Clinical Evaluation of Intravenous Abdominal Aortography and Peripheral Arteriography

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The Robb-Steinberg method of visualization of the cardiovascular system by the rapid intravenous injection of concentrated organic iodides and precise roentgenography has been available since 1938.1-3 Recently, modification of the method by the rapid, simultaneous, and bilateral injection of concentrated contrast media after accurate prediction of the circulation time has achieved abdominal aortography, peripheral arteriography, and cerebral angiography.4-5 Inexpensive needle stop-cock units, 12-gage syringes, and the use of roentgen equipment ordinarily on hand for gastrointestinal or genitourinary roentgenography make this method readily available and practical for use in the average well-equipped radiologic department.

Almost 300 patients have had abdominal aortography and peripheral arteriography with the intravenous method. The purpose of this report is to reiterate the principles and emphasize the details of the method of intravenous abdominal aortography and peripheral arteriography and to discuss and illustrate its value for diagnosis of disease of the abdominal aorta and its branches.

Method

The intravenous method of abdominal aortography and peripheral arteriography6 depends upon the principles developed for angiography.1-8 Speed of injection of the contrast material is essential and this is accomplished by simultaneously injecting the large veins of both arms. This eliminates the factor of dilution of the contrast material by blood from the opposite innominate vein when only one injection is made and, of course, increases the bolus effect of the contrast material into the circulation. Speed of injection is also facilitated by elevating the arms and having the patient perform respiratory maneuvers.

The time of roentgen exposure of the abdominal aortic or peripheral arteriogram is determined by the preliminary circulation time with sodium dehydrocholate (Decholin). Standard roentgen technic similar to that of intravenous pyelography, which makes use of the Bucky-Potter grid, is all that is needed for roentgenography of the abdominal aorta and its branches.

The percutaneous insertion of the Robb-Steinberg 12-gage needle stop-cock unit has previously been described.2,6 In the absence of a large vein, it may be necessary to perform a cut-down for insertion of the needle. The position of the cannula is then secured by adhesive tape. To make certain that the cannula is properly seated in the vein, an injection of normal physiologic saline to safeguard against extravasation is advisable. The patient is then briefed about the technic of the examination and is instructed about breathing during the examination.

The determination of the preliminary circulation time with the patient supine will serve as a good rehearsal of the patient's participation in the test. Three milliliters of a 20 per cent solution of Decholin are mixed with 15 ml of saline in a 50-ml syringe and attached to one of the cannulas. The arm is then elevated, making certain that it is relaxed at the shoulder (this avoids physiologic obstruction of the subclavian vein underneath the first rib). The stop-cock is then opened and the patient is instructed to “breathe out” gently. Then he is asked to “breathe in” making certain that only a moderate breath is taken, for it is important to avoid the Valsalva maneuver, which tends to delay circulation into the heart. Injection of the Decholin-saline mixture is made simultaneously with the direction to “breathe in.” This is also the signal for the assistant to start the stop-watch. Once the injection is completed, the patient having been told to anticipate a bitter taste, he is urged to go through the motion of tasting by smacking his lips, tongue, and mouth. This automatically releases the tendency to perform the Valsalva maneuver. The onset of the bitter taste is then recorded by stop-watch. The modified circulation time from arm to

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Abdominal aortoiliac arterial circulation in a 50-year-old man.

Enlargement of figure 1A to show detailed visualization of the celiac axis and renal arterial vasculature.

Tongue is used as a guide for the starting time of the roentgen exposure for the abdominal aorta. If the accuracy of this determination is uncertain, a repeat circulation-time determination is done. The exposure for abdominal aortography is prolonged to 2 or 3 seconds and begins about one-half second after the circulation time.

The patient is told to anticipate an intense wave of heat soon after injection of the contrast

The peripheral vascular system from the bifurcation of the abdominal aorta to the mid thigh regions.

The normal superficial femoral arterial tree.
Hypertension due to a renal artery aneurysm in a 50-year-old man. Intravenous abdominal aortogram showing the right renal artery aneurysm (arrow).

