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Bilateral Renal Cortical Necrosis with the Changes in Clinical Features over the Past 15 Years (1980-1995)

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A rare case of bilateral renal cortical necrosis (BRCN) diagnosed only by the characteristic and specific findings of a contrast-enhanced CT scan during the acute initial phase of the disease is presented in this paper. Furthermore, twenty-eight patients of BRCN in the world literatures in English after 1980 were analyzed to investigate the changes in its clinical features over the past 15 years in comparison with the reported data before 1980 from two large centers in France (F) and India (I). Obstetric causes decreased from 68% (F) and 71% (I) before 1980 to 28% after 1980, whereas nonobstetric causes increased from 32% (F) and 29% (I) to 72% after 1980. Among the nonobstetric causes of BRCN, the leading causes were sepsis in 4 out of 12 patients (F) and snake bite in 6 out of 14 patients (I) before 1980, but, in contrast, drugs in 4 out of 21 patients after 1980. As a definite diagnostic procedure for BRCN, 95 to 100% before 1980 but 86% after 1980 performed renal biopsy, of which renal biopsy while living was done in only 42% (F) and 16% (I) before 1980 and 67% after 1980, None showed renal calcification in abdominal X-ray, and only 25% (3 / 12) had nonspecific echo findings in renal ultrasonography, whereas the high sensitivity for BRCN was noted in renal arteriography in 100% (6 / 6) and contrast-enhanced CT scan in 88% (7 / 8). The mortality of BRCN decreased from 55% (F) and 86% (I) before 1980 to 36% after 1980. This review of BRCN, in conclusion, revealed the distinctive changes over the past 15 years in the etiology with a higher incidence of non-obstetric causes than obstetric ones, diagnostic procedures with less dependence on renal biopsy but new trials of non-invasive radioimagings incuding CT scan and even MRI, and a further declining mortality rate.

Key Words : *Renal cortical necrosis, Review, Etiology, Diagnosis, CT scan*

INTRODUCTION

Since BRCN, a rare but the most catastrophic type of all cases of acute renal failure (ARF), was first reported in 1883 by Friedlander, hundreds of patients have been described in either scattered case reports or analysis of a large number of patients from two seperate single centers from France (the Necker hospital) and India (a referral center) before 1980 (Kleinknecht et al., 1973 ; Chugh et al., 1983 ; Madias et al., 1988). From these previous reports, it has been claimed that the most common source of ARF secondary due to BRCN was obstetric patients.

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However, recently, as a result of marked improvement in obstetric care in Western countries, the incidence of obstetric acute renal failure in general and BRCN in particular, has come down drastically (Madias et al., 1988 ; Sibai et al., 1990). Also, during the past 15 years after 1980, more and more cases of BRCN of nonobstetric origin have been reported with unusual causes such as aortic dissection, trauma, and drugs (Goergen et al., 1981 ; Darwish et al., 1984 ; Schneider, 1986 ; Jordan et al., 1990 ; Badiola-Varela 1992 ; Cusmano et al., 1992).

Though the definite diagnosis of BRCN depends on histological examination by renal biopsy, a serious medical condition with coagulopathy often presents in the initial phase of BRCN and precludes renal biopsy. Therefore, noninvasive diagnostic procedures rather than renal biopsy have been sought (Madias et al., 1988). Then, a cortical tram-track or eggshell calcification on plain X-ray of the abdomen was initially cited as the hallmark of BRCN (Gjorup et al., 1957 ; Whelan et al., 1967). But, it usually did not develop in the early phase of BRCN and was not even found in all cases of BRCN (Gjorup et al., 1957 ; Lloyd-Thomas et al., 1962 ; Phillips, 1962). As other alternatives, radioimagings, renal selective angiography (Deutsch et al., 1971 ; Tuttle and Minielly, 1978), ultrasonography (Sefczek et al., 1984), contrast-enhanced CT scan (Goergen et al., 1981 ; Laupacis et al., 1983 ; Papo et al., 1985 ; Jordan et al., 1990 ; Agarwal et al., 1992) and even MRI (Kim et al., 1992) have recently been tried with various findings for BRCN, so far, Among them, CT scan was suggested as an extremely representative and specific imaging procedure of kidneys for BRCN good enough to replace or supplant renal biopsy or other diagnostic procedures for BRCN by Goergen TG et al.(1981).

