

TREATMENT OF HEMORRHAGE FROM RENAL TRAUMA BY ANGIOGRAPHIC INJECTION OF CLOT

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ABSTRACT

Experimental results in rats and modest clinical experience now indicate that persistent or massive hemorrhage from renal trauma can be treated by injection of clot (under angiographic control) into the bleeding vessels. There is minimal loss of renal tissue and an operation is avoided.

Surgical intervention for control of massive renal hemorrhage after trauma generally results in nephrectomy or, at least, heminephrectomy.^{1, 2} Fortunately, most cases of blunt trauma can be managed with conservative measures such as bed rest and replacement of blood volume because the enclosed retroperitoneal space allows for tamponade. However, cases with persistent or massive hemorrhage are traditionally thought to need surgical exploration.

Our present research and clinical experiences show that angiographic injection of autologous clot into a segmental renal artery stops the bleeding and rapid subsequent recanalization

after percutaneous renal biopsy and present the experimental work supporting our approach.

CASE REPORT

J. F., 419280941, a 49-year-old man, was admitted to the hospital on February 4, 1975 for investigation of hypertension first noted in 1963. Management consisted of hydralazine, propranolol and furosemide. The patient also had a history of chronic alcohol abuse and numerous episodes of delirium tremens. From time to time the blood pressure became uncontrolled with

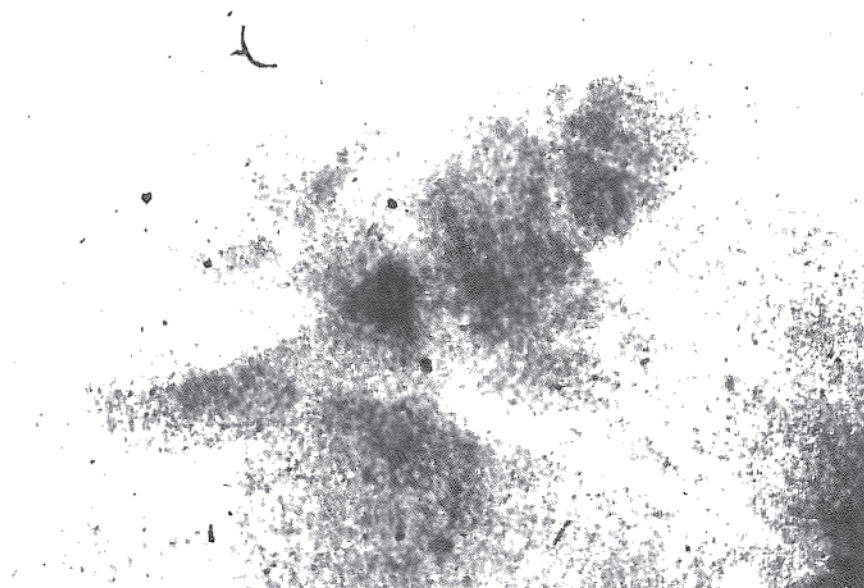


FIG. 1. Selective left renal arteriography immediately after renal biopsy shows early filling of renal vein representing arteriovenous fistula and multiple bleeding points in lower pole of kidney.

ensures minimal infarction of renal tissue.^{3, 4} We have used this technique to control persistent renal hemorrhage from blunt trauma non-operatively and for massive hemorrhage from renal biopsy, with minimal sacrifice of renal tissue.⁴ In addition, our experimental data in rats now indicate that this is a repeatable phenomenon and not just an incidental fluke occurrence. Herein we report a case of severe hemorrhage

risers to 190/130. The patient's mother had had malignant hypertension leading to uremia and maintenance dialysis.

Physical examination revealed a healthy appearing black man in no acute distress. Blood pressure was 170/120 supine. An S4 ejection murmur was heard at the left sternal border. There was no S3 murmur and no cardiac rub. The lungs were clear to percussion and auscultation. Examination of the abdomen, flanks, extremities and nervous system was normal.

