Translumbar Aortography

A Study of Its Safety and Usefulness

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• **We reviewed the clinical courses of 14,550 patients in whom translumbar aortography was performed. The principal aim of the survey was to determine the incidence of major and fatal complications attributable to this diagnostic study, as an index of its safety. We found that in this group, seven major (0.05%) and two fatal (0.014%) complications occurred. The corresponding incidences for transfemoral catheter aortography reported in the literature were found to be 1.34% and 0.06%, respectively. Translumbar aortography, when performed under the proper indications and appropriate conditions, has a degree of safety equal to or greater than that of transfemoral catheter aortography, and its diagnostic reliability within its technical scope is high.**

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In 1962 we reported[1] the results of our study of the value and hazards of translumbar aortography (TLA) in 2,399 patients, and concluded that this mode of examination, when performed under appropriate safeguards, was not only free from undue risks, but yielded excellent diagnostic results. Following this study, we continued to use this method, and confirmed the view that for the roentgenological exploration of the peripheral arterial tree from the renal to the infrapopliteal arteries, it offered important advantages: technical simplicity, broad clinical applicability, diagnostic reliability, and the potential of remarkable freedom from complications.

In recent years, most diagnostic angiographic procedures have passed into the domain of the radiologist. As a consequence, the virtues of translumbar aortography have become neglected, and to a great extent the method has been replaced by more complex procedures. Aside from considerations of cost and safety, this change has had the regrettable effect of depriving the surgeon dealing with vascular problems of his role in the diagnostic investigation of his patients, which, in our view, is an essential precondition of intelligent treatment. In order to assess the proper role of translumbar aortography in current surgical practice, we have reviewed our experience since the date of our previous report until June 30, 1976. Since the cause for the decline in the popularity of TLA has generally been ascribed to its inferior quality of safety as compared with transfemoral catheter techniques, we paid special attention to this criterion.

Fig 1.—Translumbar aortogram of normal infradiaphragmatic arterial tree in patient with multiple gunshot wounds, in whom arterial injury was suspected.

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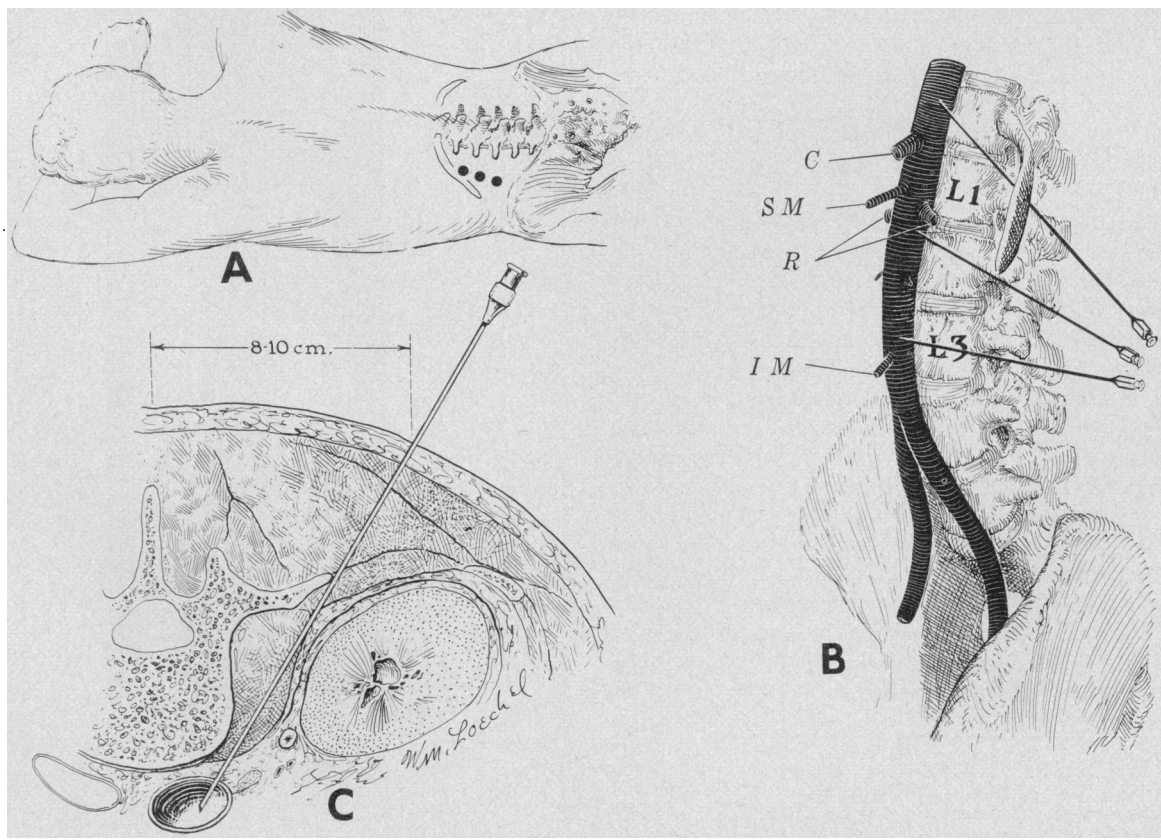
MATERIALS AND METHODS

The cases we reviewed, numbering 14,550, comprised all the examinations of translumbar aortography performed at our service between Jan 1, 1961, and June 30, 1976. (As noted above, 2,399 such examinations had been carried out before 1961 and reported in 1962.) In clarification of the scope and type of this clinical experience, it should be noted that in our practice the indications for the use of angiographic examinations are broad.

