease in patients with atheromatous renal artery stenosis. *Nephrol Dial Transplant* 13: 945-948, 1998.
14. Metcalfe W, Reid AW, Geddes CC: Prevalence of angiographic atherosclerotic renal artery disease and its relationship to the anatomical extent of peripheral vascular atherosclerosis. *Nephrol Dial Transplant* 14: 105-108, 1999.
15. Conlon PJ, Little MA, Pieper K, Mark DB: Severity of renal vascular disease predicts mortality in patients undergoing coronary angiography. *Kidney Int* 60: 1490-1497, 2001.
16. Shurrab AE, MacDowall P, Wright J, Mamtora H, Kalra PA: The importance of associated extra-renal vascular disease on

the outcome of patients with atherosclerotic renovascular disease. *Nephron* 93: c51-c57, 2003.
17. London GM, Drüeke DB: Atherosclerosis and arteriosclerosis in chronic renal failure. *Kidney Int* 51: 1678-1695, 1997.
18. Wright JR, Shurrab AE, Cheung C, Waldek S, O'Donoghue DJ, Foley RN, Mamtora H, Kalra PA. A prospective study of the determinants of renal functional outcome and mortality in atherosclerotic renovascular disease. *Am J Kid Dis* 39: 1153-1161, 2002.
19. Cheung CM, Wright JR, Shurrab AE, Mamtora H, Foley RN, O'Donoghue DJ, Waldek S, Kalra PA: Epidemiology of renal dysfunction and patient outcome in atherosclerotic renal artery occlusion. *J Am Soc Nephrol* 13: 149-157, 2002.
20. Freedman BI, Iskandar SS, Buckalew jr VM, Burkart JM, Appel RG: Renal biopsy %ndings in presumed hypertensive nephrosclerosis. *Am J Nephrol* 14: 90-94, 1994.
21. Eiser AR, Katz SM, Swartz C: Reversible nephrotic range proteinuria with renal artery stenosis: a clinical example of renin-associated proteinuria. *Nephron* 30: 374-377, 1982.
22. Montoliu J, Torras J, Campistol JM, Darnell A, Panadés MJ, Ramos J: Proteinuria intensa e insuficiencia renal en la nefroangiosclerosis «benigna». *Nefrología* XI: 30-39, 1991.
23. Thadhani R, Pascual M, Nickeleit V, Tolkoff-Rubin N, Colvin R: Preliminary description of focal segmental glomerulosclerosis in patients with renovascular disease. *Lancet* 347: 231-233, 1996.
24. Ubara Y, Hara S, Katori H, Yamada A, Morii H: Renovascular hypertension may cause nephrotic range proteinuria and focal glomerulosclerosis in contralateral kidney. *Clin Nephrol* 48: 220-223, 1997.
25. Kanagasundaram NS, Allan BJ, Kessel D, Newstead CG, Worth DP: Nephrotic syndrome after successful renal angioplasty. *Nephrol Dial Transplant* 13: 767-768, 1998.
26. Louden JD, Leen GLS, Cove-smith R: Systemic thrombolysis for bilateral atherosclerotic renal artery occlusion resulting in prolonged recovery of renal function. *Nephrol Dial Transplant* 13: 2924-2926, 1998.
27. Dwyer KM, Vrazas JI, Lodge RS, Humphery TJ, Schlicht SM, Murphy BF, Mossop PJ, Goodman DJ: Treatment of acute renal failure caused by renal artery occlusion with renal artery angioplasty. *Am J Kid Dis* 40: 189-194, 2002.
28. Appel RG, Bleyer AJ, Reavis S, Hansen KJ: Renovascular disease in older patients beginning renal replacement therapy. *Kidney Int* 48: 171-176, 1995.
29. Fatica RA, Port FK, Young EW: Incidence trends and mortality in end-stage renal disease attributed to renovascular disease in the United States. *Am J Kid Dis* 37: 1184-1190, 2001.
30. Van Ampting JMA, Penne EL, Beek FJA, Koomans HA, Boer WH, Beutler JJ: Prevalence of atherosclerotic renal artery stenosis in patients starting dialysis. *Nephrol Dial Transplant* 18: 11471151, 2003.
31. Korsakas S, Mohaupt MG, Dinkel HP, Mahler F, Do DD, Voegele J, Baumgartner 1: Delay of dialysis in end-stage renal failure: Prospective study on percutaneous renal artery interventions. *Kidney Int* 65: 251-258, 2004.
32. Coen G, Manni M, Giannoni MF, Bianchini G, Calabria S, Mantella D, Pigorini F, Taggi F: Ischemic nephropathy in an elderly nephrologic and hypertensive population. *Am J Nephrol* 18: 221227, 1998.
33. Baboolal K, Evans C, Moore RH: Incidence of end-stage renal disease in medically treated patients with severe bilateral atherosclerotic renovascular disease. *Am J Kid Dis* 31: 971-977, 1998.
34. Strandness Jr DE: Natural history of renal artery stenosis. *Am J Kid Dis* 24: 630-635, 1994.
35. Caps MT, Zierler RE, Polissar NL, Bergelin RO, Beach KW, Cantwell-Gab K, Casadei A, Davidson RC, Strandness Jr DE: Risk of atrophy in kidneys with atherosclerotic renal artery stenosis. *Kidney Int* 53: 735-742, 1998.