A chest x-ray was normal. An electrocardiogram showed only non-specific ST-T wave abnormalities. Serum creatinine averaged 2.7 mg. per cent. Two creatinine clearances were 30 and 35 per ml. per minute. Urine culture was sterile. Urinalysis

Accepted for publication October 24, 1975.
Read at annual meeting of Western Section, American Urological Association, Portland, Oregon, April 13-17, 1975.
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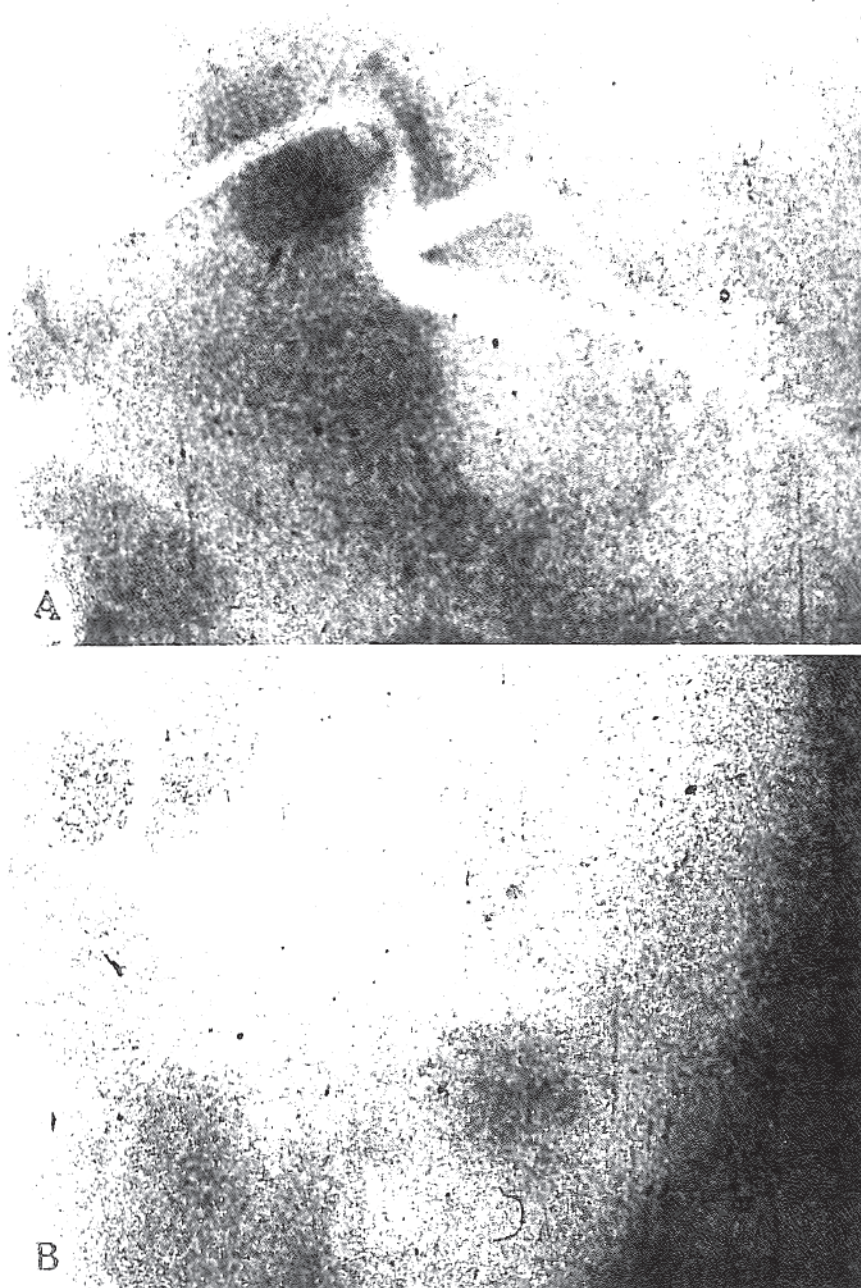


FIG. 2. A, catheter has been advanced into lower pole primary artery and 1 ml. autologous clot has been injected. Arteriovenous fistula is no longer present but contrast extravasation is noted. B, injection of 1.7 ml. autologous clot has caused occlusion of entire primary renal artery branch and cessation of contrast extravasation.

showed 4 plus protein, 2 plus sugar and pH 6.0. Microscopic examination of the sediment showed 20 to 30 white and 1 to 2 red blood cells per high power field, no bacteria and no casts.

Urinary excretion of protein was 6.6 gm. protein per 24 hours. Prothrombin time was 10.8 seconds with a control of 10.7 seconds. Platelets were 200,000 per ml., hematocrit 41 per cent and white blood count 4,900 per ml. with a normal differential. An excretory urogram showed no obstruction and normal size kidneys with decreased visualization consistent with decreased function.

