Emergency Ligation of the External Iliac Artery

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During a 19-year period, 35 of 1526 renal transplant operations were complicated by gross hemorrhage from infected arteriotomies. In 13 patients the common or external iliac artery was ligated and resected without immediate reconstruction for arterial continuity. There was no mortality from this procedure, and there was no limb loss. Early signs and symptoms of arterial insufficiency were rapidly reversed in most patients. Six patients, presently alive and 4–10 years after iliac artery ligation, were subjected to follow-up examinations of their distal circulation. One hemodialysis patient had slight symptoms of intermittent claudication, while the others were totally free of symptoms during daily activities. All patients had adequate distal arterial blood pressures. Postischemic maximal blood flows, obtained in three patients, were only slightly decreased. It is concluded that, for control of massive hemorrhage from infected arteriotomies in renal transplant patients, the iliac arteries can safely be ligated without immediate arterial reconstruction. The risk of limb loss is little but necessitates optimal postoperative support of the patient and close surveillance for early detection of irreversible arterial insufficiency.

IN THE PRACTICE of renal transplant surgery, massive hemorrhage from infected arteriotomies occasionally necessitates the ligation and resection of the common or external iliac arteries. Several case reports have appeared, indicating that this can be performed safely without simultaneous reconstructive procedures and without endangering limb viability.[3] This seems to conflict with the views of most surgeons and of recent textbooks of vascular surgery; a 50% limb loss rate should be anticipated after such procedures.[8]

In this communication we report our experience from 13 consecutive cases of iliac artery ligation without reconstruction.

Material and Methods

More than 1500 renal transplantations have been performed in Gothenburg since 1965. Thirty-five of these were complicated by massive hemorrhage from the transplant renal or iliac arteries, in association with septic arteritis (Table 1). The hemorrhages occurred after the transplant operation itself, after transplant nephrectomy, or after reoperation for renal artery stenosis. Nine patients died as a direct consequence of this complication, either at first hemorrhage or due to recurrent bleeding after inadequate surgical procedures, *i.e.*, when the affected artery was not resected. When resection was done, no further bleedings occurred. All but three patients lost their grafts.

The external or common iliac arteries were resected and ligated in 19 patients. In the early years, immediate arterial reconstructions were performed with a saphenous vein femorofemoral bypass. In 1973, the policy was adopted not to perform arterial reconstruction in this situation and no such procedure has been performed since then. Consequently, 12 patients, including two earier cases (1969 and 1971), were left with a ligated external iliac artery without reconstruction and these constitute the patient material to be reported. To these is added one patient with an autotransplanted kidney and without infection, but with emergency iliac artery ligation under otherwise similar circumstances.

One or both of the authors were personally involved in the treatment of all patients. For this report, survivors were interviewed as to their functional capacity, Doppler systolic pressures were obtained and ankle/arm pressure indices (API) calculated. Clinical physiological laboratories were consulted for toe pressures (strain gauge), postischemic maximal blood flow measurements (plethysmography), and treadmill tests.

Results

None of the 13 patients subjected to common or external iliac artery resection suffered any tissue loss, nor did elective reconstruction for functional deficit become necessary in any of the cases (Table 2).

Early Signs and Symptoms

Five patients had either no symptoms at all or minimal pallor and coolness of the limb during the first 24 hours,

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TABLE 1. *Hemorrhage from Septic Arteritis in Renal Transplant Recipients*

Year	Transplants n	Patients with Septic Arteritis n	%	Died	Patients with Iliac Artery Ligation With n	Without Reconstruction n	(Patient No.)*
1965–70	275	16	5.8	6	6	1	(1)
1971–74	378	8	2.1	1	1	3	(4, 5, 12)
1975–79	414	9	2.2	1	—	7	(2, 3, 6–10)
1980–84 (June)	459	2	0.4	1	—	1	(13)
Total	1526	35	2.3	9	7	12	

* Refers to patient numbers in Table 2 and in case reports.

and experienced no functional problems on early ambulation (cases 5, 6, 7, 10, and 13).