Incidentally discovered right common iliac artery aneurysm (arrow) in a 51-year-old man with hypertension (160/110 mm Hg).

Enlargement of figure 2A better to show the aneurysm in the hilus of the kidney (arrow).

Incidentally discovered right common iliac artery aneurysm (arrow) in a 51-year-old man with hypertension (160/110 mm Hg).

for obese patients over 200 pounds. The syringes are then attached to the cannulas, the stop-cock is opened, and the arms are elevated with a physician standing on a platform on each side of the patient. At the signal, "breathe in," the technician starts the stop-watch. The simultaneous injections are made rapidly and completed in 1½ to 2 seconds. Because of viscosity the concentrated contrast agent may be difficult to inject rapidly unless the mixture is warm. The patient is then told to "breathe naturally." Two or 3 seconds prior to the selected exposure time, the patient is ordered to "stop breathing." A 2-second roentgen exposure for abdominal aortography is then made while the patient holds his breath. If peripheral arteriography is desired, another exposure of 3 seconds' duration may be made either with a portable roentgen apparatus or with another x-ray tube. The standard grid-cassette technic for lower extremity roentgenography suffices. If, after inspection, the roentgenogram proves satisfactory, the cannulas may be removed and a tight, temporary bandage applied. There should be no hesitancy in repeating the injection after a short interval, if the patient has tolerated the procedure. Also, if the peripheral circulation at the bifurcation of the iliac arteries is desired, the Bucky grid
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Figure 4
Intravenous abdominal aortogram of a 40-year-old man with an 8-year history of hypertension (145/110 mm. Hg) and contracted right kidney (arrow). Note the tortuosity of the abdominal aorta and common iliac arteries. Nephrectomy revealed chronic pyelonephritis and arteriosclerosis of the kidney, following which there was some decrease in blood pressure.

cassette may be shifted to include the extremities and another injection made.

Results
Since March 31, 1959, when the method of rapid, bilateral, and simultaneous intravenous injections of concentrated contrast agents for visualization of the entire cardiovascular system began, 350 patients have been studied. Of these, 67 patients had simultaneous double injections for reasons other than for abdominal aortography; some during the development of the technic of carotid-vertebral arteriography soon to be published,° and others for visualization of the cardiovascular system. The latter because visualization of the cardiovascular structures was enhanced when chronic heart failure, or aortic valvular disease, or both existed. Two hundred and eighty-three patients have had intravenous abdominal aortography and peripheral arteriography and form the basis of this report. Failure to visualize the abdominal aorta occurred in only two instances. The first was in an 81-year-old man with chronic heart failure, atrial fibrillation, and aortic and mitral insufficiency with a modified (Dechol) circulation time of 34 seconds. The other was in a 55-year-old man with advanced siliosis, cor pulmonale and congestive heart failure. In the latter, although the first series of double injections failed to show the abdominal aorta, a repeat single injection for angiography revealed a massive pericardial effusion as well as a dilated pulmonary artery and cardiac chambers due to congestive heart failure.

In 32 cases a normal abdominal aorta and peripheral arterial system was revealed (fig. 1). The patients in this group had been referred because of an unusually pulsatile aorta

Figure 5
Arteriosclerotic tortuosity of the aortoiliac arterial system in a 62-year-old man with normal blood pressure (140/85 mm. Hg).
Fusiform abdominal aortic aneurysm beginning just below intact renal arteries. A right common iliac artery (arrow) was also resected and replaced by a graft.

Simulating an abdominal aortic aneurysm. In one case, a large firm mesenteric lymphoma exaggerated and transmitted the abdominal aortic pulsations. In another, a previous laparotomy for ileitis had caused abdominal peritoneal adhesions, which had transmitted the pulsations of the aorta.