36. Textor SC: Revascularization in atherosclerotic renal artery disease. *Kidney Int* 53: 799-811, 1998.
37. Plouin PF, La Batide Alanore A: Management of the patient with atherosclerotic renal artery stenosis. New information from randomized trials. *Nephrol Dial Transplant* 14: 1623-1626, 1999.
38. Beutler JJ, van Ampting JMA, van de Ven PJG, Koomans HA, Beek FJA, Woittiez AJJ, Mali WPTM: Long-term effects of arterial stenting on kidney function for patients with ostial atherosclerotic renal artery stenosis and renal insufficiency. *J Am Soc Nephrol* 12: 1475-1481, 2001.
39. Plouin PF, Rossignol P, Bobrie G: Atherosclerotic renal artery stenosis: To treat conservatively, to dilate, to stent, or to operate? *J Am Soc Nephrol* 12: 2190-2196, 2001.
40. Textor SC: Stable patients with atherosclerotic renal artery stenosis should be treated first with medical management. *Am J Kid Dis* 42: 858-863, 2003.
41. Tuttle KR, Chouinard RF, Webber JT, Dahlstrom LR, Short RA, Henneberry KJ, Dunham LA, Raabe RD: Treatment of atherosclerotic ostial renal artery stenosis with the intravascular stent. *Am J Kid Dis* 32: 611-622, 1998.
42. Van Jaarsveld BC, Krijnen P, Pieterman H, Derkx FHM, Deinum J, Postima CT, Dees A, Woittiez AJJ, Bartelink AKM, Man in't Veld AJ, Schalekamp MADH: The effect of balloon angioplasty on hypertension in atherosclerotic renal-artery stenosis. *N Engl J Med* 342: 1007-1014, 2000.
43. Leertouwer TC, Derkx FHM, Pattynama PMT, Deinum J, van Dijk LC, Schalekamp MADH: Functional effects of renal artery stent placement on treated and contralateral kidneys. *Kidney Int* 62: 574-579, 2002.
44. Ramos F, Kotliar C, Álvarez D, Baglivo H, Rafaelle P, Londero H, Sánchez R, Wilcox CS: Renal function and outcome of PTRA and stenting for atherosclerotic renal artery stenosis. *Kidney Int* 63: 276-282, 2003.
45. Van de Ven PJG, Kaatee R, Beutler JJ, Beek FJA, Woittiez AJJ, Buskens E, Koomans HA, Mali WPT: Arterial stenting and balloon angioplasty in ostial atherosclerotic renovascular disease: a randomised trial. *Lancet* 353: 282-286, 1999.
46. La Batide-Alanore A, Azizi M, Froissart M, Raynaud A, Plouin PF: Split renal function outcome after renal angioplasty in patients with unilateral renal artery stenosis. *J Am Soc Nephrol* 12: 1235-1241, 2001.
47. Jungers P, Khoa TN, Massy ZA, Zingraff J, Labrunie M, Descamps-Latscha B, Man NK: Incidence of atherosclerotic arterial occlusive accidents in predialysis and dialysis patients: a multicentric study in the Ile de France district. *Nephrol Dial Transplant* 14: 898-902, 1999.
48. Muray S, Martin M, Amoedo ML, García C, Rodríguez Jomet A, Vera M, Oliveras A, Gómez X, Craver L, Real MI, García L, Botey A, Montanyá X, Fernández E: Rapid decline in renal function reflects reversibility and predicts the outcome after angioplasty in renal artery stenosis. *Am J Kid Dis* 39: 60-66, 2002.
49. Amoedo ML, Fernández E, Pais B, Mardaras J, Salamero P, Montoliu J: Insuficiencia renal aguda durante el tratamiento con inhibidores de la enzima de conversión. *Nefrología* XII (Supl. 4): 160-164, 1992.
50. Van de Ven PJG, Beutler JJ, Kaatee R, Beek FJA, Mali WPTM, Koomans HA: Angiotensin converting enzyme inhibitor-induced renal dysfunction in atherosclerotic renovascular disease. *Kidney Int* 53: 986-993, 1998.
51. Ducloux D, Jamali M, Chalopin JM: Chronic congestive heart failure associated with bilateral renal artery stenosis. *Clin Nephrol* 48: 54-55, 1997.

52. Pedersen EB: New tools in diagnosing renal artery stenosis. *Kidney Int* 57: 26572677, 2000.
53. Vasbinder GBC, Nelemans PJ, Kessels AGH, Kroon AA, de Leeuw PW, van Engelshoven JMA: Diagnostic tests for renal artery stenosis in patients suspected of having renovascular hypertension: A meta-analysis. *Ann Intern Med* 135: 401-411, 2001.
54. Van Jaarsveld B, Krijnen P, Bartelink A, Dees A, Derkx F, Man in't Veld A, Schalekamp M: The Dutch renal artery stenosis intervention cooperative (DRASTIC) study: rationale, design and inclusion data. *J Hypertens* 16, (Supl. 6): 21-27, 1998.
55. Rodicio JL, Alcázar JM: Hipertensión arterial y nefropatía isquémica. *Nefrología* XXII, (Supl. 2): 68-69.