The remaining eight patients had varying degrees of weakness, coolness, and early intermittent claudication. Signs of arterial insufficiency in the resting position were reversed within the first few days in all patients. Muscle perfusion was adequate for early ambulation in some patients, while others could walk only a few steps before pains developed. Rapid improvement followed and, within 2–3 weeks, most of the patients were able to walk around in the hospital without symptoms from their legs, exceptions being cases 2 and 3, who continued to experience marked claudication, and case 1, who developed a limb paralysis (see case report).

Early API:s were obtained in cases 2, 6, 8–11, and 13, and were 0.48 (at 1 and 4 days), 0.71 (20 days), 0.64 (11 days), 0.53 (7 days), 0.59 (4 days), 0.67 (3 days), and 0.56 (10 days), respectively. In case 3, no ankle or toe pressures could be obtained in either leg due to extensive diabetic mediasclerosis. All other patients examined had normal distal pressures and API:s in the contralateral leg. Postischemic maximal bloodflow in case 13 was 29 ml/min/100 g (60 ml in the contralateral leg) at 2 weeks.

Late Symptoms

Patients 1–3 died 3 months after return to hemodialysis, from myocardial infarction or uremic complica-

TABLE 2. *Functional Outcome after Common or External Iliac Artery Ligation*

Patient No.	Age, Sex	Arteries Ligated Ipsilateral	Contralateral	Gangrene	Claudication	Survived Months	Comments
1*	22 M	C	—	—	?	3	Limb paralysis
2	45 M	E	I†	—	+	3	
3	40 M	E, I†	—	—	++	3	Type I diabetes
4	44 F	E, I†	—	—	+	12	2 Retransplants failed
5	54 M	E	—	—	—	12	2 Retransplants failed
6	37 F	E	I†	—	—	15	Fourth transplant successful

Patient No.	Age, Sex	Arteries Ligated Ipsilateral	Contralateral	Gangrene	Present Status Claudication	Ankle Pressure mmHg	API	Years Postoperative	Comments
7*	56 M	E	—	—	—	115	0.72	4	Retransplanted, well
8*	34 M	E	I‡	—	—	110	0.53	5	Retransplanted, well, Type I diabetes
9	30 M	E, I†	—	—	+	130	0.76	5	Hemodialysis
10	57 F	E	I†	—	—	80	0.67	5	Retransplanted, well
11*	44 M	E, I†	—	—	—	120	0.77	6	Autotransplant retained, well
12*	25 M	E, I†	I†	—	—	145	0.85	10	Retransplanted, well
13	37 M	E	—	—	—	70	0.56		Hemodialysis

* Details in case report.
† I = I ligated in previous (2 months–6 years) transplant operations.
‡ I = I Ligated in subsequent transplant operations.
C/E/I = common/external/internal iliac artery.

tions. The limb paralysis of case 1 had improved, and there were no further symptoms of arterial insufficiency. Patients 2 and 3 had continued claudication, severe enough in case 3 probably to have made late elective reconstruction justified, had he survived his myocardial infarction.

Three patients (cases 4–6) died 12–15 months after the iliac artery ligation. All three had received two further renal transplants, unsuccessful in two patients who later died from uremic complications on hemodialysis, while the third (Patient 6) died from congestive cardiac failure with a well-functioning transplant. She was an avid folk-dancer and had no symptoms of arterial insufficiency. Patient 4 had claudication after 500 m fast-walking and patient 5 experienced no symptoms but claudication could be provoked with the treadmill test.

Six patients are presently alive 4–10 years after their iliac artery ligation and were subjected to follow-up examinations. One has retained his autologous renal graft, four were successfully retransplanted, and one has continued on chronic dialysis. Case 13, added during the preparation of this report, is doing well on dialysis while awaiting a second transplant.