The remaining 251 patients with disease of the abdominal aorta and its branches were classified according to the major lesion. Abdominal aortography was performed in 62 hypertensive patients, chiefly to determine if renal arterial deformities were present. In four instances, renal artery stenosis with post-stenotic dilatation of the distal portion of the renal artery was discovered. In three of these, splenectomy with anastomosis of the splenic artery to the distal post-stenotic left renal artery was followed by return of the blood pressure to normotensive levels.\textsuperscript{10} In two hypertensive patients, right renal artery aneurysms, one a saccular renal artery aneurysm, (fig. 2) was visualized.\textsuperscript{11} Aortic aneurysms were also encountered in hypertensive patients, but these were classified with the aortic aneurysm group because the major lesion was the aneurysm. A hypertensive patient with an isolated right iliac aneurysm is shown in figure 3. Other patients with hypertension were found to have striking tortuosity of the abdominal aorta and iliofemoral arterial system, a finding usually due to arteriosclerosis, but they were included in the hypertensive groups; the tortuosity was considered to be an arteriosclerotic complication of hypertension (fig. 4).

Twenty-four patients without hypertension had pronounced arteriosclerotic abdominal aortic and iliofemoral tortuosity (fig. 5). Often, the reason for referral of these patients was an unusually pulsatile aorta. Indeed, in three instances, arteriosclerotic plaques seen in the conventional abdominal film were located in the walls of a tortuous
but intact abdominal aorta that had been mistaken for the calcified thrombus wall of an aneurysm.

Arteriosclerotic abdominal aortic aneurysms without serious peripheral vascular involvement were visualized in 24 patients (fig. 6). Thirteen additional patients with arteriosclerotic abdominal aortic aneurysms had pronounced peripheral vascular disease; the poor run-off denoted a bad prognosis (fig. 7). A huge saccular aneurysm of the lower descending thoracic aorta due to syphilis is shown in figure 8.

Arteriosclerotic endarteritic involvement of the abdominal aorta and common iliac arteries without significant peripheral vascular disease was present in 31 patients. Arteriosclerotic peripheral vascular disease (usually occlusion) as well as arteriosclerotic abdominal aortic endarteritis were found in 11 cases (fig. 9). Severe chronic arteriosclerotic thrombotic occlusion of the abdominal aorta was demonstrated in 13 patients (fig. 10). Peripheral arteriosclerotic vascular disease with arterial occlusions but without demonstrable abdominal aortic involvement was present in 47 patients (fig. 11).

A miscellaneous group totaling 23 patients, comprised various, albeit unusual conditions such as: arteriosclerotic splenic artery aneurysms, 4 cases, an aberrant spleen (fig. 12), a ruptured spleen, and an arteriosclerotic hepatic artery aneurysm. Four patients had arteriovenous fistulas. One followed laminectomy for a ruptured lumbar disk (fig. 13). Another was caused by a gun-shot wound of the left leg, while the remaining two were congenital, also involving the left leg.

A congenitally single hypertrophied right kidney was found in one patient. Two patients with peripheral vascular disease also had had nephrectomies several years prior to arteriography; the remaining kidney was markedly enlarged. In intrinsic disease of the kidneys, the abdominal aortography studies were often supplemented by nephrotomography.
nine patients a nonfunctioning kidney (3 cases), hydronephrosis (1 case), and pyelonephritis (5 cases) were revealed. A patient with a huge fibromyxosarcoma showed unusual displacement of the right kidney (fig. 14). Finally, an anomalous abdominal aortic communication to the right lower lobe of the right lung was demonstrated in a 10-year-old boy with anomalous pulmonary venous drainage of the right lung into the inferior vena cava associated with bronchiectasis; the abdominal aortic as well as the cardiovascular structures were visualized via the intravenous route.

Discussion

The advantages of securing abdominal aortography and peripheral arteriography by intravenous injection are obvious. No longer need there be hesitancy in attempting to visualize these structures, since the complications of arterial puncture, especially those of translumbar aortography, are entirely avoided. Now that surgical excision of aneurysms and replacement by homografts and synthetic materials are possible, aneurysmal and occlusive disease of the abdominal aorta and its branches is no longer of merely academic interest. With elimination of the necessity for anesthesia and the hazards of direct abdominal aortic puncture, greater use of intravenous aortography for diagnosis of disease of this system will be forthcoming. Furthermore, the benefits and results of surgery can be readily demonstrated, and the complications and shortcomings of surgical procedures may also be evaluated.