BRCN was considered a severe condition with almost invariably fatal outcome up to 95% before the era of dialysis (Gjorup et al., 1957), and this decreased to 55% (F) and 86% (I) with the advent of dialysis in the late 1950s (Kleinknecht et al., 1973 ; Chugh et al., 1983). Furthermore, recently, it seems to be possible that the increasing number of cases and the longer periods of survival in patients of BRCN are probably due to the improvement in dialysis techniques and other supportive modern medical care.

From the above descriptions, we believe this is the right time to reevaluate the clinical features of BRCN in adults. Therefore, it is the aim of this paper to see the changes in clinical features of BRCN over the past 15 years between 1980 and 1995 with special attention given to etiologies, diagnostic procedures, and prognosis of BRCN compared to those before 1980. Also, in this paper, a 38-yr-old woman after an automobile accident, who was diagnosed as BRCN during the early hospital course by the characteristic and specific findings of contrast-enhanced CT scan alone, is reported.

CASE REPORT

A 38 year old Korean woman (MH YOU) with no significant past medical history was involved in an automobile accident on September 6, 1994 and initially admitted to a local hospital but 48 hrs later transferred to the intensive care unit of Hanyang university hospital, Seoul, Korea, because of shock and total anuria. She was stuporous responding to only painful stimuli and was put on a ventilator with blood pressure 100/60 mmHg on dopamine, temperature 100 F, and pulse rate 110/min. The heart had a rapid regular rhythm (110/min), and both lungs showed scattered rales with a decreased breathing sound over the lower 1/2 of the right lung field with bloody drainage from a (rt) thoracostomy tube. There was guarding and distension in the abdomen. Bowel sounds were hypoactive. 1(+) pitting edema on the lower extremities was noted.

The initial laboratory data included a hematocrit of 24 percent, white blood cell count 14,500/mm^3 without shift to left, serum urea nitrogen of 45 mg/dL, creatinine 4.2 mg/dL, serum sodium 138 mEq/L, potasium 6.0 mEq/L, carbon dioxide 13 mEq/L and chloride 103 mEq/L. Lactate dehydrogenase (LDH) was 356 Wroblesky-Ladue units, serum glutamic oxaloacetic transaminase (SGOT) 95 U/L, creatine phosphokinase (CPK) 252 U/L and bilirubin 1.6 mg/dL. Urinalysis was not done due to absence of any urine, even in a urine collecting bag. Arterial blood gases obtained on 40 percent FiO_2 on a ventilator (SIMV) setting with mandatory respiratory rate (10/min) showed a pH of 7.32, carbon dioxide tension of 27 mmHg, bicarbonate of 15 mEq/L, and an oxygen tension of 80 mmHg, indicating mixed metabolic acidosis and respiratory alkalosis. A coagulation profile revealed a platelet count of 55,000/mm^3, prothrombin time of 19/15 (control) seconds and partial thromboplastin time of 31/23 (control) seconds. Fibrinogen level and fibrinogen degradation product (FDP) were 72 mg/dL and 65 mg/ml, respectively.

D-dimer test was strongly positive. This abnormal coagulation profile was indisputable evidence of disseminated intravascular coagulation (DIC)

On the same day, due to totally anuric acute renal failure with unstable hemodynamic status and a requirement of administration of large amount of fluids for DIC (blood and fresh frozen plasma) and nutritional support, continuous arteriovenous hemofiltration (CAVH) was initially started but changed to hemodialysis on the 10th hospital day and subsequently to peritoneal dialysis on the 33rd day in hospital due to pericarditis and continuous bloody drainage through the (rt) thoracostomy tube unresponsive to daily successive hemodialysis with strict heparinization for 7 days. At present (4 months after initial automobile accident), her daily urine output has increased up to 250 to 550 ml on CAPD with 3 exchanges of 2 liters of 1.5% dextrose solution per day but serum creatinine still remains between 5 to 7.5 mg/dL. Several repeated plain X-rays of the abdomen in hospital course did not reveal renal calcification.