Three days after the patient was hospitalized a left percutaneous renal biopsy was done under fluoroscopic control. Immediately afterward the patient suffered massive gross hematuria and hypotension. The hematocrit of the urine was 34 per cent. Within an hour approximately 4 units of blood were lost and 3 units were transfused along with 3.1 Ringer's lactate solution.

The patient was rushed to the operating room by the gen-

eral surgery resident and an immediate nephrectomy was planned. When we intervened the patient was on an operating table and we, therefore, had recourse only to cine-angiographic equipment. This situation was unfortunate since standard serial arteriograms give better resolution of detail.

With the cine-angiographic technique, selective left renal arteriography revealed contrast extravasation and an arteriovenous fistula in the lower pole of the left kidney (fig. 1). The catheter was advanced into the primary branch of the renal artery feeding the affected area. An injection of 1 ml. autologous clot plugged the arteriovenous fistula and decreased contrast extravasation in the parenchyma (fig. 2, A). Another injection of 0.7 ml. autologous clot completely occluded the primary arterial branch to the lower pole and halted contrast extravasation (fig. 2, B).

Clinically, bleeding stopped immediately. A small suprapubic cystostomy was done to evacuate the 800 cc retained clot from the bladder. Thereafter the urine remained clear and

flowed at a rate of 30 to 50 cc per hour. After the initial transfusions blood pressure was stable at 180/110 to 160/100 and remained in this range thereafter. The next day the serum creatinine was 4.2 mg. per 100 ml. and the second day after the bleeding episode it was 5.5 mg. per 100 ml. The creatinine then decreased daily to 3.0 mg. per 100 ml. 5 days after the procedure and to 2.7 mg. per 100 ml. 3 weeks later.

The day after biopsy delirium tremens developed and required large doses of diazepam intravenously. However, after

8 days the patient had recovered, was off intravenous fluids, ambulating and feeling well.

A selective left renal arteriogram 12 days after the renal biopsy showed complete lysis of all clot in the primary arterial branch to the lower pole and in 1 secondary branch (fig. 3). The other secondary arterial branch showed partial recanalization. There was less than 15 per cent infarction of the renal mass. The blood pressure remained approximately 130/90 and the patient was not taking any medication.

EXPERIMENTAL WORK

Lewis rats were studied to see how rapidly a large amount of clot injected into the renal artery would dissolve and what degree of renal infarction to expect. In addition, studies were done on other groups of Lewis rats to determine the effects of graded amounts of warm ischemia time.

Renal tolerance of clot injection. In 5 Lewis rats, under $\times 36$ magnification with a Zeiss operating microscope, the left renal artery was dissected free and occluded near the aorta with a Scoville-Lewis neurosurgical clip. A small arteriotomy was made and a tapered polyethylene catheter was introduced a few millimeters into the renal artery (internal diameter in rats averages 0.5 mm.). We injected 0.1 ml. syngeneic freshly clotted blood that generally occluded all renal artery branches. The catheter was removed, the arteriotomy was closed with 2, 10-zero nylon interrupted sutures and the clamp was removed. Pulsation and flow were noted to the most proximal extent of the clot. The artery and the renal surface were examined under the microscope for up to 6 hours and again at 24 hours. In 5 other rats 0.3 ml. clot was injected and this filled the entire renal artery as well as the branches. In 5 controls an arteriotomy was simply opened and closed. At 1 week the contralateral kidney was removed, blood urea was measured until stable and then the embolized kidney was removed for histologic examination.

Renal tolerance of warm ischemia time. We used 5 Lewis rats in each experimental group.

Group 1: The left renal artery was clamped with a Scoville-Lewis clip and a right nephrectomy was done. The clamp was removed from the left renal artery at 30 minutes and at 1, 2 and 3 hours in 4 separate groups of animals. Blood urea determinations were made daily.

Group 2: The left renal artery was clamped for 2, 4 and 5 hours in separate groups of rats. A right nephrectomy was performed 14 days later. Blood urea determinations were made daily.

Group 3: The left renal artery was clamped with a Scoville-Lewis neurosurgical clip and a right nephrectomy was done. The clamp was removed from the left renal artery for 3 minutes every half hour and then replaced. Total warm ischemia times were 1, 2, 3 and 4 hours in 4 separate groups of animals. Blood urea determinations were made daily.