The five patients with well-functioning kidneys are all without symptoms of arterial insufficiency in daily activities, although functional deficits could be provoked by a treadmill test or heavy physical exercise (in patient 8 when walking fast uphill, in patient 11 when running fast, and in patient 12 at heavy games of badminton). Patient 7 had a normal treadmill test and patient 10 could not be provoked due to bilateral hip replacements. Patient 9 is suffering from serious osteodystrophy and a deteriorated general condition after 5 years of dialysis. He complains of numbness and weakness of the limb after walking 150 m, symptoms which also could be provoked by treadmill test.

Patients 7–13 all had palpable femoral pulses some also having palpable distal pulses); toe pressures were 75–120 mmHg and API:s were 0.53–0.85 (Table 2). All had normal toe pressures and API:s in the contralateral limb. Postischemic maximal blood fow measurements were obtained in three patients; patient 7 had 29 ml/min/100 g (37 ml in contralateral leg); one patient had 38 ml (49); and patient 12 had 43 ml (67). Flows could not be obtained in two patients; in one diabetic patient (no. 8) due to femoral mediasclerosis, and in one adipose patient (no. 10) due to pains from the tourniquet itself.

Arteriograms were obtained in several patients for the assessment of subsequent renal transplants. Collateral circulation was seen to be supplied by different arteries in different patients, with examples of major contributions from visceral as well as various parietal pathways (Fig. 1).

Case Reports

Case 1

A 22-year-old man with chronic glomerulonephritis. Seven days after cadaver kidney transplantation, massive anastomotic hemorrhage occurred and was treated with simple suture. At rebleeding 4 days later, the septic nature of the events was suspected and later verified. The graft was removed and the common iliac artery was resected, as it had been used for the renal artery anastomosis. There were palpable pulses in both external and internal iliac arteries with good retrograde flow and no reconstruction was performed. Initially there were no signs or symptoms of arterial insufficiency. However, the following day, while walking about in the hall, the patient suddenly developed pain, pallor, and weakness of the limb. At immediate reoperation and after considerable blood volume substitution, the distal parts of the iliac arteries were again pulsating with good reflow. The limb resumed normal color and temperature but a total limb paralysis had developed. Considerable functional improvement occurred during the following 3 months and there were no further signs of arterial insufficiency. He continued on intermittent hemodialysis but died from uremic complications. The nerve injury did not follow any one special nerve or nerve segment, and was considered secondary to ischemic assault, inflicted during a hypovolemic episode some 12 hours after surgery.

Case 7

A 56-year-old man with chronic glomerulonephritis. The three arteries of a cadaver transplant were connected to the external iliac artery. A massive hemorrhage from infection 10 days later necessitated graft nephrectomy and external iliac resection. During the first few days the limb seemed somewhat cooler but, otherwise, there were no immediate symptoms of arterial insufficiency, or during the years to follow. Three years later the patient had a second renal transplant that has functioned satisfactorily now for about 1 year. He is still without symptoms from his leg and a treadmill test was normal. Postischemic maximal blood flow was 29 ml/min/100 g, toe and ankle pressures 115 and 143 mmHg, API 0.72 (37 ml, 150 and 200 mmHg, API 1.20 in the contralateral leg).

Case 8

A 34-year-old male, blind diabetic received a cadaver kidney transplant which had to be removed after 2 weeks due to acute irreversible rejection. The renal artery, anastomosed to the external iliac artery, was ligated. Three weeks later massive hemorrhage occurred from the site of the anastomosis and the external iliac artery was resected without reconstruction. During the first 2–3 days some coolness and weakness was observed, but within 2 weeks the patient was able to walk down the hall without symptoms. API was 0.64. Seven months later the patient received a second cadaver transplant which was connected to the contralateral internal iliac artery. This kidney still functions very well; he is in good general condition and has no symptoms from the leg during daily activities. At a treadmill test 4 years after the ligation, numbness and some pain in the popliteal fossa could be provoked after a physical load comparable to "fast walking up strong ascents." Intended postischemic blood flow measurements could not be performed due to noncompressible femoral arteries, obviously secondary to diabetic mediasclerosis. Arterial toe and ankle pressures were 110 and 130 mmHg, API 0.53 (250 mmHg and >1.0