The diagnosis of BRCN, which seemed likely according to the history and clinical pictures with total anuria and DIC, was initially considered with other differential diagnoses including acute tubular necrosis and hemolytic uremic syndrome. As described above, the very unstable hemodynamic status with coagulopathy (DIC) in the early period of hospital was not suitable for the procedure of renal biopsy. Therefore, as one of the noninvasive diagnostic procedures as well as for the consideration of retroperitoneal hemorrhage and bleeding from intraabdominal organs, contrast-enhanced CT scans of the abdomen were performed on day 2 and 30 of the hospital course. This, as shown in previous reports (Goergen et al., 1981; Laupacis et al., 1983; Papo et al., 1985; Jordan et al., 1990; Agarwal et al., 1992; Badiola-Varela, 1992), showed the characteristic and specific CT findings compatible with BRCN, i.e., a radiolucent zone of the renal cortex between the radio-opaque subcapasular rim and medulla suggestive of further collateral circulation to the subcapsular area and congestion to the medulla with no excretion of contrast media into the collecting system (Fig. 1). The typical characteristic findings of the CT scan and the total anuria during the early period in hospital despite the lack of histological findings of a renal biopsy could make the diagnosis of BRCN in its acute intial phase.

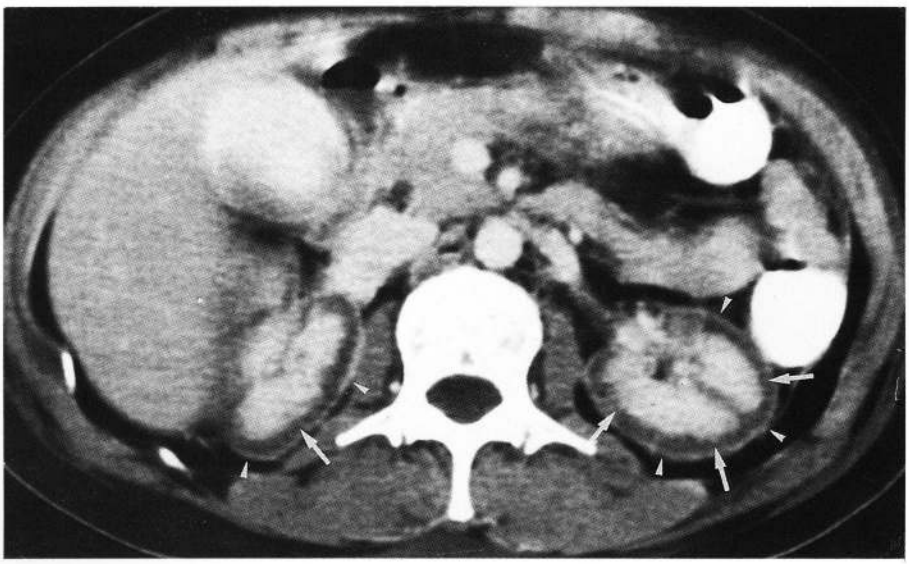

Fig. 1. Contrast-enhanced CT scan of day 2 in hospital course showing the characteristic and specific findings of bilateral renal cortical necrosis (BRCN). Note the lack of enhancement of the cortex (white arrows) with preserved enhancement of a thin rim of the subcapsular area (white arrow heads) and medulla. There is no excretion of contrast media from both kidneys and the vicarious excretion of contrast media was noted in the hyperdense gall baldder.

METHODS

With Medline computer program from US national library of medicine, twenty three articles were retrieved for an analysis of BRCN in adult patients from the world literatures in English published over fifteen year period between January, 1980 and January, 1995. Out of 23 articles, one article performed an analysis of acute renal failure (ARF) in hypertensive pregnant patients between 1977 and 1989, but it was included because most of the study period was after 1980 (Sibai et al., 1990). On the contrary, one of the most recent analyses of BRCN from India performed between 1964 and 1992 was excluded because more than half of the study period was before 1980 (Chugh et al., 1994). A total of twenty-eight patients of BRCN including a case of renal allograft rejection in these twenty three articles are reported. There were 17 female and 11 male patients with a mean age of 40.9 yrs old ranging from 18 to 83 yrs in the available data (3 patients without age data). The clinical features and clinical courses of these patients with special attention

Table 1. The clinical features of twenty-eight patients of bilateral renal cortical necrosis (BRCN) of adults in the world literature in English from 1980, January to 1995, January.