The clinical circumstances that in our opinion call for the use of angiography can be summarized as follows: In the occlusive type of arterial disease, we regard an angiographic survey of the infradiaphragmatic peripheral arterial tree as a nearly indispensable source of information for the evaluation of operability and for planning of the appropriate surgical procedure. In aortic aneurysmal disease, the information that can be gained from aortography concerning the relationship of the aneurysmal sac to the renal arteries, as well as concerning the size, disposition, and state of disease of the proximal aorta and distal arterial bed, has in our opinion been valuable enough from the point of view of assessing the operative risk and planning surgical intervention to warrant the routine employment of this diagnostic tool in cases of asymptomatic abdominal aortic aneurysms in which specific contraindications to its performance do not exist. It must be emphasized that the use of translumbar aortography in the management of abdominal aortic aneurysms does not serve the purpose of diagnosis, but that of gathering information as described above. It should further be noted that in symptomatic aneurysms, the performance of this examination is seldom warranted.

In aneurysms of the peripheral arteries, preoperative angiographic studies, although not essential for management, are useful in delineating the exact anatomical location of the lesion and the distribution and abundance of the collateral arterial branches, thus making surgical repair safer and faster. In cases of arterial emboli, as a rule, diagnosis is made on the basis of symptoms and clinical history. Very occasionally, situations arise in which only angiography or exploration can lead to a definitive diagnostic decision. A problem in the differential diagnoses between embolization and thrombosis may, for instance, be created by sudden arterial occlusion in the presence of advanced arteriosclerosis, especially if there is not a readily visible source for embolization. If the clinical data are insufficient to make differentiation, carefully performed angiography of the appropriate type and with the necessary precautions usually reveals the diagnosis. A similar situation is presented by the difficulty experienced at times in distinguishing between an embolus at the level of the femoral bifurcation and one at the level of the division of the popliteal artery. Here, distinction is particularly important, since in certain types of popliteal embolization conservative management is the therapy of choice, and in case of surgical

Fig 2.—Technique of translumbar aortic puncture. A, Landmarks for puncture sites. B, Position of needle for high, intermediate, and low puncture. C, Topographic relationships of needle (C indicates celiac artery; SM, superior mesenteric; R, renal; and IM, inferior mesenteric).



therapy, anatomical approaches are significantly different. Here, too, a percutaneous femoral angiogram would usually decide the issue.

In penetrating trauma of the abdomen and both blunt and penetrating trauma of the limb, whenever the trajectory of the tool of violence or the physical findings suggest possible injury to an artery, appropriate angiographic studies are carried out. In the management of traumatic arteriovenous fistulae, preoperative femoral angiography is a useful, albeit not an indispensable, source of information with respect to the exact location and size of the fistulous communication and pattern of collateral vessels.

Angiographic studies are essential in the therapeutic evaluation of congenital vascular malformations. In a practical sense, the greatest usefulness of postoperative angiography is the confirmation of the operative result. The only true proof of success of a grafting operation is the patency of the graft, and the only unequivocal evidence of the patency of the graft is its angiographic demonstration. We use postoperative check-up angiography as a predetermined routine.

Methods of Angiography

The techniques of examination employed in this series have long been described, and are in general clinical use[2,3]; we have added only minor modifications. Abdominal aortograms are obtained through the standard translumbar percutaneous route or through two similar routes at somewhat lower levels, as shown in Fig 1. The standard translumbar or high-puncture aortograms require the introduction of the needle at the level of the lower border of the 12th rib in the left lumbar area at 8 cm lateral to the midline, the point of the needle aiming at the undersurface of the body of the 12th thoracic vertebra.

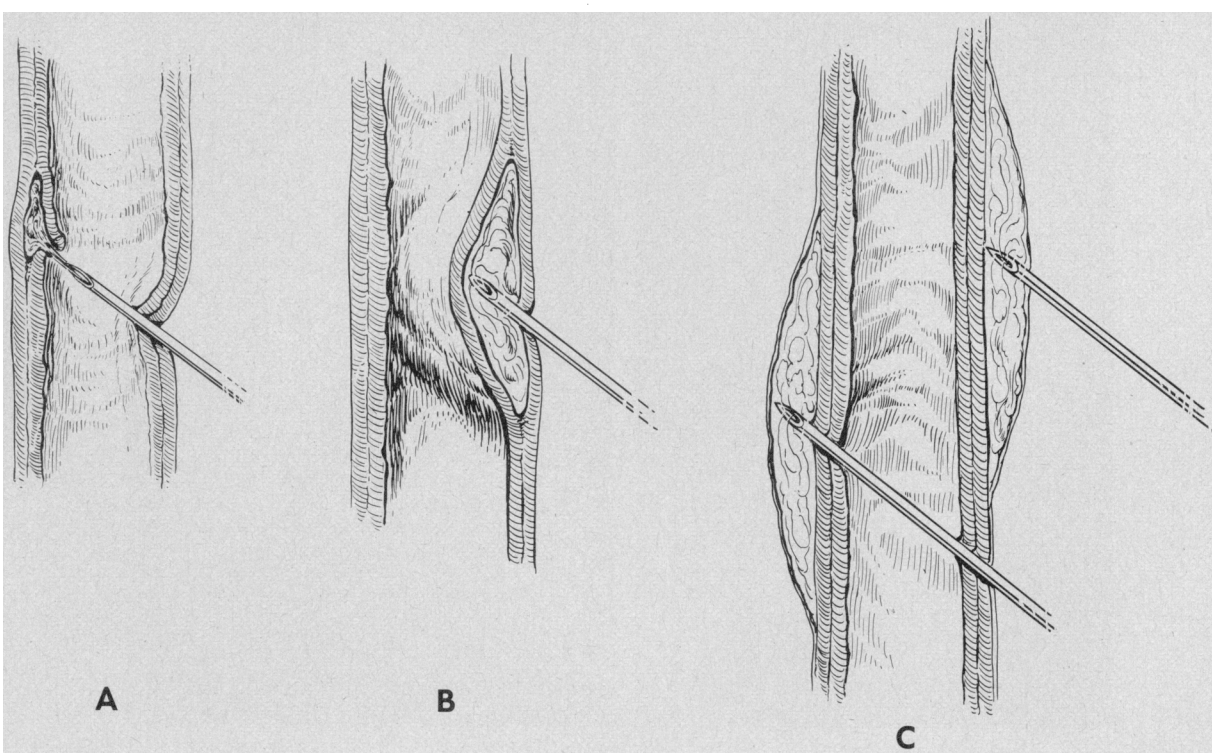
The level of the so-called low puncture is approximately 2 cm above the left iliac crest, 8 to 10 cm to the left of the midline, the point of the needle aiming at the body of the third lumbar vertebra at its upper border. The intermediate puncture is placed at a similar distance from the midline, but about 4 cm above the iliac crest, and the point of the needle aims at the lower border of the first lumbar vertebra. In recent years, the last-named level has become the most commonly used one, since it provides a satisfactory visualization of the renal arteries as well as of the distal arterial tree.

