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Technique and the clinical application of phlebograms of the lower extremity

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A TECHNIQUE AND THE CLINICAL USE OF PHLEBOGRAMS OF THE LOWER EXTREMITY

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INTRODUCTION

The phlebogram of the lower extremity as a diagnostic means is a comparatively new technique, as compared with other measures used in diagnosis of pathology of the venous sys em of the lower extremity. I will be shown, however, later in the content of this paper, that it has become a very useful adjunct in helping the clinician, both the surgeon and the intern is , decide the proper course of treatment for the patient in question. This is dependent, of course, upon accurate diagnosis of the condition, and this is aided immensely by visualization of the vascular pattern of the venous system in the extremity.

It is not the purpose of this paper to cover exhaustively the work that has been done in this field, but rather to review some of the techniques of other radiologists, compare them with our own here a University Hospital, and to objectively survey it's value to the clinician in applying to various venous problems of the lower extremity.

HISTORY

Among the first workers in the field of venous study by means of x-ray and a contrast medium were Frank and Alwens (I) (1910), who injected Wismitol

into veins and hearts of animals and studied them by x-ray. Berberich and Hirsch (2) (1923) were the first to make experimen al studies on humans using strontium bromide in the arm. Ratschow (3) (1930), using Uroselectan injected the arm and leg and observed the results. Barber and Orley (4) (1932) described 30 cases of varicosities using Abrodil. Pomeranz (5) (1933) used Skiodan demonstrating venous pools and feeders in varicose ulcers. Allen and Barker (6) (1934) used thorium dioxide solution in studying varicosities. Barker and Camp (7) (1936) used Diodrast in studying venous problems of the leg. Bauer (8) (1940) studied acute throm-bosis and chronic venous disease of the lower extremity. Baker (9) (1940) began his series of study of The venous pattern of the lower extremity. All of these men have contributed to the present day techniques by usin various types of contrast media, and stimulating interest in this type of study.

TECHNIQUES

Moore (10) advocates the use of a tournequet at the thigh, using 140 mm of pressure, as well as one at the ankle, using the same amount of pressure, and injecting 20 cc of Pyelosil at the medial base of the great toe. This technique, he contends, is of definite

value in varicosities, because it shows if there is any filling by reflux from the deep system. If there were no tournequet at the ankle, one could not tell which end the superficial system were filling from. If there were no tournequet at the thigh, the outflow is too great, and the dilution is too great to get good visualization of the venous system.

Baker (9), with precautions of skin testing and antihistaminics, uses 20cc of Diodrast, a 25 gauge needle and no tournequet. He states the site of injection on the dorsum of the foot makes little difference, but notes that if injected laterally, most of the medium travels up the external saphenous system first, and if injected medially, the internal saphenous system fills first, but that they both eventually fill if there is no block. Normally the filling time is rapid, however, if the leg is swollen, it is much slower. Two films are taken from ankle to knee, two are of the upper leg, knee and lower thigh, and two are of the thigh and pelvis. He routinely uses three 14 x 17 films, taking two stereos on each. The first film is made after 8cc of Diodrast has been injected, and the remainder of the films are taken serially in rapid succession, being completed when the Diodrast is completely injected.

He believes the tournequets used in other techniques blot out and distort the superficial channels which are necessary for correct interp retation of the entire venogram.

Massel and Stinger (11) describe a echnique which is essentially the same as that used by Moore (10) described earlier.

Here at the University of Nebraska Hospital, several methods were attempted in an effort to find the one most suitable and most practical for the needs of the clinician. The patient was always prepared for the procedure with 1cc of Benadryl, skin tested with Diodrast and several drops of Diodras were placed in the conjunctiva, as precautionary measures to protect the patient from possible sensitivity reactions to the solution. Two types of injections were used. (1) A portion of the patients were being studied for venous pressures and circula ion times at the same time, f or a more complete picture of the venous circulation in the lower extremity. These had a venous cut-down anterior to the medial malleolus and a segment of polythene tubing inser ed directly into the vein. Through th is tubing, all three studies were carried out. It was learned that it was much easier to inject the Diodrast through this tubing, because of it's flexability

and accessibility, than to insert a needle directly in- to the vein. This, however, would be imprac icable as a routine procedure where only a venogram is to be desired. (2) On the other portion of the patients, the needle was inserted enywhere on e dorsum of the foot where a vein was readily accessible. At times, this was no small task, due to the fragility of the veins in the feet of some of the elderly patients. A small amount of blood was withdrawn into a 2cc syringe, than a three-way stop-cock was placed on the needle and a 20cc syringe containing the diodrast was a tached. The s op-cock was used to prevent mechanical difficulties due o positioning of the pa ient. The patient was en placed upon the fluoroscopic table. A rubber tubing tourniquet was placed just above the ankle to prevent direct filling of the superficial veins. A blood pressure cuff was used in a portion of the patients, inflated to 60 mm of mercury, but it was found that a rubber tourniquet was adequate to accomplish the desired results. The table was then elevated to approximately an 80 degree angle with the horizontal. Injec ion of the dye was made under direct fluoroscopy and films were taken when filling seemed to be mos complete. This has the advantage of being able o visualize directly (1)

the rapidity of filling of the deep sys em, (2) the competency of the communicating veins, (3) any block which might be present in the deep system and (4) the competency and valves present in the deep sys.em. A record can then be made with film at the optimum time when filling is at a maximum, or when pathology is best demonstrable. An A-P and stereo film of knee to ankle in rapid succession was then taken. Following this, a film of the circulation at the knee was taken, after visualization with the fluoroscope. A few times films higher up in the thigh were taken, but these did not show much, due to the dilution factor. The tourneqmet was then released, and a follow-up film was made. These were taken at 60-65 KV, 100 milliamperes at one-fourth second.