Cases No.	Reference (yr)	Age & sex	Etiology	Diagnostic procedures				Urinary pattern		Renal	Tx	Outcome
				Biopsy	X-ray	Ang.	CT or others	Anuria	Oliguria	HD	PD	
1	Goergen et al.(1981)	M, 45	Trauma	A			CT(+)			+		D
2	Date et al.(1981)	F, 40	Snake bite	+				+		+		RP
3	Date et al.(1981)	F, 35	Snake bite	+				+		+		PD
4	Laupacis(1983)	F, 34	Abruptio placentae	+		+	CT(+)		+	+		T
5	Blumhardt et al.(1983)	M, 26	Renal transplant	+		+	US(hyper)	+				HD
6	Sefczek et al.(1984)	F, 33	Postpartum	A			US(hypo)	+				D
7	Darwish et al.(1984)	F, 45	Drug-NSAID	+	−		US(−)	+				RP
8	Slater et al.(1984)	M, 33	Pancreatitis	+	−	+		+		+		RP
9	Williams et al.(1985)	M, 51	Polyarteritis nodosa	+		+	US(−)	+		+		D
10	Papo et al.(1985)	F, 20	Postpartum				CT(+)		+	+	+	HD
11	Schneider(1986)	F, 73	Drug-NSAID			+		+				
12	Schneider(1986)	M, 66	Drug-NSAID	+				+				
13	Scully et al.(1988)	F, 83	HUS	A			US(−)	+	+		+	D
14	Chugh et al.(1989)	M, 58	Snake bite	+	−		US(−)	+	+	+	+	RP
15	Sibai et al.(1990)	F	Pregnancy unknown							+		D
16	Sibai et al.(1990)	F	Abruptio placentae					+		+		
17	Sibai et al.(1990)	F	Pregnancy lupus	A						+		D
18	Jordan et al.(1990)	M, 25	Trauma	A			CT(+)US(−)					D
19	Fox et al.(1990)	M, 21	Pancreatitis	+	−	+	CT(−)US(−)	+	+			T
20	Tumlin et al.(1990)	F, 28	HUS	+			US(−)	+		+		RP
21	Chervu et al.(1991)	F, 27	Sepsis	+	−		US(hyper)	+	+	+		HD
22	Chervu et al.(1991)	M, 26	Sepsis	+	−			+	+	+		HD
23	Thaysen et al.(1991)	F, 54	Infection	+		+	US(−)	+		+		HD
24	Agarwal et al.(1992)	M, 25	Pancreatitis	+	−		CT(+)US(−)			+		HD
25	Kim et al.(1992)	F, 28	Abortion	+	−		CT(+)MRI(+)	+		+		RP
26	Badiola-Varela(1992)	F, 74	Aortic dissection	A			CT(+)					D
27	Cusumano et al.(1992)	M, 55	Drug Rifampin	+				+		+		
28	Jasnosz et al.(1993)	F, 18	Abortion	A								D

Tx, treatment ; yr, year ; F, female ; M, male ; A, autopsy ; D, died ; Ang, renal arteriography ; CT, computerized tomography ; US, ultrasonography ; HD, hemodialysis ; PD, peritoneal dialysis ; RP, recovered partially ; hyper, hyper-echoic renal cortex ; hypo, hypo-echoic renal cortex ; HUS, hemolytic uremic syndrome.

to precipitating causes (etiology), diagnostic procedures of renal biopsy while living or at autopsy, radioimagings of kidneys including abdominal X-rays, renal angiography, contrast-enhanced CT scans and ultrasonography, urinary pattern of either anuria (0 to 50 ml/d) or severe oliguria (less than 250 ml/d), renal replacement therapy in the early period and final outcome are summarized in Table 1.

The above stated clinical features of BRCN collected over the past 15 years between 1980 and 1995 were compared with the previous data before 1980, in which the two seperate analyses of the data of a large number of patients of BRCN have been reported already from two large world centers, i.e., the Necker hospital in France (38 patients) from 1953 to 1972 and a tertiary referral center in India (49 patients) from 1964 to 1979 were selected (Kleinknecht et al., 1973 ; Chugh et al., 1983).