Unless specific contraindications exist, all cases of peripheral arterial occlusive disease are investigated by abdominal aortography, the puncture being low or intermediate whenever at least one femoral pulse is clearly palpable. Femoral arteriograms are used in cases where contraindications exclude the use of low-puncture aortography, or where some special detail of the peripheral arterial tree has to be investigated. All examinations for the study of the abdominal aorta and its branches are carried out on equipment permitting the sequential exposure of eight x-ray plates, 91.4 cm in length and 35.5 cm in width and yielding angiograms with adequate details of the arterial tree from the renal to the infrapopliteal arteries (Fig 2).

In order to secure serial angiograms of the peripheral arterial tree from the renal to the infrapopliteal arterial branches, as briefly mentioned in the previous paragraph, special equipment is necessary. The essential part of this equipment is an automatic cassette changer that has previously been described in detail.[1]

All our essential information related to the surgical management of peripheral vascular disease is coded on special cards, and

Fig 3.—Intravasation (deposition of contrast medium in subintimal layers of arterial wall) may be caused by jet effect (A) or by placement of needle point within parietal layers (B). Extravasation (C) results from impinging needle point in adventitial layer before entering, or after traversing, lumen.



then transferred to magnetic tape. From these computer tapes, information can be obtained after the preparation of appropriate programs. The computer programming supplies our basic data, but certain details must be hand-sorted by direct inspection of case histories.

During the years 1952 through 1956, acetrizoate sodium, and between 1956 and 1965, diatrizoate sodium, served as contrast media. During the past ten years we have used iothalamate sodium in 80% solution for aortography, and iothalamate meglumine in 60% solution (Conray) for femoral arteriography.

In our earlier practice we found that intravenously administered thiopental sodium was the most pleasant form of anesthesia from the patient's point of view, but it presented the highest incidence of a singularly troublesome complication: laryngospasm. Because of this untoward experience, we gradually adopted the method of local analgesic infiltration, reserving inhalation general anesthesia for the very few patients whose apprehensive attitude precludes the use of a local anesthetic agent.

