Visualization of the Renal Artery

A Comparison of Translumbar and Percutaneous Retrograde Catheter Approaches, Single-Film and Seriographic Technics

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RENAL ARTERIOGRAPHY is the most important diagnostic procedure for discovering patients with correctable hypertension due to obstructive renal arterial disease. If this procedure is to be used more widely, it must be simple, precise, and safe. There is no unanimity of opinion as to which technic provides better visualization of renal arteries: percutaneous translumbar\(^1\),\(^2\) or transfemoral retrograde\(^3\)-\(^13\) single film\(^2\),\(^6\) or serial films obtained by a rapid cassette changer (seriography).\(^4\),\(^12\),\(^14\) Except for the case report by Hemley et al.,\(^8\) the renal arteriograms in all these reported studies were obtained by only one method in a given patient. In such studies a comparison of these technics and the resulting radiographic findings is therefore difficult. It would appear that a critical evaluation of these two approaches and filming technics in the same individual is desirable.

Such an evaluation was possible at the Duke University Medical Center because renal arteriograms were performed by at least two groups with different methods. The Cardiovascular Laboratory group utilized the percutaneous transfemoral retrograde catheter technic with seriography for filming; the Urology group used the percutaneous translumbar approach and a single film radiographic technic. These procedures differed not only in the approach and filming technic, but also in the type and volume of contrast medium injected and the position of the patient. Twenty-nine patients were studied sequentially by both groups during the same hospitalization. Therefore, it was possible to compare in the same patient the two methods for delivering the contrast media and filming, the resulting radiographic findings and the discomfort and morbidity to the patient.

Material and Methods

Renal arteriography was attempted by both translumbar and percutaneous transfemoral catheter technics in 29 hypertensive patients with suspected renal arterial disease. Translumbar visualization was carried out by the Urology Section and was performed by percutaneous placement of a 17-gage, 6-inch needle through the left lumbar area into the abdominal aorta with the patient in the prone position. A single x-ray film was taken near the end of the hand injection of 10 ml. of 50 per cent sodium diatrizoate. A compression band over the lower abdomen was used in most of the studies to decrease the blood flow in the aorta. Repeat injections were frequently made after repositioning the needle to obtain better opacification of the renal arteries.

Transfemoral retrograde aortic renal arteriography was performed by a member of the Cardiovascular Laboratory group and was accomplished by the Seldinger percutaneous technic\(^15\) with a straight no.-8 Lehman catheter introduced into the abdominal aorta via a femoral artery. For these studies the patient was supine. The tip of the catheter was positioned approximately 1 inch below the hilar area of the right kidney, usually at the lower margin of the second lumbar vertebra. Twenty-five to 30 ml. of 75 per cent sodium diatrizoate\(^*\) was introduced through the catheter by a power injector. Twelve to 15 serial films (3 films per second for 3 to 4 seconds, then 1½ films per second for 2 seconds) were taken by a Schonander rapid film changer. A second injection was occe-
Patients

Unsatisfactory studies

Omplete visualization

Satisfactory studies

Comparison of Results of Renal Arteriography

<table>
<thead>
<tr>
<th></th>
<th>Translumbar</th>
<th>Transfemoral</th>
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<tr>
<td></td>
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<td>catheter</td>
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<td>seriographic</td>
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<td>Complete failures</td>
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sionally performed with the patient in the left or right posterior oblique position for improved visualization of suspected pathologic lesions.

The arteriograms obtained by both methods of approach and filming were carefully compared as to contrast, detail of the renal vasculature and the aorta, the pathologic lesions visualized and the over-all diagnostic value of the study.

Results

The translumbar single-film technic was unsuccessful in four patients because of difficulty in placement of the needle (table 1). In four other patients only one renal artery was opacified (fig. 1). The films by this technic were of unsatisfactory diagnostic quality in four additional patients. There were satisfactory contrast and detail in the remaining 17 studies (60 per cent).

Twenty-seven of the 29 studies (93 per cent) obtained by the percutaneous transfemoral seriographic technic resulted in satisfactory renal arteriograms. One study was discontinued because of excessive bleeding from the puncture site. Another study was unsatisfactory because of malfunction of the Schonander film changer.