RESULTS

Incidence and etiology (Table 2)

The incidence of BRCN in the total number of patients with acute renal failure (ARF) was found to be approximately 2% (38/2000) in France and 7.4% (49/662) in India before 1980. However, due to the lack of description of the total number of patients with ARF in the present data of 23 articles of BRCN reported after 1980 in the English literature of the world, we could not compare the incidence with that of before 1980.

Regarding etiology, obstetric causes responsible for BRCN were more frequent than nonobstetric causes before 1980 with 68% (26/38) vs. 32% (12/38) in France and 71% (35/49) vs. 29% (14/49) in India. After 1980, in contrast, the distribution of underlying causes between obstetric and nonobstetric was reversed to 29% (8/28) vs. 71% (20/28). Also, in a total of 8 patients in the obstetric group after 1980, a non-abortion related subgroup such as abruptio placentae, postpartum hemorrhage, and toxemia comprised 6 patients, whereas an abortion related subgroup was only 2 patients. Before 1980, in the distribution of patients between non-abortion related vs. abortion related subgroups, similar distribution was shown in France with 18 vs. 8 patients but there was a different picture in India with 16 vs. 19 patients. Of totals of 12 (F) and 14 (I) patients of nonobstetric causes before 1980, sepsis (4/12) was the most common cause, followed by toxin (2/12), tumor (2/

Table 2. Etiology of bilateral renal cortical necrosis(BRCN) in adults before and after 1980

	Before 1980		After 1980
	The Necker Hospital (France)	A referral center (India)	The world literature
Total cases	38	49	28
Obstetric causes	26(68%)	35(71%)	8(29%)
postpartum	18	16	6
abortion	8	19	2
Nonobstetric causes	12(32%)	14(29%)	20(71%)
sepsis	4	----	3
toxin	2	1	----
tumor	2	----	----
HUS*	2	2	2
pancreatitis	1	----	3
transfusion**	1	----	----
snake bite	----	6	3
gastroenteritis	----	5	----
drugs	----	----	4
trauma	----	----	2
allograft rejection	----	----	1
aortic dissection	----	----	1
polyarteritis nodosa	----	----	1

*HUS, hemolytic uremic syndrome ; **transfusion, incompatible transfusion reaction

12), HUS (2/12), pancreatitis (1/12) and incompatible transfusion (1/12) in France whereas snake bite (6/14) was the most common, followed by gastroenteritis (5/14), HUS (2/14) and toxin (1/14) in India. In contrast, after 1980, the nonobstetric causes were 20 cases in total. Among them, drugs (4/20) due to non-steroidal antiinflammatory drugs (NSAID) and rifampin were responsible for the most common cause of BRCN, and the other causes were sepsis (3/20), pancreatitis (3/20), snake bite (3/20), trauma (2/20), HUS (2/20), allograft rejection (1/20), aortic dissection (1/20) and polyarteritis nodosa (1/20). Therefore, drugs, trauma, aortic dissection and polyarteritis nodosa developed as the new causes of BRCN after 1980, which were not previously included before 1980.

Diagnostic procedures (Table 3)

Up to 95 to 100% of diagnoses of BRCN were dependent on renal biopsy in France and India before 1980. However, antemortem renal biopsies were performed in only 44% (16/36) in France and 16% (8/49) in India, whereas postmortem renal biopsies were done in over half of renal biopsy cases - 56% (20/36) in France and 84% (41/49) in India. As other alternative diagnostic procedures before 1980, plain abdominal X-ray showed renal calcification in 11% (4/38), and renal angiography was used in 16% (6/38) of total patients of BRCN in France, of whom all had positive findings for BRCN. In contrast, in India, none of the patients of BRCN had other diagnostic procedures except renal biopsy either antemortem or postmortem.