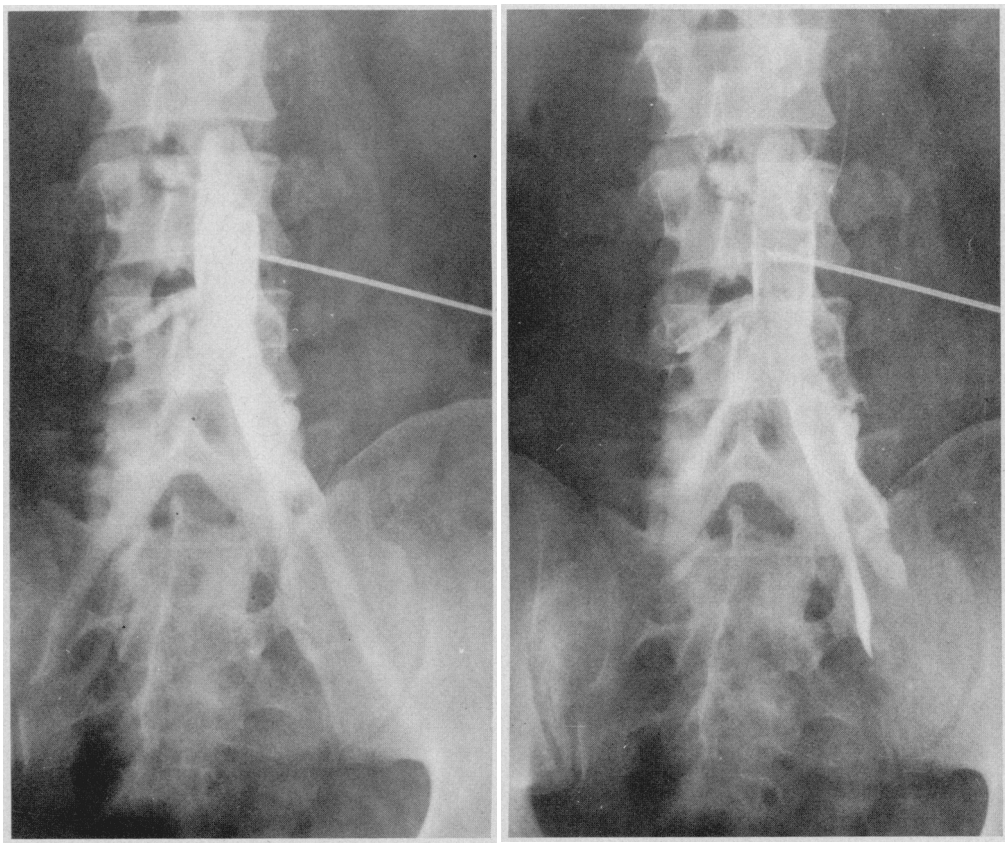
COMPLICATIONS

The complications that we have experienced during the performance of translumbar aortography can conveniently be divided into categories of technical and systemic complications. Technical complications consist of intravasation, extravasation, misdirection of the injection, and hemorrhage. Intravasation (Fig 3 and 4) designates the infiltration of the contrast medium into the layers of the aortic wall. Extravasation (Fig 3 and 5) denotes the injection of the contrast medium into the adventitial layer of the wall.

Misdirection of the injection (Fig 6) describes a variety of events in which the point of the needle is inadvertently introduced into an organ or body cavity that was not intended to be the subject of examination. Such an organ may be a viscus or an arterial branch. Hemorrhage, obviously, is the escape of blood from the puncture site in the aorta (Fig 6).

Theoretically, all these technical mishaps are preventable, but in actual practice, they occur even though all the necessary safeguards are carefully observed. There is no doubt, however, that, by the exercise of caution, their incidence can be reduced to a very small quantity. Systemic complications of translumbar aortography are the result of reaction to the circulating contrast medium by the cardiovascular or central nervous system, or are due to drug hypersensitivity or some coexisting coagulopathy. The consequence of any technical or systemic mishap may be either of minor or of major character.

Fig 4.—Left and right, Angiographic appearance of intravasation of contrast medium in low-puncture translumbar aortography.



Minor

Table 1 lists the incidence of minor complications arrived at by sampling 500 consecutive aortograms. This statistical approach was necessary, since our computer records do not contain information of such extensive details as would cover the minor incidents that lead to these complications.

The definition of minor complications is arrived at by exclusion. Complications that lead to significant morbidity, permanent loss of some function, or need for a secondary surgical intervention are classified as major complications. All the other untoward defects are designated as minor complications. These include back pain, abdominal discomfort, abdominal ileus, headache, and manifestations of

Fig 5.—Left and right, Angiographic appearance of extravasation of contrast medium immediately after completion of test injection in translumbar aortography.

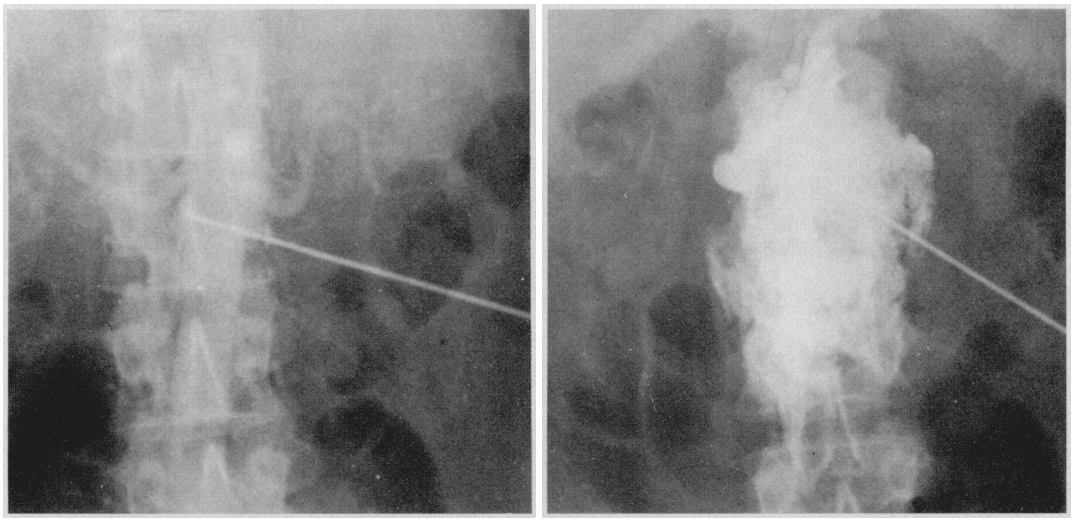
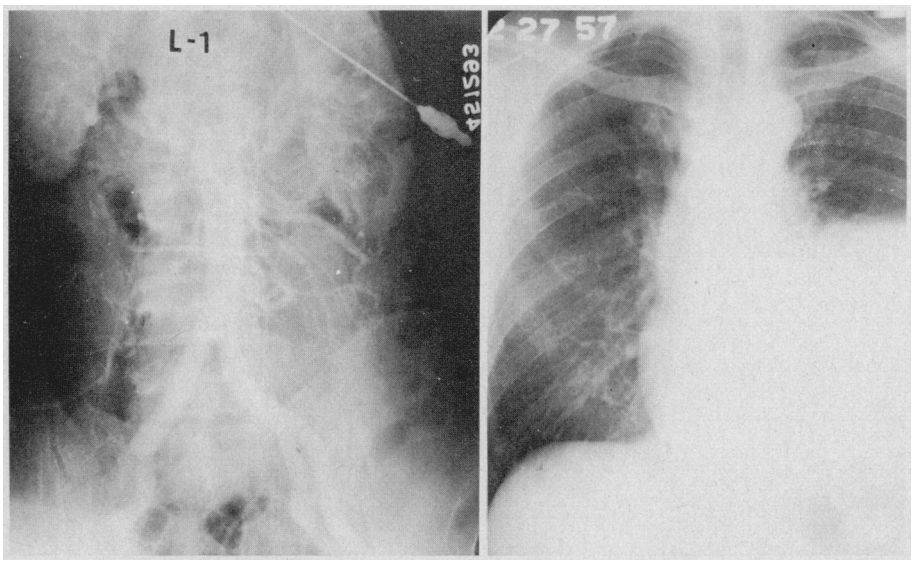