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Arteriosclerotic abdominal aortic endarteritis and peripheral vascular disease in a 52-year-old woman with marked irregularity and stenosis of the abdominal aorta (arrows). Diminution of blood flow at the bifurcation of the aorta is evident.

Since the principles of visualizing the thoracic aorta angiographically are similar to those that apply to the abdominal aorta, it is important to pay close attention to the details of the method of angiocardiography. While retrograde aortography may be indicated for coronary arteriography, the differentiation between a patent ductus arteriosus and an aorticopulmonary window, in the differential diagnosis of a ruptured aortic sinus and a coronary arteriovenous fistula, and for demonstration of mitral insufficiency and aortic valvular disease, it need not be used for routine visualization of the aorta. Failure to opacify the thoracic aorta angiographically is usually due to disregard of the principles of speed of injection, proper positioning of the patient, and attention to roentgenographic details.

The concentrated contrast materials now available commercially are well tolerated in-
Thrombotic occlusion of the abdominal aorta. In several instances double injections have been tolerated without apparent venous damage. The usual reaction to the simultaneous double dose is mild and transient and very much like that in angiocardiography with a single injection, except that there is a more intense flush and a greater sensation of heat, traveling from head to toe. The reaction is probably also aggravated by the supine position, since reactions are usually less pronounced in erect patients during angiocardiography. Vomiting does not occur when the study is made during the fasting state (the meal prior to the examination is omitted). Reactions to the contrast material can be markedly diminished if there is a calm, reassured, nonapprehensive attitude. In contrast to translumbar aortography, where there is danger to the kidney when the aorta is occluded by thrombus, visualization of the renal arteries via the intravenous routes does not harm the kidneys.

Two severe reactions and one fatality have occurred in the first 350 patients who had double injections of concentrated organic iodides. A 16-year-old boy developed severe orbital edema after one double injection; this promptly subsided after antihistamine therapy. Another patient, a 38-year-old man, had fever, leukocytosis, and mild hypotension after three double injections lasting for 6 hours only. A 74-year-old man with moderately severe peripheral, cardiovascular, and cerebral arteriosclerosis had no immediate reaction to two double injections of contrast material. Six hours later there was sudden onset of pulmonary edema. The electrocardiogram did not show arrhythmia or myocardial infarction. At autopsy, 41 hours after the intravenous study, advanced arteriosclerotic, cerebral, cardiac, abdominal aortic, and peripheral arteries. Bottom. Despite absent femoral pulses there is an intact, though hypoplastic, peripheral vascular system. Endarterectomy of the abdominal aorta was followed by good femoral pulses and complete subsidence of claudications of the hip and buttocks.
Severe intermittent claudication of both legs in a 38-year-old woman with bilateral occlusion of the common femoral arteries (arrows). Note that the renal artery on the right arises from the common iliac artery while the splenic artery originates from the left common iliac artery.

Severe intermittent claudication of the right leg after one half block due to occlusion of the right superficial femoral artery (arrow) in a 53-year-old man.

The roentgen exposure time of the abdominal examination has been 2 seconds. In contrast to cardiac chamber and great vessel visualization, which requires short exposure times, the abdominal aortic and peripheral arterial exposure times may be prolonged. The present technic results in only one contrast roentgenogram of the abdominal aorta. A simultaneous angiogram of the peripheral arterial tree can be easily made by another exposure of the lower extremities (with suitable coning to prevent fogging of the abdominal roentgenogram) with a portable roentgen unit. Since only three or, at the most, four films (including preliminary positioning and pyelographic roentgenograms) are exposed during a contrast study of the abdominal aorta, the amount of radiation to the patient is low. The physicians making the injection receive very little exposure if the roentgen beam is suitably collimated and conventional.
Occlusion lower end of the left superficial femoral artery (arrow) in a 33-year-old man with disabling claudication of the left leg.

protective garments are worn. As a further precaution, the arm, once the injection is completed, may be placed at the side of the patient on the table and the operators can move to a shielded area. Sufficient time for this is afforded because the exposure of the roentgenogram is made 10 seconds or more after the beginning of injection; the injection is usually concluded at the end of 2 seconds.