The pathologic lesions demonstrated are summarized in table 2. Stenosis or obstruction of a renal artery was demonstrated by the retrograde seriographic technic in 10 patients (figs. 2 to 9). In four of these patients the lesion could not be seen on translumbar renal arteriograms because of poor detail or contrast. An intrarenal arterial aneurysm was demonstrated in one patient by both technics (figs. 4 and 5) and fibromuscular hyperplasia in another patient (fig. 6). Minimal arteriosclerotic-appearing changes in renal arteries without significant stenosis or obstruction were demonstrated in three retrograde renal arteriograms, while these changes were demonstrated in only one patient by the translumbar technic. Accessory renal arteries were visualized in eight patients by the retrograde seriographic method, but in only five patients with the translumbar approach (fig. 9). In no case was an apparent pathologic lesion demonstrated by the translumbar tech-
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and not by the retrograde renal arteriogram. Obviously the transfemoral seriographic study allowed visualization of more vessels than the translumbar single film technic. The seriographic study also routinely yielded a nephrogram phase that clearly outlined the size and shape of the kidneys.

Morbidity was minimal by both technics and confined to transient pain over the puncture site. Bleeding was more apparent with the retrograde method, since the site of the arterial puncture was readily visible. In one patient a large retroperitoneal hematoma resulting from translumbar approach was found during the surgery for correction of the stenosis of the renal artery. It was not clinically apparent. Intramural injection of contrast medium occurred in four cases with the translumbar technic. Arterial thrombosis, embolism or dissection, occasionally reported with arterial catheterization, did not occur in this series.

Table 2

<table>
<thead>
<tr>
<th>Abnormality</th>
<th>Translumbar catheter seriographic</th>
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<tr>
<td>Aorta</td>
<td>6</td>
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<tr>
<td>Tortuosity</td>
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<tr>
<td>Arteriosclerotic plaque</td>
<td>5</td>
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<tr>
<td>Renal Artery</td>
<td>12</td>
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<tr>
<td>Stenosis or obstruction</td>
<td>10</td>
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<tr>
<td>Arteriosclerotic</td>
<td>8</td>
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<tr>
<td>Fibromuscular hyperplasia</td>
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</tr>
<tr>
<td>Intrarenal aneurysm</td>
<td>1</td>
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<tr>
<td>Absence of right renal artery (ectopic kidney)</td>
<td>1</td>
</tr>
<tr>
<td>Minimal arteriosclerotic change</td>
<td>3</td>
</tr>
<tr>
<td>Accessory renal artery</td>
<td>8</td>
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</table>

Discussion

The translumbar approach for renal arteriography was introduced by dos Santos et al.16

Figure 2

Translumbar (left) and transfemoral retrograde (right) renal arteriograms of a 45-year-old white man with malignant hypertension (BP = 190/120 mm. Hg). Definite stenosis of left main renal artery with poststenotic dilatation is present. This finding was confirmed at surgery. Following nephrectomy, the blood pressure returned to 130/80 mm. Hg.

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Figure 3
Renal arteriograms of a 38-year-old white man with a blood pressure of 180/100 mm. Hg showing stenosis of right renal artery. The lesion is well demonstrated on the transfemoral retrograde film (right) but not apparent on the translumbar film (left) because of inadequate opacification of renal artery and the superimposition of the vertebra.

Figure 4
Renal arteriogram of a 25-year-old white woman with severe hypertension (blood pressure 190/120 mm. Hg) of 4 months' duration. Both translumbar (left) and transfemoral (right) renal arteriograms demonstrated an intrarenal aneurysm (arrow) at the first bifurcation of the right renal artery. The lesion was confirmed at surgery. Blood pressure became normal after nephrectomy.
in 1929. Despite many reported complications, it appears to be the most widely used technic in this country. The percutaneous transfemoral catheter method introduced by Pierce and modified by Seldinger\textsuperscript{15} is the method of choice in most European countries and in an increasing number of clinics in this country. Opinions differ as to the superiority of the two methods.\textsuperscript{2–12} All previous studies attempting to evaluate the two technics have compared the results obtained by one approach in one patient with those obtained by the other in another patient. Such studies lack sufficient controls to justify definite conclusions.

The present study was designed to evaluate in the same patient the two technics for introducing contrast media and the two methods of filming. The design of the study is not completely satisfactory as pathologic confirmation at surgery or autopsy was available in only six patients. It is also noteworthy that 10 ml. of 50 per cent sodium diatrizoate was used for the translumbar studies, while 30 ml. of 75 per cent of the same agent was used for the retrograde studies.

An ideal renal arteriogram should have good contrast and detail of the aorta and the whole renal arterial tree, but without filling of other major intra-abdominal arteries, such as the splenic and superior mesenteric. The procedure should be simple and economical, subjecting the patient to minimal risk and discomfort.