Fig 6.—Left, Misdirection of needle in translumbar aortography. Right, resulting hemothorax. Needle points to undersurface of 11th instead of 12th thoracic vertebra.



minor hypersensitivity such as transient joint pain or hives. The tabulation shows that the incidence of minor complications was quite acceptably low.

Major and Lethal

There were seven (0.05%) major complications, and two (0.014%) lethal ones. Table 2 shows the periods of major complications. Table 3 contains essential clinical data related to lethal complications. A scrutiny of the tabulations shows that, by far, the most common cause of major complications was misdirection of the needle puncture, that is, high puncture of the aortic wall, creating transpleural penetration and intrathoracic hemorrhage. The puncture of the thoracic aorta by a 17-gauge needle may easily cause significant loss of blood, even in the presence of normal blood pressure. The scanty retropleural tissues may be inadequate to tamponade the puncture hole. When such a puncture coexists with arterial hypertension, this danger is greatly increased, as illustrated by the patient in whom massive and fatal hemorrhage ensued.

Three other major complications occurred under very unusual circumstances. In one instance, intravenous administration of heparin sodium 24 hours after the performance of the translumbar aortography led to significant retroperitoneal loss of blood. In another case, an unrecognized coagulopathy was the initiating cause of a large retroperitoneal hematoma following the aortic puncture, which otherwise was in every way normal. In a third case, no cause for a retroperitoneal hematoma could be detected. In the case of paraplegia, a very careful scrutiny of the result of the translumbar aortography, as well as the circumstances of the performance of the puncture, yielded no clue regarding the cause of the damage to the spinal cord. In the second lethal case, the anaphylactic drug reaction was completely unexpected, since the patient had undergone previous aortographic studies without untoward side effects.

Table 1.—Minor Complications in 500 Consecutive Prospective Cases*

Complication	No. (%)
Intravasation	9 1.8
Extravasation	5 1.0
Misdirection	24 4.8

*All technical.

PREVENTION OF COMPLICATIONS

The list of safeguards against possible complications with translumbar aortography begins with the attitude of the operator in regard to the risks of aortography. Since basically the technique of examination is very simple, it is easy to look at it as a minor procedure. Such a lighthearted view disregards the essential point of the matter, namely, that the act of introducing the needle into the vessel, from the point of view of the potential dangers, is the least important part of the examination, and that in the moment of injection a number of risks are triggered that may bring

Table 2.—Major Complications

Case No.	Diagnosis	Level of Puncture	Technical Problem	Type of Complication	Treatment
1	Arteritis of lower limbs, unknown origin	T-12	Transplural puncture	Left-sided hemothorax	Thoracoabdominal suture repair, recovery
2	Abdominal aortic aneurysm	T-11	Transplural puncture	Left-sided hemothorax	Transfusion, thoracostomy tube, recovery
3	Abdominal aortic aneurysm	T-11	Transplural puncture	Left-sided hemothorax	Transfusion, thoracostomy tube, recovery
4	Aortoiliac & femoropopliteal occlusive disease	L-2	Heparin sodium administered intravenously within 24 hr	Hypotension, retroperitoneal hemorrhage	Transfusion, recovery
5	Abdominal aortic aneurysm	L-1	Unrecognized coagulopathy	Hypotension, retroperitoneal hemorrhage	Transfusion, corticosteroid therapy, recovery
6	Abdominal aortic aneurysm	L-1	None	Retroperitoneal hematoma	Evacuation of hematoma during R & G of aneurysm, recovery
7	Follow-up aortography	L-1	None	Paraplegia	Supportive; permanent disability

Table 3.—Fatal Complications

Case No.	Diagnosis	Level of Puncture	Technical Problem	Type of Complication	Treatment
1	Abdominal aortic aneurysm, hypertension	T-11	Transplural puncture	Left-sided hemothorax	Transfusion, thoracostomy tube
2	Follow-up aortography	L-2	None	Anaphylactic drug reaction	Cardiopulmonary resuscitation

about grave and even fatal consequences: the vascular wall in a severely diseased aorta may be damaged or disrupted; or the contrast medium may be injected into the wrong vessel or at the wrong level, or into the wrong layer of tissue. When these disasters, which are clearly possible in every instance, are remembered, aortography assumes the importance of a major operation. Indeed, the mortality rate of aortography has at times been observed to be higher than that of some operations that are universally classified as major procedures.

The view of aortography as a major operation may appear to be extreme, but its acceptance is an indispensable condition of safety. Thus, the institution of safeguards against complication begins with the classification of the candidates for aortography as patients about to have a major operation. Like other candidates for major surgical procedures, the patients about to undergo aortographic examinations should be hospitalized (usually for 48 hours) and undergo the usual preoperative clinical and laboratory evaluation, with particular regard to cardiac and renal function.