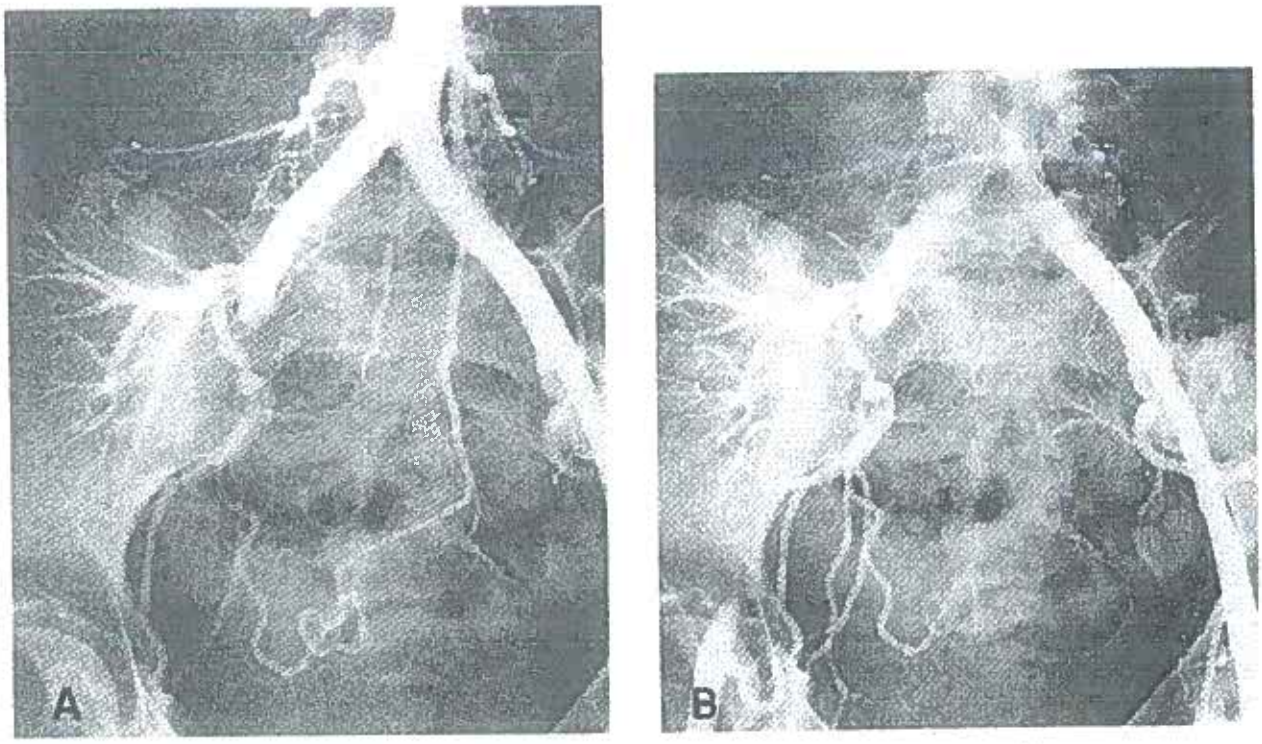

FIG. 1. Superior hemorrhoidal artery feeding the right femoral artery *via* branches of the right internal iliac artery. Right external, right internal, and left internal iliac arteries ligated 2, 10, and 15 months earlier, respectively. (Branches of left internal iliac artery are fed by collaterals and over-projected on the ligated proximal stump of the artery). Renal graft anastomosed to the right common iliac artery.

in the contralateral leg). At later examinations with normalized systemic blood pressure, API was unchanged.