The personnel for performance of abdominal arteriography via the intravenous route consists of two physicians who make the injection and a technician. This is much less formidable than translumbar aortography, where the injector must maintain sterile precautions necessitating a trained attendant. If general anesthesia is required for the translumbar study, another trained nurse or anesthesiologist is needed. Since local anesthesia is used only for insertion of the cannulas for the intravenous method, general anesthesia is not needed.

Determination of the preliminary modified circulation time with Decholin prior to the injection of the contrast material is advised for every patient. This is not only indicative as to whether there is obstruction (physiologic or pathologic) to blood flow into the heart but may also predict inability to secure a satisfactory study. Delay of passage of the contrast material occurs in cases of pulmonary disease associated with cor pulmonale, some types of congenital heart disease (Ebstein's anomaly, aortic stenosis), congestive heart failure, and valvular disease such as mitral stenosis and aortic stenosis or regurgitation. Rarely, in such instances, abdominal aortography may not be successful because of dilution of the contrast material and disruption of its continuity. Fortunately, patients requiring abdominal arteriography are usually free of congenital heart disease, congestive heart failure, and valvular heart disease.
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Figure 13A
Right common iliac arterial-inferior vena caval fistula in a 47-year-old woman following laminectomy for intervertebral disk. The intravenous abdominal aortogram.

A single bilateral intravenous injection succeeded in satisfactorily visualizing the abdominal aorta and peripheral vascular system in 65 per cent of the patients. In the remainder, another double injection was necessary. Failure of the patient to suppress breathing during the exposure of the abdominal aorta causing blurring of the renal arterial circulation was the prime reason for a repeat examination. Another, was the performance of the Valsalva maneuver, especially in apprehensive individuals. Aneurysms of the abdominal aorta apparently cause marked delay in blood flow and the usual exposure time of the abdominal film (one half second) after the modified Decholin circulation time often failed to fill the aneurysm completely. Accordingly, when an abdominal aortic aneurysm is suspected, exposure of the abdominal aortic roentgenogram should begin

3 or more seconds after the Decholin circulation time.

Contraindications to intravenous abdominal aortography are rare. The patient should be cooperative and well enough to lie on a roentgen table for at least one-half hour. Unconscious or anesthetized patients may, however, be examined successfully; experience with angiocardiography indicates that anesthetized patients may be injected rapidly without the aid of respiratory maneuvers. In such instances an objective type of circulation time may have to be used in order to estimate the time of exposure of the abdominal roentgenograms. No longer need azotemia contraindicate study of the circulatory system using organic iodides. Indeed, such compounds are used widely for diagnosis of kidney disease, even when uremia is present. Diagnosis of an obstructive urologic lesion amenable to surgical alleviation or cure far outweighs the risk, if any, of adding to nitrog-
There is a clear indication for study of the circulatory system, the rare fatality must be accepted as an unavoidable risk. However, the availability of emergency treatment for severe reactors will further cut the risk. Good clinical judgment based on experience is all important for selection of the patient suitable for study; this will also detect the high-risk patient who requires special facilities for the intravenous injection.

Complete opacification of the circulatory system, total body intravenous angiography, in man is now feasible. To accomplish this ideally, biplane angiocardiography at onset of the intravenous injection will provide studies of the entire cardiovascular system. Cerebral angiography, preferably biplane, may then be secured beginning with the systemic (Decholin) circulation time. Soon after (one half to one second), roentgen exposure of the abdomen will visualize the abdominal aorta. Finally, the peripheral circulation (the exposure time commencing at the conclusion of the abdominal aorta study) can be visualized. Motion of the various circulatory components may also be had by cineangiography.