The next important safeguard concerns the consideration of the choice of the type of examination to be used. This choice should aim at the employment of the technique involving the smallest risk and yet compatible with the full demonstration of the details of the lesion. When the examination is undertaken for the study of the lower extremities, serious thought should be always given to the advantages of obtaining this study by low or intermediate rather than by high puncture. It is a reliable rule that if at least one femoral pulse is palpable and of normal amplitude, a low or intermediate-puncture aortogram will yield all the important information. In the absence of questionable presence of both femoral pulses, high puncture is mandatory, but in such instances the usual precautions as to the amount of injected contrast material are particularly important. While a complete survey of the infradiaphragmatic arterial tree is desirable and useful in all cases of peripheral arterial occlusive disease, when the lesion of clinical importance is in the femoropopliteal trunks, in instances of poor-risk patients, the examination must be limited to the visualization of the femoral artery, percutaneous femoral arteriography being the least hazardous of all the available techniques.

The anesthetic agent must be chosen and administered with the care demanded by a major surgical procedure. Among the various types of anesthetic methods, local infiltration is the safest when the patient's personal traits permit its use. With the currently used contrast medium, the discomfort experienced after the injection is mild, but still significant enough to upset and even frighten the high-strung and apprehensive patient. Among the techniques of general anesthesia, endotracheal inhalation anesthesia is to be preferred.

Throughout the performance of the examination, the cardiac function of the patient should be monitored by an oscilloscopic display of continuous electrocardiography. There should be standby arrangements for cardiorespiratory resuscitation, and an intravenous line must be kept open for the immediate availability of emergency drug administration.

The choice of the type of contrast medium has obvious importance. The risks associated with injectable radiopaque material are two-fold: the danger of an anaphylactic reaction, and chemical toxicity. The problem of hypersensitivity to the iodine-containing intravenously or intra-arterially administered contrast media is complex because our knowledge of its pathogenesis is very sketchy. We do not know with certainty which portion of this substance injected (the iodine or the organic portion) is responsible for the antigenic effect, nor how hypersensitivity to either is acquired. From a practical point of view, however, it is reassuring that fatal anaphylactic reactions to radiographic contrast media are very rare; we have seen this only once in the entire series. Nonfatal but significant allergenic reactions are more often seen, but are still uncommon.

It is of great practical interest whether one can detect an allergic disposition in patients about to undergo angiographic studies. In our experience, the simple tests presently available are of little genuine value. These tests miss some patients who show allergic manifestations after the angiographic examination. When the tests elicit reactions, on the other hand, the patient may still safely undergo the examination. It is to be feared that the truly anaphylactic patient may have a fatal reaction to the test dose itself.

In spite of these shortcomings, however, we recommend the routine use of preexamination tests, since they yield useful warning for possible greater difficulties. Moreover, if an anaphylactic reaction with fatal or permanently disabling consequences should occur, from the medicolegal point of view the omission of the preinjection testing would be difficult to defend. Owing to considerations of toxicity, we are convinced that, currently, iothalamate is the preferable contrast material. Even though the toxicity of this material is low, the amount injected must be kept at a minimum. If the technical equipment is satisfactory, the total amount of dye required for a good visualization of the entire infradiaphragmatic arterial tree is 30 ml of 80% solution. In about 10% of the patients, this dose may have to be repeated.

This reduction of the amount of injected contrast material cannot, however, be achieved without satisfactory mechanical aid in obtaining the roentgenograms. The definition of this mechanical aid in the study of the peripheral arterial tree is simple: it should enable the operator to obtain at least five serial exposures, and preferably more, about two seconds apart, of the entire field to be surveyed. Needless to say, the ability to obtain sequential exposures has many other advantages beside the avoidance of repeated injections of the contrast medium. It shortens the time the patient spends on the examination table, and thus the duration of the anesthesia, and, more important, it shortens the time during which the translumbar needle must remain in place, since the examination can be concluded without the need for checking the exposed films. This is so because, in good serial examinations, the need for repeated studies is so rare that the

patient can be returned to his room as soon as the last exposure has been obtained. An important dividend of multiple exposures is, of course, the greatly increased diagnostic refinement.

With respect to the technique of injection, the entire purpose of the safeguards is to ascertain with absolute certainty the position of the needle before the contrast medium is introduced. The great importance of fastidious care in positioning the needle is obvious from the consideration of the causes of the serious mishaps: in four of the nine grave complications, the cause was the improper position of the needle. This aim is achieved in two phases.

First, the operator must be sure of his landmarks. The pleura may be punctured and hemothorax may be created by mistaking the 11th rib for the 12th that is too short to palpate. The roentgenographic visualization of the bony landmarks obviates such tragedies. The position of the 12th rib and the relationship of this rib to the 12th dorsal and first lumbar vertebrae must be scrutinized in the roentgenogram, which may be available from previous studies, or, if not on hand, should be obtained as the first step in the injection technique.

Second, once the needle is in position, the injection of a test dose is an indispensable requirement. The injection without undue pressure of 3 to 5 ml of contrast material, in our experience, has never caused serious damage, regardless of where it was deposited through the translumbar needle, whether in the arterial branch or in the subadventitial layer of the aorta, or even in the pleural space. When a large amount under the required greater pressure is injected, however, the consequences may be grave.