In this study the retrograde seriographic technic gave excellent results in almost every patient and provided much more information than the translumbar single-film technic. The translumbar approach had a higher rate of failure; only 17 of 29 studies (60 per cent) were of diagnostic quality. Foster and Kilen\textsuperscript{14} reported a similar result. In a series of 127 abdominal aortograms by the translumbar route, the renal artery was visualized in only 40 per cent. Of those abdominal aortograms specifically obtained for renal arterial studies, only 60 per cent were diagnostic; 69 per cent were diagnostic if two needles were simultaneously used. Kincaid and Davis\textsuperscript{4} reported a series of 1,500 translumbar aortograms in which 300 studies were made specifically for visualization of the renal artery. The renal arteries were satisfactorily demonstrated in only 85 per cent of the studies. The main difficulty of this approach is that of needle placement. It is a more or less blind procedure, requiring considerable technical skill. The needle may frequently be inserted too low (fig. 10), with nonfilling of renal artery, or too high (figs. 8 and 10), resulting in opacification of other major intra-abdominal vessels obscuring the renal arteries. Repositioning the needle is often difficult. It may lead to added discomfort to the patient and possible increase of other complications. It

![Figure 5](http://circ.ahajournals.org/)

**Figure 5**

Arteriogram of the kidney specimen removed from the patient whose renal arteriograms are present in figure 4. An intrarenal aneurysm (arrow) is clearly apparent at the bifurcation of the first and second branch of renal artery. Histologic examination revealed a saccular aneurysm with medial defect.

\textit{Circulation, Volume XXVIII, November 1963}
Figure 6
Renal arteriogram of a 33-year-old Negro man who had a blood pressure of 170/110 mm Hg and grade III fundi. Both translumbar (left) and transfemoral retrograde (right) renal arteriogram showed stenosis of right renal artery, apparently due to fibromuscular hyperplasia.

Figure 7
Transfemoral retrograde renal arteriograms of a 50-year-old white woman with a blood pressure of 230/130 mm Hg of 2 years' duration. Stenosis with poststenotic dilatation was present on both renal arteries. The lesion on the right was partially obscured by the superior mesenteric artery on the anteroposterior projection (left) but was much better demonstrated on the right posterior oblique view (right). Blood pressure returned to 140/90 mm Hg after endarterectomy of right renal artery.
has been recommended that no more than one attempt at repositioning the needle be tried.\textsuperscript{2, 17} Since the needle is inserted from one side of the aorta, resultant streaming of contrast medium often causes nonfilling or poor visualization of one renal artery (fig. 1).\textsuperscript{3–5} This may also prevent visualization of pathologic lesions or accessory renal vessels, and false-positive or false-negative interpretation may result.

The femoral artery is more superficial and easily accessible, making the procedure of introducing the catheter quite simple. There may be some difficulty in advancing the catheter in patients with severe arteriosclerosis and tortuous iliac-femoral blood vessels. This was no problem in this series of patients, however. In such cases use of an image amplifier is desirable. The tip of the catheter can be easily positioned and repositioned without discomfort to the patient. Therefore, an ideal injection site can be chosen to opacify only the renal arteries. Because the contrast medium is injected in a retrograde manner into the main stream of the aorta, mixing is usually adequate. Streaming of injection into only one vessel is unlikely. A potential improvement of this technic was recently reported by Amplatz,\textsuperscript{8} who adapted the ring catheter, used in coronary artery visualization, for renal arterial studies. This catheter directs the jet of the contrast medium downward and along the aortic wall, thereby obtaining better filling of the renal arteries and avoiding opacification of the celiac axis.

With the transfemoral retrograde approach the patient is supine and is more comfortable than in the prone position required for the translumbar approach. In the supine position the kidney and its blood vessels are closer to the film, producing less magnification with better detail. The oblique position has been valuable for studying patients with pathologic lesions located near the origin of the renal arteries, superimposed on a vertebra or obscured by other blood vessels (fig. 7). This position is also useful in differentiating aneurysms from "blood vessels-on-end." Such positioning of the patient presents no prob-

lem when the transfemoral approach is used. On the other hand, in the translumbar approach with a rigid needle in the aorta, movement or positioning of the patient is difficult and may result in serious complications.