Although a total body survey of the circulatory system may be of limited clinical value, the data may prove invaluable for physiologic study. Continuous electrocardiography during intravenous injection will relate the opacification of the various systems to the cardiac cycle. Biplane studies will permit volumetric determinations of the cardiac chambers and great vessels and the cardiac output. Variations of the circulatory system with systole and diastole and propagation of the pulse can also be evaluated.

The large variety of abdominal aortic and peripheral vascular disease encountered in the series of cases herein described well illustrates the value of intravenous abdominal aortography. In this report of 350 patients who had bilateral intravenous injections, 101 had abnormalities of the abdominal aorta and its branches. This figure results when the two patients who could not be visualized, the 67 who were primarily studied for carotid-vertebral arteriography and cardiovascular

Figure 14

Huge lipomyxosarcoma causing marked upward displacement of the right renal artery (arrow).

Enous wastes in the blood. Furthermore, in the presence of poor renal function, much of the contrast material is excreted in the biliary tract.

The increasing use of splenoprostography without harm in patients with cirrhosis of the liver also demonstrates that advanced liver disease is not a contraindication to the injection of the organic iodide compounds into venous channels. Since the organic contrast compounds are securely bound to the iodide molecule, patients allergic to the iodides need not be deprived of diagnostic studies with such agents. In our large experience many allergic patients have tolerated angiocardiographic and urographic studies without ill effects. Finally, there remains the rare individual who reacts severely to the radiopaque material in an anaphylactic fashion. Since preliminary testing, whether intradermal, ocular, oral, or intravenous, does not designate the severe reactor, routine pretesting or premedication need not be done. If
angiography, and the 32 patients with normal abdominal aortas are subtracted from the total number of cases.

Data derived from translumbar arteriography have shown that a significant percentage of patients can be discovered to have a renal cause for hypertension.20, 31 Renal artery aneurysm (fig. 2) and stenosis of the renal artery with post-stenotic dilatation of the distal arterial segment have also been demonstrated with the intravenous method of abdominal arteriography. A hypoplastic right kidney was also revealed (fig. 4). In another hypertensive patient, a right common iliac artery aneurysm was found (fig. 3).

Arteriosclerosis of the abdominal aorta and its branches is a common disease. The diagnosis of an abdominal aortic aneurysm often depends upon discovery of a pulsatile abdominal mass or calcifications adjacent to the lumbar spine in the abdominal roentgenogram. Routine palpation of the peripheral arterial system will often be rewarding in the evaluation of the hip and leg pains.23, 32 Tortuosity of varying degrees is a common manifestation of arteriosclerosis of the abdominal aorta (figs. 4 and 5). Arteriosclerotic abdominal aortic aneurysms can be of all sizes and shapes (figs. 6 and 7). By demonstrating the run-off into the legs, practical and valuable preoperative data can be provided by intravenous arteriography (fig. 7B).

The diagnosis of arteriosclerotic occlusive disease of the abdominal aorta and peripheral vascular system although easily established clinically requires angiography for adequate surgical treatment.23, 32 Because translumbar arteriography is especially dangerous when there is occlusive disease of the abdominal aorta, translumbar arteriography has been abandoned in many centers.28 Accordingly, intravenous abdominal arteriography can provide a significant and important aid in the diagnosis and treatment of chronic insidious occlusive disease of the abdominal aorta and peripheral vascular system (figs. 9, 10, and 11). Arteriosclerotic aneurysms of the splenic artery were encountered four times; a hepatic artery aneurysm, once in this series.13, 14

Penicillin has made syphilitic and mycotic aneurysms of the abdominal aorta and branches rare. Actually, the etiologic diagnosis is only of academic interest, since the treatment, as in the case of the arteriosclerotic aneurysm, is the same; namely, resection of the aneurysm after suitable bypass procedures are provided and replacement by a plastic prosthesis. Figure 8 is an example of a large syphilitic aneurysm of the thoracoabdominal aorta, the only example of an aneurysm due to an infectious agent in the series.