When the dye is injected directly into the visceral artery, the damage done depends a great deal on the toxicity of the drug, as well as on the speed of injection and the cleanness of the puncture. If the puncture in the visceral artery is jagged, hemorrhage or thrombosis may follow the injection. Spilling the contrast material in the subadventitial plane seldom causes serious complications, but almost invariably results in annoying and often severe discomfort that may last for days. The forcing of the drug into the subintimal layer, on the other hand, is laden with ominous possibilities. In this study, this complication has fortunately been prevented, but in our previous reported group[1] of patients it caused the loss of a limb and of a life. Intravasation is at times difficult to detect, and a scout x-ray film after the test injection must be scrutinized most carefully. If any doubt exists a second scout film taken within three to four minutes may help in detecting a small area of intravasation otherwise not visible.

In the same connection, a comment should be made on the mechanism of the complications of high puncture. The escape of blood in case of high puncture and the appearance of hemothorax are not necessary consequences of this type of mishap. Although blood has a greater tendency for persistent seepage from the thoracic aorta than from the abdominal aorta after a clean puncture, the escape of blood would ordinarily not assume important proportions. Test injections through punctures that were by mistake placed too high do not as a rule lead to significant escape of blood. The greater the trauma to the aortic wall through the prolongation of the examination, the greater will be the likelihood for serious bleeding. The presence of hypertension will further accentuate this effect.

Table 4.—Incidence of Major and Fatal Complications From Translumbar and Transfemoral Catheter Aortography

Type of Aortography	Source, yr	No. of Cases	Complication: Major No.	Major %	Fatal No.	Fatal %
Translumbar	Beall et al,[7] 1964	4,613	0	...	8	0.17
	Diemel & Schmitz-Drager,[8] 1968	310	3	0.96	0	...
	Dorph & Folke,[9] 1972	420	0	...	1	0.25
	Gammill & Craighead,[10] 1975	475	1	0.21	0	...
	Lang,[11,12] 1963	3,240	11	0.3	1	0.03
	Moore et al,[13] 1970	380	0	...	0	...
	Total	**9,438**	**15**	0.16	**10**	0.10
Transfemoral catheter	Cormier et al,[14] 1966	5,387	104	1.9	8	0.13
	Diemel & Schmitz-Drager,[8] 1968	290	5	1.7	0	...
	Halpern,[15] 1964	1,000	19	1.9	0	...
	Kerstein & Ramsby,[16] 1973	215	6	2.8	0	...
	Lang,[11,12] 1963	11,402	81	0.7	7	0.06
	Moore et al,[13] 1970	824	10	1.2	0	...
	Schreiber,[17] 1971	706	14	2.0	0	...
	Seidenberg & Hurwitt,[18] 1966	1,500	26	1.7	0	...
	Total	**21,324**	**265**	1.24	**15**	.07

Two additional simple but useful precautions must be kept in mind in regard to the location of the needle. First, one cannot judge the position of the needle solely by the force and pulsatile character of the reflux of aortic blood. Disregarding this truth may cause serious mishaps. Second, once the position of the needle has been ascertained by a scout x-ray film and test injection, the reflux must be watched closely. The motions of aspiration of the movements of the patient may dislodge the needle sufficiently to direct its tip into the layers of the aortic wall. These changes in the position of the needle are usually reflected in the character and force of the reflux.

An equally important warning to bear in mind is that in doubtful situations it is best to stop and repeat the examination at a later date. Angiography is an aid to diagnosis and not an act of emergency. When technical difficulties arise, there is no reason other than convenience or stubbornness to insist on the completion of the study. Invariably, a second attempt on another day is easier, safer and more fruitful.

RELATIVE SAFETY OF TRANSLUMBAR VS TRANSFEMORAL AORTOGRAPHY

It is not simple to uncover the reason for the increase in popularity in recent years of the transfemoral catheter

method, as compared with the translumbar method of contrast visualization of the infradiaphragmatic arterial tree. One suspects that the radiologists who have taken over this field prefer the use of the transfemoral (usually Seldinger) technique for all forms of visualization of the abdominal aorta and its branches, since this is the method with which they become most familiar in the course of selective angiography, for which obviously catheter techniques are highly successful. The reason often quoted is, however, that the safety of the catheter technique is greater.

On careful analysis this argument does not hold. Table 4 summarizes the reported incidences of major and lethal complications in transfemoral and translumbar aortographic examinations. The quoted figures represent all the published results for the period of time during which modern methods have been employed. Some statistical summaries[4-6] that cover the period from 1932 to 1955 have not been included, since the contrast media and techniques employed for translumbar aortography during those years were different from, and many ways inferior to, the currently popular methods. The comparison clearly shows that the incidence of both major and lethal complications was probably acceptable by either method, but that the overall incidence with translumbar aortography was lower.

When one uses the term "acceptable," one faces a great difficulty in definition. In any diagnostic examination, the acceptable degree of risk is extremely difficult to determine or quantitate. In a general way, one may say that an examination that causes serious complications in no more than one patient out of 1,000 can be regarded as safe. Both methods fulfill and surpass this requirement. In the collective summary, major complications were much less frequent with translumbar aortography, and fatal complications slightly less common with catheter studies. Our own results were superior to those reported for catheter technique in both categories.

Nonproprietary Names and Trademarks of Drugs

Acetrizoate sodium—*Cystokon, Thixokon, Urokon Sodium.*
Iothalamate sodium—*Angio-Conray.*

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Discussion

TOSHIO INAHARA, MD, Portland, Ore: There are three angiographic techniques applicable to this segment of the vascular tree.