Case 11

A 44-year-old farmer with severe hypertension had one normal and one contracted kidney with arterial stenosis. After nephrectomy, the hypertension was cured but recurred after 1 year and a new renal arterial stenosis was found to have developed on the contralateral side. This kidney was autotransplanted to the iliac fossa and connected to the internal iliac artery. One year later, a recurrent stenosis necessitated reoperation. Extensive fibrosis around the vessels made dissection difficult and it became necessary to remove the kidney for extracorporeal reconstruction with an autologous vein graft. It was then reimplanted to the common iliac artery. A few hours after the operation, massive hemorrhage occurred from the external iliac artery, obviously severed during the first operation and just distal to the newly performed anastomosis. There was no infection suspected but it was considered unwise to endanger the arterial reconstruction or the viability of the organ by further reconstructive procedures. The severed iliac artery was thus resected. After surgery, there was some coolness and weakness of the limb during the first few days, with early intermittent claudication. Symptoms rapidly improved and the patient resumed his occupation as a farmer. He normally experiences no symptoms from his leg, except occasionally when chasing escaped cattle. He has palpable pulses in the femoral as well as distal arteries. Postischemic maximal blood flow was 38 ml/min/100 g, toe and ankle pressures 90 and 120 mmHg, API 0.77 (contralateral leg 49 ml, 124 and 170 mmHg, API 1.10).

Case 12

A 25-year-old man with chronic glomerulonephritis received his first renal transplants in 1968 and 1969, both anastomosed to the internal iliac arteries. A third cadaver transplant was performed in 1974. After 10 days, a massive hemorrhage occurred from an arteritic defect in one of two renal arteries. The graft was removed and the external iliac artery resected. After surgery, there was rapidly reversible pallor and weakness, but also multiple cutaneous septic emboli in the affected limb. Intermittent claudication was obvious during the first few days but improved rapidly and, at discharge from the hospital 3 weeks later, he was able to walk 1000 m without pain. Five months later he had a fourth renal transplant, anastomosed to the stump of the ipsilateral common iliac artery, after thromboendarterectomy. This transplant is still functioning satisfactorily. The patient has no signs or symptoms of arterial insufficiency, except when forced to run back and forth by a superior adversary in his favorite game of badminton. After 9 years, functional capacity was found to be normal with the standardized treadmill test. Postischemic maximal blood flow was 43 ml/min/100 g (contralateral leg 67 ml/min). Toe and ankle arterial pressures were 125 and 145 mmHg, API 0.85 (contralateral leg 150, 205, and 1.2).

Discussion

Thirteen patients had common or external iliac artery ligation following complications after renal transplant

surgery. Vascular reconstructive procedures were not necessary in any case, immediately or later. Signs of arterial insufficiency in the resting position were reversed within a few days, symptoms of intermittent claudication also improving rapidly in most patients. With time, the functional capacity of most patients became adequate for daily activities, in some cases even for heavy physical loads. In one diabetic patient, elective reconstructive surgery was contemplated because of ischemic pains during hemodialysis treatment but the patient died from a myocardial infarction. Similar experiences of iliac artery ligations in renal transplant patients have been reported by others and are reviewed by Gorey and coworkers.[3] Among 14 patients, one developed incipient gangrene and three required reconstruction at a later date for claudication.