After 1980, diagnosis of BRCN was established in 24 (86%) out of 28 patients by renal biopsy and 4 patients without renal biopsy based on clinical findings and other diagnostic procedures. Out of 24 patients, renal biopsy while living in 16 (67%) and on autopsy in 8 (33%) was performed, respectively. With less dependency on renal biopsy for diagnosis of BRCN after 1980 compared to before 1980, other noninvasive radioimaging modalities, CT scan, renal ultrasonography, and even MRI were developed as new methods after 1980 in addition to plain abdominal X-ray and renal angiography performed already before 1980. Plain abdominal X-rays to see renal calcification were done in 8 patients (29%), renal arteriography in 7 patients (25%), contrast-enhanced CT-scan in 8 patients (29%), ultrasonography in 12 patients (43%) and MRI in 1 patient. The positive findings for BRCN were shown in none of 7 in plain abdominal X-ray, 3 of 12 (25%) in ultrasonography but with hypo- or hyper-echoic renal cortical findings without consistency, 7 of 8 (88%) in CT scan, 7 of 7 (100%) in renal arteriography and 1 of 1 in MRI.

Presenting features and renal replacement treatments

Total anuria was the commonest presenting feature and was noted in 78.8% of patients of BRCN in the study from India, but there was no description of urine output in that from France. After 1980 as shown in table 1, anuria with urine output less than 50 ml/day was stated in 19(68%) out of 28 patients, of whom 5 patients changed to oliguric pattern in the early course of hospital, and severe oliguria alone was seen in 2 patients. In the remaining 9 patients of BRCN, there was no description of urine output. Out

Table 3. Diagnostic procedures in bilateral renal cortical necrosis (BRCN) in adults before and after 1980

	Before 1980		After 1980
	The Necker Hospital (France)	A referral center (India)	The world literature
Renal biopsy	36/38 (95%)	49/49 (100%)	24/28 (86%)
antemortem	16/36 (44%)	8/49 (16%)	16/24 (67%)
postmortem	20/36 (56%)	41/49 (84%)	8/24 (33%)
Plain X-ray	---- 4/38 (11%)**	----------	8/28*, 0/8 (0%)**
Renal angiography	6/38*, 6/6 (100%)**	----------	7/28*, 7/7 (100%)**
CT scan	----------	----------	8/28*, 7/8 (88%)**
Ultrasonography	----------	----------	12/28*, 3/12 (25%)**
MRI	----------	----------	1/28*, 1/1 (100%)**

*Number of patients of BRCN having each diagnostic procedure

**Number of patients of BRCN with characteristic findings of each diagnostic procedure

of 28 patients, renal replacement therapies for BRCN were hemodialysis in 16, of whom 2 patients with both peritoneal and hemodialysis, peritoneal dialysis alone in 3 patients, and for the other 9 patients there was no description.

Outcome

Before 1980, twenty one (55%) of 38 patients in France and 42 (86%) of 49 patients in India died during the course of hospital stay. In contrast, 9 (36%) out of 28 patients BRCN after 1980 died (Table 1). Of the 18 survivors of the initial hospital course, 6 patients continued to be dependent on hemodialysis, 1 patient on peritoneal dialysis and 2 patients with successful renal transplant 1 year after dialysis. Of the remaining survivors, 6 patients recovered their renal function partially and discontinued dialysis.

DISCUSSION

Diffuse acute bilateral cortical necrosis, a rare but catastrophic extreme of acute renal failure, is characterized by confluent (gross, massive) necrosis of the entire cortex apart from a thin rim of viable tissue in the subcapsular, juxtaglomerular areas, and medulla. This is due to unique involvement of only part of the renal vasculature, e.g., renal interlobular and afferent arterioles with the patent main renal arteries and branches up to the arcuate level and the collateral circulation from extra-renal arteries to subcapsular portions (Deutsch et al., 1971 ; Madias et al., 1973).

Despite intensive investigation over the past half a century of the pathogenetic mechanism of BRCN, a universally accepted mechanism has not been produced yet. However, BRCN can be thought of as consisting of a precipitating event or "trigger mechanism" by underlying causes such as abruptio placentae, sepsis, toxins, burns, trauma and hemorrhagic pancreatitis, which then interacts with various preset or selected physiologic determinants involving mainly vascular and coagulation components and resulting in severe renal parenchymal damage (Matrin and Gary, 1974). The final common pathway, therefore, is permanent occlusion of afferent arterioles and interlobular arteries in the cortical vasculature, either by prolonged vasospasm, with secodary thrombosis, primary vascular damage with thrombosis or some combination of both. But, neither the vasospastic nor vascular injury theory, individually or in combination with DIC, fully explains localization of the process to the renal cortex. The conclusion must be that there is something intrinsically different about the renal vasculature in these patients (Madias et al., 1988). The recent discovery of a number of endothelium-derived vasoactive substances has generated much interest about their role in the pathogenesis of ARF. Significant among them is endothelin-1, which is one of the most potent vasoconstrictor substances known (Yanagisawa et al., 1988). The renal ischemia or endothelial injury could lead to endothelin release either directly or through release of various circulating substances, and it is possible that this acts as the final common messenger producing renal injury leading to BRCN (Chugh et al., 1994).