RESULTS

The result of massive clot injection into the renal artery is summarized in table 1. There was a remarkably rapid lysis of clot with nearly complete return of perfusion. With enough clot injected to fill all the distal branches 50 per cent of clot was lysed within an hour and 90 per cent within 6 hours. An average

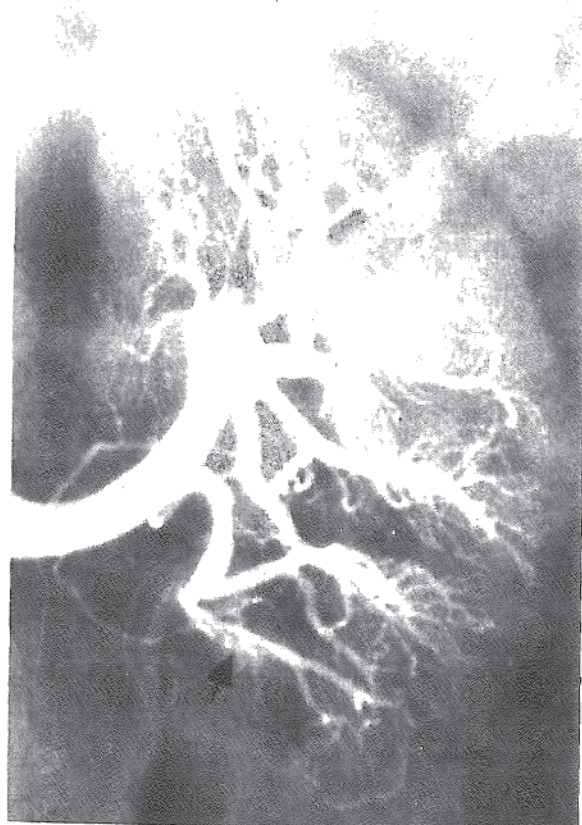


FIG. 3. Selective left renal arteriogram 12 days after renal biopsy shows lysis of clot in primary and in all but 1 secondary renal artery branch. Approximately 15 per cent renal infarction is noted.

TABLE 1. Renal tolerance of massive clot injection in rats

	Ml. Clot Injected	
	0.1	0.3
Amount of renal vasculature filled with clot	All distal branches	Entire vasculature including main renal artery
Time required for clot lysis:		
50 per cent	30 mins. to 1 hr.	6 hrs.
90 per cent	30 mins. to 6 hrs.	24 hrs.
Percentage infarction	10 to 20	60 to 85
Blood urea (mg. per cent)	32 \pm 7	250 \pm 34

TABLE 2. Effect of graded warm ischemia times on degree of immediate acute renal failure: non-ischemic kidney removed at same time

Total Renal Ischemia Time	Blood Urea (mg. per cent)*					
	Day 0	Day 1	Day 2	Day 5	Day 7	Day 8
30 mins.	42 \pm 5.8	90 \pm 11.1	63 \pm 8.3	36 \pm 6.9		
1 hr.	48 \pm 6.7	107 \pm 15.8	131 \pm 25.2	85 \pm 17.2	62 \pm 8.4	
2 hrs.	45.6 \pm 2.8	136 \pm 20.6	210 \pm 31.2	156.7 \pm 31.6	88 \pm 28.7	49.2 \pm 10.3
3 hrs.	39.8 \pm 4.5	200 \pm 31.2	All died			

* All values plus or minus standard error.

TABLE 3. *Effect of graded warm ischemia times on ultimate renal damage: non-ischemic kidney removed on day 14*

Total Renal Ischemia Time (hrs.)	Blood Urea (mg. per cent)*	Histologic Infarction (%)
	Day 15	
2	53.2 ± 8.7	0
3	73.6 ± 5.3	0-5
4	102.4 ± 21.4	0-25
5	163 ± 33.0	40-70

* All values plus or minus standard error.

TABLE 4. *Effect of intermittent unclamping of the renal artery on degree of acute renal failure from long warm ischemia time: non-ischemic kidney removed at same time*

Total Renal Ischemia Time* (hrs.)	Blood Urea (mg. per cent)†			
	Day 1	Day 2	Day 3	Day 7
1	65 ± 11.8	52.8 ± 8.4		
2	52.6 ± 8.5	41 ± 4.7		
3	117 ± 23.2	196 ± 38.7	180 ± 31.2	67 ± 14.5
4	228 ± 22.3 (1 died)	All died		

* Arteries unclamped every 30 minutes.