Besides the experience gained from the management of complications after renal transplant surgery, there is little information in modern literature on the effect of iliac artery ligation. William Halsted's report in 1912[4] of an approximately five per cent rate of limb loss after such procedures has been disregarded in favor of the more discouraging results from battle surgery during World War II with a limb loss rate of nearly 50%.[2] Following this latter report and with the advent of modern vascular surgical techniques, both civilian and war injuries to the iliac arteries have been treated with immediate arterial reconstruction.[1,5,7] The results of this more recent approach have been rewarding with low rates of limb loss. However, in some of the cases reported, the reconstructions failed, "surprisingly" without symptoms of severe arterial insufficiency.[7]

The discrepancy between the high rate of limb loss reported from World War II and the almost negligible limb risk described both in Halsted's report and in recent renal transplant surgery may be explained by the different settings in which the iliac ligations were performed. War casualties are inclined to have other more or less severe injuries contributing to hypovolemia, shock, and compromised distal circulation. Delayed and suboptimal volume substitution was indeed a major problem in World War II surgical care. In addition, the increased demand on nutritional supply caused by injuries of the ipsilateral limb might finally render this supply insufficient for distal extremity survival.

DeBakey suggested that preexisting arteriosclerotic lesions in Halsted's 100 patients with already developed collateral pathways could have contributed to the favorable outcome. Also a uremic population, in principle is inclined toward arteriosclerotic occlusive disease. In the present series, two patients had extensive diabetic mediasclerosis, but there were no preexisting arteriosclerotic occlusions in any of the patients. However, in eight patients one or both internal iliac arteries had been utilized and, therefore, ligated in previous transplant operations. Consequently, the previous interruption of one or two main tributaries to the collateral circulation might have helped rather than complicated the rapid reestablishment of adequate nutritional flow to the limb. Uremic patients also may have some rheological benefit of chronic anemia, the capacity of oxygen delivery to tissues being compensated by increased enzyme activity. Uremia also entails platelet dysfunction with defective hemostasis. Obviously, experiences gained from renal transplant patients may not necessarily be applicable to nonuremic patients. However, it is unlikely that these factors are of critical importance in the present situation, and there seems to be no reason why the collateral circulation should not suffice also in nonuremic patients under similar circumstances.

The alternative way to handle the problem with septic arteritis in the iliac region is to create an extraanatomical bypass. In the early years, we believed such an approach mandatory and femorofemoral bypasses with autologous saphenous vein grafts were performed in some cases, two of which are still alive after successful retransplantations with patent grafts. In one case, however, the pseudomonas infection spread to the new anastomoses, finally necessitating the ligation of the femoral artery below the level of all main collaterals. This resulted in an ischemic limb which had to be amputated some years later. This risk of spreading the infection, either directly due to the proximity of the infected area or due to the bacteremia that by definition is always present, constitutes the main rationale for avoiding reconstructive procedures in this situation. Another good reason to abstain from extended surgical procedures is the sometimes extremely critical situation of the patient, maybe barely resuscitated from hemorrhagic shock.

We have resected the infected artery with as wide margins as feasible, with proximal and distal ligatures within the transplant wound. More remote ligations, as suggested by others,[6] have not been necessary in our experience.

The immediate outcome after major artery ligation is decided by there critical factors: the speed at which existing potential collateral pathways can be opened, the actual nutritional demand of distal tissues during this first critical period, and the general condition of the patient, *i.e.*, mainly systemic blood pressure levels. To ensure adequate nutritional arterial flow after iliac artery ligation, proper monitoring of blood volume and pressure is mandatory, although this may not initially be self-evident. In a patient just deprived of his renal function and scheduled for hemodialysis, the prime concern is usually to avoid overhydration, low blood volumes or

pressures usually being of less concern. The ischemic nerve injury experienced by case 1 in this report might illustrate the importance of proper volume substitution in these cases. It may also be appropriate to refrain from physical exercise and early ambulation, at least during the first few postoperative days.

The severe ischemic symptoms seen in some of the patients during the early postoperative phase emphasize the fact that the margin to nutritional insufficiency is narrow. The risk of gangrene, although small, still exists and necessitates close postoperative surveillance for its early detection and for institution of reconstructive procedures. With such precautions, we consider simple resection and ligation of the affected artery to be the preferable procedure in the emergency situation of massive hemorrhage from infected external iliac arteriotomies in renal transplant patients.

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