In most series reported in the literature before 1980, BRCN accounted for 2% of all cases of ARF in France and 7.4% in India (Kleinknecht et al., 1973 ; Chugh et al., 1983). The recent incidence of BRCN after 1980 could not be estimated in this study but seems to be decreasing in view of the decreased incidence from 7.4% between 1964 to 1970 to 3.8% between 1964 to 1992 as shown in the two seperate studies of the same center from India (Chugh et al., 1983 ; Chugh et al., 1994). Obstetric cases constituted the most frequent underlying cause of BRCN, fully 50 to 70 percent (Sheehan and Moore, 1953 ; Kleinknecht et al., 1973). Among them, abruptio placentae with either concealed or overt hemorrhage was the single most common underlying cause of the obstetric causes of BRCN (Sheehan and Moore, 1953). However, there is compelling evidence that the incidence and severity of obstetrical BRCN is declining steadily, indicating that in modern obstetric practice cortical necrosis will be seen as an almost vanishingly rare condition complicating only 1 in 80,000+ or 1 in 100,000+ deliveries (Silke et al., 1980 ; Sibai et al., 1990). Indeed, obstetric causes after 1980 in this review constituted only 29% of the total cases of BRCN (Table 2). This stems largely from the near universality of prenatal care, the aggressive replacement of blood loss at delivery but probably also from a decrease in the incidence and severity of abruptio placentae.

Non obstetric cases of BRCN accounted for less than 35% of all cases in either studies from France and India before 1980 or the other scattered reports before 1970 (Brown and Crane, 1943 ; Perry, 1953 ; Williams et al., 1968), and various clinical situations including overwhelming infections with shock, snake bite, poisoning, burns, severe gastroenteritis, and hyp-

eracute allograft rejection were shown as causes in combinations of shock associated with disseminated intravascular coagulation usually. In comparison to the incidence of non-obstetric causes between before and after 1980, the latter period of the present study revealed a striking increase up to 72%. Moreover, the most common nonobstetric cause after 1980 was drugs including nonsteroidal antiinflamatory drugs (zomepirac, ibuprofen) and rifampin rather than sepsis from France or snake bite from India before 1980, followed by sepsis, pancreatitis, snake bite, trauma, hemolytic uremic syndrome, allograft rejection, aortic dissection, and polyarteritis nodosa. Among them, allograft rejection, aortic dissection and polyarteritis nodosa rarely accounted for the nonobstetric causes of BRCN before 1980.

Regardless of the past and the present, though there has been no dispute about the role of renal biopsy as a gold standard procedure for BRCN, the dependency on renal biopsy was decreased from 95-100% (France and India) before 1980 to 86% after 1980. Further more, renal biopsy done while living was performed in only 42% (F) , 16% (I) and 67% after 1980. Therefore, other alternative noninvasive diagnostic procedures have been steadily developed to confirm the impression of BRCN, particularly during the initial hospital course of these desperately ill patients, when renal biopsy may not be practical or impossible if either shock or active coagulopathy is accompanied in the intial phase of BRCN (Madias et al., 1988). As for the initial alternative noninvasive diagnostic modalities, plain abdominal X-ray and selective renal angiography were tried before 1980 but followed by renal ultrasonography, contrast-enhanced CT scan and even MRI after 1980 (Goergen et al., 1981 ; Sefczek et al., 1984 ; Kim et al., 1992). But the sensitivity of each procedure for the diagnosis of BRCN by the individual characteristic findings found different from each other. The typical appearance of renal cortical calcification, especially tramline, in plain abdominal X-ray (Lloyd-Thomas et al., 1962 ; Phillips, 1962) was shown in only 11% (4/38) in France before 1980 and in no patient (0/7) after 1980 in this review (Table 3).