First is the original technique of translumbar insertion of the needle, as described by Dr Szilagyi and his colleagues. It is still a good technique: technically easy to perform, relatively safe for the patient, and generally free of major complications as just described. Because of the high upstream injection in the aorta and resultant hemodilution, its major limitation is the difficulty in clearly defining the popliteal artery and its tributaries, particularly when there is extensive occlusive disease. This often necessitates an addition of femoral arteriography as another procedure.

The second method is the Seldinger technique, by use of the catheter in the aorta. Again, clear delineation of the popliteal and tibial branches is difficult for the same reasons, but to this is added a partial obstruction of the iliac and femoral arteries by the intraluminal catheter. Angiograms of the ipsilateral limb are often inadequate. Also compared to the translumbar technique, incidence of complication is greater for hemorrhage, thrombosis, and embolization. Despite these shortcomings, this technique is most commonly used.

The third method is retrograde aortography. We have used this technique for 13 years and still find it most satisfactory. Both areas, aortoiliac and femoral popliteal, can be clearly visualized on the same study.

This study is performed with needles in both common femoral arteries, and a retrograde pressure injection is made by use of a volume-controlled injector. Two separate injections are made. Two standard 35.5 × 43-cm films placed end to end are exposed by differential timing, using two x-ray machines, with each injection. The first study with two films covers the vessels between the xiphoid process and the knees; and the second, from the iliac crest to the ankles. First, retrograde injection to visualize the aorta is made at the rate of 30 ml/second for a total volume of 100 ml. The second injection to visualize the femoral popliteal segment is made at the rate of 10 ml/second for a total volume of 80 ml.

There are several advantages of this technique. The most important is that the quality of the angiographic study is excellent, where both the aortoiliac and the femoral popliteal areas are

well visualized with a single approach. Second, it is a safe technique. Third, the entire tree is visualized on four x-ray films, which is most convenient. Last, irradiation exposure for the patient is kept at a minimum.

As I have stated, we have used this technique for the past 13 years, performing 1,123 aortographies. This total does not include straight femoral arteriography. We have had no mortality. Our only morbidity has been one patient who required immediate surgical treatment for dissection of the common femoral and external iliac arteries.

There are several technical factors that contribute to the success of this procedure. The more important are: using No. 17 thinwall needles, ability to cannulate the femoral arteries when the pulse is not palpable, and learning the delay in circulation time for proper timing of x-ray film exposures.

An important point that Dr Szilagyi and his associates make, and I would certainly agree, is that the object of any arteriographic study is to determine whether or not the arterial tree will lend itself to vascular restoration. Only the surgeon can make that decision; therefore, he should perform the study, and the study should be carried out until he is fully satisfied with the visualization of the arterial tree.

JAMES J. MONGE, MD, Duluth, Minn: I cannot speak from the wide experience and the number of cases that Dr Szilagyi and his associates have offered. However, in our last 500 translumbar aortograms (we have done a total of 550 aortograms), we have had no major complications. There have been a few instances of extraaortic extravasation. Two people have had their hospital stay prolonged for one day because of residual back pain.

We have seen some difficulties after retrograde aortography: considerable hematoma formation, dissection and hematoma within the vessel wall, and thrombosis of the femoral artery. When there has been a delay before inserting a femoral graft, extensive fibrosis of the anterior vessel wall has been seen.

The worrisome part about surgeons discontinuing doing their own arteriograms is that patients may be sent to the radiologist for arteriography without review by a physician or surgeon knowledgeable in vascular diseases. In some instances, an unnecessary number of injections of contrast material and x-ray films are made, or adequate distal filming is not done, or arteriography was not really required. Compared to ten years ago, we now have "special procedures" rooms and young radiologists trained to do these procedures. Because of this, there has been considerable pressure on the surgeon to discontinue arteriography. I think that we should resist this. The figures presented in this article support the safety of translumbar aortography.

JOHN W. SMITH, MD, Omaha: Dr Smith, you have pointed out the importance of the surgeon who is taking care of the patient involved in the diagnostic procedures, and I would certainly say amen to Dr Monge, too.

In our area, the surgeons did all the arteriography until the last five or six years. Some of us still do our own arteriography, whether it is translumbar, catheter, or whatever.

We have no quarrel with the well-trained radiologist doing these studies, but it is essential that whoever does the study, examines the patient both before and after the study, and has a clear understanding of whether the study is needed, and if the study is needed, what the surgeon needs to make his decision about whether the patient is suitable for an operation, and if so, what operation.

This is just one more area in which Francis Peabody's old saying is certainly true: "The secret of the care of the patient is in caring for the patient."

DR SMITH: In response to Dr Inahara, I readily accept that excellent quality arteriograms can be obtained by the retrograde pressure injection technique, and apparently in his hands this has been a satisfactory experience. However, my early exposure to pressure injection techniques caused concern about the inherent danger of doing any intravascular pressure injection by the percutaneous needle method. We, therefore, do all of our studies by hand injection through a 17-gauge needle, which has allowed a rapid enough injection to obtain diagnostic-quality x-ray films and has paid dividends in terms of safety.

Another objection that I have regarding the regrograde needle technique is that it does not lend itself to the large majority of arterial occlusive problems. We insist that the contrast medium be injected proximal to the major occlusive involvement, and, therefore, such an approach would have very limited application in our practice.

I wish to particularly thank Drs Monge and Smith for supporting our contention that the vascular surgeon should be directly involved in the diagnostic evaluation of his patients. Also, I would like to mention that when our senior vascular residents enter practice, the majority continue to perform their own translumbar aortograms, and they have indicated to me how much they appreciate this valuable experience that was acquired during their training period.