† All values plus or minus standard error.

of 15 per cent of the kidney was infarcted by this procedure. The blood urea was unaffected. However, when the entire renal artery and branches were filled with clot lysis required more time and infarction of renal tissue was 60 to 85 per cent. Therefore, the degree of infarction after clot injection appears to depend on the interval required for lysis, which is related to the amount of clot injected.

The effect of graded warm ischemia time on degree of acute renal failure is summarized in table 2. Up to 1 hour of warm ischemia resulted in only a mild, quickly reversible degree of renal failure. Two and 3 hours of warm ischemia produced progressively more severe degrees of acute renal failure. However, even with 2-hour ischemia all animals recovered renal function soon enough to survive.

Table 3 summarizes the degree of renal infarction from graded ischemia time when the other kidney is left in to keep the animal alive. More than 4 hours of total warm ischemia time were necessary for a large amount of tissue to be infarcted. Three hours of ischemia, although shown to produce severe temporary renal failure, produced hardly any infarction.

Intermittent, brief (3 minutes) unclamping of the renal artery greatly increased the amount of warm ischemia time required even to produce acute renal failure and, presumably, the risk of infarction also was greatly diminished (table 4).

DISCUSSION

Any time a renal biopsy is done there is a slight risk of losing the kidney from a complication, such as the one described in our case report.⁶ At best operative intervention will lead to heminephrectomy or more often total nephrectomy. Because in most cases it is the presence of renal disease that prompts biopsy, a loss of a kidney in such a patient can be a major disaster.

Bookstein and Goldstein,⁶ and Rizk and associates⁷ used angiographic embolization with clot and with subcutaneous fat, respectively, to stop hemorrhage in patients bleeding from renal biopsy who were considered poor operative risks. They thought that non-operative infarction of the kidney would have been an acceptable solution to the problem.

Rösch and associates injected 2 ml. clot after epinephrine infusion into the gastroduodenal artery to stop bleeding from a

duodenal ulcer.⁸ The clot did not lyse, possibly owing to the epinephrine. White and associates reported a similar case except that they used vasopressin initially instead of epinephrine.⁹ Margolis and associates injected clot into the obturator artery to stop massive hemorrhage in patients with pelvic fractures.¹⁰ Smith and associates injected clot into vesical branches of the hypogastric artery to control massive retroperitoneal bleeding from a prostatic needle biopsy.¹¹ In each of these instances there was no advantage to be gained by clot lysis because the bleeding branches were not fed by end arteries as in the kidney. Moreover, the major objective of preventing exsanguination in these circumstances overshadowed any concern about infarction.

However, in the clinical example presented infarction or surgical resection of a major portion of the kidney would have been a serious loss. Fortunately, rapid dissolution of clot occurred in vessels supplying uninjured areas of the kidney while hemostasis persisted at the biopsy site. Thus, not only was the bleeding controlled non-operatively but a maximal amount of functioning renal tissue was preserved. We have reported similar clinical success in treating blunt renal trauma with this technique.⁴

The experimental work reported herein supports the notion that angiographically injected clot may persist at bleeding sites in the artery but disappears within hours from most of the normal adjacent renal vasculature. Indeed, if clot lysis were not this rapid there would be a far greater amount of infarction despite ultimate reopening of the arterial branches. It would be dangerous to assume that the human fibrinolytic system is as active as that of the rat since in vitro studies have suggested that it may not be.¹² However, it certainly appears in vivo to be active enough to prevent any major loss of renal function from clot injection. It is clear that rat kidneys can tolerate up to 3 hours of warm ischemia with minimal ultimate infarction, which is enough time for most of a massive clot injection to lyse.

This concept is not new, only its application. In 1964 Warren investigated the fibrinolytic activity of vascular endothelium in detail.¹³ He noted that normal vascular endothelium has a strong clot-lysing effect, which was not present in damaged endothelium. Rösch and associates, in their animal experiments, demonstrated rapid fragmentation and dissolution of tantalum labeled blood clots injected into visceral arteries as long as vasoconstrictors were not concomitantly injected.¹ However, the aforementioned investigators were not the first to recognize this intriguing phenomenon. Hewson in 1772, Hunter in 1774 and Gulliver in 1846 noted clearly that "contact of blood with living vessels retards its coagulation".¹⁴

On the basis of this principle it appears that with angiographic injection of autologous clot for managing renal hemorrhage the need for operation and the fear of losing a kidney from percutaneous renal biopsy or blunt renal trauma may be considerably alleviated.

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