Although there were no serious complications with the translumbar approach in this series, such do occur and have been well reviewed by Crawford et al.,\textsuperscript{17} McAfee,\textsuperscript{18} and many others.\textsuperscript{2, 7, 19} The over-all serious complication rate was estimated at about 1.02 per cent.\textsuperscript{18} These complications include intra-abdominal bleeding, kidney damage, spinal cord injury, hemothorax, chylothorax, superior mesenteric arterial thrombosis, pancreatitis, and adrenal necrosis. Misplacement of needle was believed responsible for the majority of the complications.\textsuperscript{18, 19} Complications associated with the transfemoral approach have been reported but with lower incidence and less severity.\textsuperscript{8–11} Our experience with a large number of other patients not included in this study suggests that the transfemoral approach is a safer procedure. Bleeding is more apparent with the percutaneous transfemoral retrograde approach. It is easier, however, to detect and control than retroperi-

![Figure 8](image-url)

\textit{Translumbar renal arteriogram of the same patient as figure 7. Stenosis of right renal artery was not well shown because of the inadequate opacification of that renal artery and the obscuration by the lumbar vertebra and other intra-abdominal vessels.}
Renal arteriogram of a 20-year-old white man with a blood pressure of 210/135 mm. Hg. Intravenous pyelogram (upper left) showed no opacification of the right kidney. Retrograde pyelogram (upper right) demonstrated an ectopic pelvic kidney on the right. Both translumbar (lower left) and transfemoral retrograde (lower right) renal arteriograms showed the renal artery on the left. No right renal artery was demonstrated by either technic. An accessory renal artery to the lower pole of the left kidney is seen on the transfemoral film but not demonstrated on the translumbar film. At surgery, a small right pelvic kidney with pyelohydronephrosis was removed and the blood pressure immediately returned to 110/80 mm. Hg.

Retroperitoneal or intra-abdominal bleeding that may occur as a result of the translumbar approach. A large retroperitoneal hematoma occurred in one patient following translumbar puncture. This was not clinically apparent until the patient was operated upon for correction of...
renal arterial stenosis. Because of this hematoma, bypass grafting was impossible. Fortunately, the patient became normotensive after nephrectomy.

Filming technic is also an important factor for obtaining good arteriograms. Foster and Killen found that after eliminating all failures resulting from improper needle placement and mechanical failure of equipment, 87 per cent of abdominal aortography was of diagnostic quality when seriography was used, but only 60 per cent with single-film technic. Kinecaid and Davis also thought multiple films were necessary. In our experience single-film technic, with a longer exposure time and lower kilovolts, produced a study with greater contrast, despite the use of less contrast medium. However, such a filming technic would not appear to be completely satisfactory as it represents only an instantaneous record of one phase of renal circulation. The possibility of making the exposure at the time of complete filling of the vessels is less than with a seriographic technic. Seriographic technics can also compensate for the obscuring effect of other opacified intra-abdominal vessels, since the filling of the renal and other abdominal vessels usually begins at different times. All phases of renal circulation are recorded, including the nephrogram phase. Nephrograms have proved valuable in demonstrating the shape and size of functioning renal tissue and, therefore, outlining intrarenal lesions such as segmental infarct, tumor, or cyst. Regardless of the technic used for delivering contrast medium, seriography is definitely superior to single-film technic. Although the cost of initial equipment and the film necessary for seriography is greater, the invaluable information it can provide makes the cost worth while.

Summary

Renal arteriograms were performed by both percutaneous translumbar single film and percutaneous transfemoral catheter seriographic technics on each of 29 hypertensive patients with suspected renal arterial disease. Comparison of the renal arteriograms obtained by these two methods demonstrates

![Figure 10](image)

Figure 10

Translumbar renal arteriograms showing difficulty in proper placement of needle. Left. The needle is too low, resulting in no opacification of either renal artery. Right. The needle is too high. Opacification of the superior mesenteric artery is excellent. The renal arteries, however, are not visible.

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that the transfemoral catheter seriographic technic is a simpler and more reliable procedure and results in better visualization of the renal artery. Ninety-three per cent of the studies by this method resulted in excellent diagnostic renal arteriograms, whereas only 60 per cent of the studies utilizing the translumbar technic were of equal quality. Pathologic and congenital abnormalities were also better demonstrated with the transfemoral catheter seriographic technic. The advantages and pitfalls of both methods have been discussed.

References

William Harvey

Harvey, the acknowledged Father of modern physiology, returned to the Greek method of experiment which had been in almost complete abeyance since the time of Claudius Galen (A.D. 130-200), "the first Father of experimental physiology" whose authority and teaching had remained sacrosanct for more than thirteen hundred years.—Sir HUMPHRY DAVY ROLLESTON. The Harveian Oration. Great Britain, Cambridge University Press, 1928, p. 1.
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Circulation. 1963;28:843-852
doi: 10.1161/01.CIR.28.5.843

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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