Trauma to the abdominal aorta and its branches was encountered in four instances. An aortico-inferior vena caval fistula was demonstrated in a patient in heart failure following laminectomy for an intervertebral disk (fig. 13).16 Gunshot wounds in the legs were responsible for two other arteriovenous fistulas of the popliteal vessels demonstrated with intravenous peripheral arteriography. Delayed rupture of the spleen was demonstrated in one case.15

Congenital anomalies demonstrated by intravenous abdominal arteriography consisted of a right renal artery originating from the right iliac artery and the splenic artery arising from the left common iliac artery (fig. 11A). Congenital arteriovenous fistulas involving the superficial femoral artery and vein of the left leg were visualized in two cases. A dangling spleen was demonstrated to be the cause of a left lower abdominal mass (fig. 12). Finally, marked displacement of the abdominal aorta and right kidney was revealed in a patient with retroperitoneal fibromyxosarcoma (fig. 14).

Summary and Conclusions

A practical intravenous method of abdominal aortography and peripheral arteriography, making use of physiologic principles learned during angiocardiography, is described which can be performed in the average hospital. This method has distinct advantages over the translumbar abdominal aortic injection route, which has sometimes been

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associated with serious complications and occasionally death.

Rapid and simultaneous injection of concentrated organic iodides can be made by injection into both arms with special syringes attached to Robb-Steinberg canulas. If dosages of 1 ml per kilogram of body weight are used, the reaction to injection of large quantities of the contrast material will be well tolerated. Since conventional roentgen equipment is all that is required for the intravenous method of abdominal aortography and peripheral arteriography, the study can be performed in almost every radiologic department.

Aneurysmal and occlusive disease of the abdominal aorta and branches can be readily diagnosed, facilitating the appropriate treatment for each patient. Traumatic, congenital, and neoplastic diseases of the abdominal aorta can also be demonstrated, permitting a preoperative view of the lesion and determining if it is amenable to surgical repair.

Finally, modification of the Robb-Steinberg method of intravenous injection of concentrated contrast material, by making a double simultaneous injection, renders possible the visualization not only of the central cardiovascular system (the great veins, the chambers of the heart, the pulmonary circulation, and the thoracic aorta) but also the abdominal aorta, peripheral arteries, and cerebral vessels. Thus, total visualization of the circulatory system is achieved—total body angiography.

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The century dating from the birth of Galileo to the death of Harvey was perhaps the most brilliant in the history of modern knowledge. The discovery of Greek texts had destroyed the conventional Aristotle, the conventional Hippocrates and Galen; since the latter part of the sixteenth century Greek had been taught in the High Schools, philosophy was born again, and men found themselves no longer the slaves but the kin of the great ancients. Telesius, Bruno, Campanella vindicated natural science and liberty of thought. Galileo taught in Padua for twenty years, including the time when Harvey graduated there; Torricelli was a pupil of the great Florentine; in 1682, on the theory of Copernicus, Gregory reformed the Calendar, and thus laid the axe to the root of astrology; by Newton terrestrial physics were established in the celestial spheres. Malpighi, who was to fulfill Harvey's discovery and foresight, was born in N.-E. Italy in the very year (1628) in which the De motu cordis was published. In 1626 Boyle was creating chemistry. Anatomy, which had slept since its days in Alexandria, was fully awake. The Society of the Lincei was virtually founded in 1603; the Royal Society in 1645; the Academy of France in 1656. Clinical teaching, initiated in Salerno and advanced by the Consilia medica, was formally established in Padua, to be pursued in Heidelberg, Leyden, and Vienna.—Thomas Clifford Allbut, M.A., M.D. Science and Medieval Thought. London, C. J. Clay and Sons, 1901, p. 99.
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Circulation. 1961;23:534-549
doi: 10.1161/01.CIR.23.4.534
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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