Selective renal arteriography has been considered as the second useful procedure in early recognition of BRCN (Deutsch et al., 1971 ; Kleinknecht et al., 1973). Its characteristic features for BRCN are failure of interlobular filling with a non-existent or extremely faint mottled cortical nephrogram, concomitantly prominent capsular arteries acting as collateral vessels for the subcapsular area of the cortex and premature filling of the renal veins (Deutsch et al., 1971 ; Tuttle and Minielly, 1978). This was done in 6 out 38 patients in France before 1980, of whom 5 also had renal biopsy and only one was diagnosed by renal angiography alone. In the present review after 1980, 6 out of 28 patients had renal angiography with 100% sensitivity (Table 3).

Among the non-invasive diagnostic procedures for BRCN reported after 1980, advanced ultrasound methodology using echotomographic imaging to delineate cortical hypoperfusion was performed in 12 out of 28 patients but showed normal findings in 9 (75%) and only nonspecific findings in 3 (25%) patients (Table 3).

In contrast, since the recent introduction of contrast -enhanced CT scan by Goergen et al. in (1981) as an extremely representative and specific imaging of the cortico-medullary interface in diffuse BRCN, this noninvasive imaging modality was suggested to replace or supplant other diagnostic procedures for BRCN. The diagnostic entities of CT scan findings for BRCN suggested as the criteria by Jordan et al. (1990) include (a) nonenhancement of the renal cortex, (b) enhancement of the medulla, and (c) lack of excretion of contrast media to the collecting system. Also, the characteristic and specific findings useful for the diagnosis of BRCN by CT scan correlating well with the histological findings were outlined in other reports (Laupacis et al., 1983 ; Jordan et al., 1990). The present review after 1980 revealed these characteristic diagnostic findings in all 5 patients in whom it was done. As described, this CT scan was not included at all for the diagnostic procedure in the study of BRCN before 1980 (Table 3). Very recently, in one case of BRCN, MRI was tried as another noninvasive diagnostic modality and found to have high signal intensity in the renal cortex on both T1- and T2-weighted images with a low signal intensity rim on both images along the corticomedullary junction, which, however, requires further studies to conclude as the specific and characteristic findings of MRI for BRCN (Kim et al., 1992).

The most striking clinical feature of BRCN is the severe protracted oliguanuric period (0 to 50 ml/day), standing in marked contrast to the urine output in ATN. Furthermore, oligoanuria in BRCN persists for a much longer period than in oliguric ATN (Perry, 1953 ; Whelan et al., 1967 ; Madias et al., 1988). Total anuria

up to 80% of patients of BRCN from India before 1980 and severe oligoanuria (less than 250 ml/day) in 75% (21/28) after 1980 were shown.

Until recently, BRCN has been considered a severe condition with an almost invariably fatal outcome in 95 percent (Matrin and Gary, 1974). Earlier studies reported a survival period of fifteen days at the most (Sheehan and Moore, 1953). Recently, increasing numbers of cases survive for longer periods, which is probably due to the improvement in the means of treatment by dialysis. The majority of those with BRCN who survived have done so since the development of hemodialysis techniques in the late 1950s. Twenty-one out of 38 patients (55%) in the study from France and 42 out of 49 patients (86%) in that from india died before 1980, and its high mortality would be related to the earlier period before the systematic use of prophylactic hemodialysis. In contrast, after 1980 in this review, as expected, only 9 (36%) out of 28 patients of BRCN died. Of the 19 patients who survived acute illness of BRCN, 6 patients showed the partial recovery of renal function and could discontinue dialysis.

In summary, these analyses can conclude that, compared to the past before 1980, striking changes over the past 15 years (1980-1995) have been noted in etiology with a higher incidence of nonobstetric rather than obstetric causes, diagnostic procedures with more dependency on noninvasive procedures such as contrast-enhanced CT scan, and a further declining mortality. Also, previously a well known fatal disease, BRCN showed an increasing incidence of spontaneous recovery after 1980. Therefore, if the diagnosis is BRCN, appropriate plans should be made for dialysis over a protracted period of time, with an expectation of delayed but eventual recovery to a life-saving level of renal function.

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