INTERPRETATION

Normally, the posterior tibial and peroneal veins ppear double, large and contain many valves. The anterior tibial rarely fills. The muscle veins appear large, profuse and with many collaterals and no valves. The popliteal has a small valve above the knee joint, and the lesser saphenous fills some with or without varicosities. The femoral appears broad, smooth and has one or two valves in the lower one-third. The profunda femoris is not seen.

If one uses the tournequet at the ankle, the superficial system does not fill. If a tournequet is no' used, the superficial system fills quite readily and rapidly, al-though the amount of dye entering the superficial sys-tem is a rela ively small amount, the majori y enters the deep circulation above and close to the ankle. The saphenous system particularly is well visualized. The ra'e of filli ng is accelera ed greatly with exercise
(Baker 9).

Pathologically, the findings on the venogram differ markedly from those out ined above. The echnique out-lined by Baker (9) is par icularly useful in demonstrat-ing obs ruction in the system, including the site, de- gree and whether it is acute or chronic. The latter is decided upon by the appearance of the veins, especially the superficial system. In (1) Acute superficial block, the dye enters the deep circulation above the ankle. It also enters the superficial system up to the site of the block, then throug communicating vessels, oes to the deep circula ion, or to another superficial plexus. From 'he block upward, no block is demons'rated, and the dye may fade ou in the tissues around the block. (2) Chronic superficial block is evidenced by the deep veins filling again, but the superficial system is di-lated, tortuous, and the dye progresses very slowly

upward. Small connecting veins extend inward to the deep circulation, or outward from the deep for 1-3 cm and seem to end abruptly in the issues. (3) Acute partial or complete block of e deep sys-em is always accompanied by definite evidence of acu-e block in the superficial circulation. The deep circulation is not visualized. Acute and chronic deep block are differ-entia-ed by the appearance of the superficial circulation. In acute deep block, the superficial circulation shows acute block. (4) Chronic deep block shows the deep circulation partly or entirely absent. The dye enters the great saphenous promptly, which is usually tortuous and dilated. Short communicators fade in o the surrounding tissues, and are larger and more tor-tuous than normal. Incompetent deep veins, owever, may not show and still may have no block. Thrombi may appear one of three ways. There may be a sudden block at the head of the column, or the vein may not be completely obliterated and may show a ragged edge, or the dye may follow the wall of the vein and outline a mass in the lumen.

In using the technique devised here a- he Univer-sity Hospital, one may visualize (1) The location of incompetent c ommunicating veins between th superficial and deep venous systems. Their exac location may be

determined by this method. The visualization of the communicators depends primarily upon the competency of their valves. If they are incompetent, they fill by reflux from the deep system, thence to the superficial system by "retrograde flow". It also depends upon the filling of the deep system by the dye. If block is present, and in some cases of incompetent deep circulation without block, they may not be visualized for this reason. By using tournequets alone in evaluating the presence of incompetent communicators, the segments of superficial veins which become visible between the tournequets are usually not directly over the incompetent communicators. In addition, there are often present incompetent communicators which are not detected by tournequet examination alone. For this last reason, treatment of varicose veins by high saphenous ligation in some instances has been unsuccessful when evaluated by tournequet testing alone before operation, Imler (12). The location of incompetent communicators may be impor-tant in doing a segmental resection of the superficial system in the treatment of varicosities. It is also particularly helpful in localizing lateral communicators (Massel and Et inger 11) which may overwise have been undetected. (2) The patency of the deep system may be shown also by using this technique. If the deep system

fills rapidly and completely, it means that system is patent. However, as pointed out above, the deep system may not be visualized in some cases of incompetency, and still the system may have no block and be patent. It is of value then, in a negative sense, only if the deep system is visualized. (3) One may gain an idea of the competency of the deep circulation by following the course of the dye upward. If the rate is slow and sluggish , and the deep vessels are widely dilated and show few valves, it may be judged incompetent. In our experience here at the University Hospital, using the technique devised by Baker with no tournquet, the results were disappointing. The deep system, which was the one we were primarily interested in, could not be clearly visualized either because the dilution factor or was too great, especially with widely dilated varicosities, or the pattern of the superficial system almost completely occluded that of the deep sys em, so that accuracy in interpretation was difficult .

The technique used here at the University Hospital has the distinct advantage over other techniques in being able to record on x-ray film the pathology present at the time when the filling of the vessel and the dye concentration are the greatest. It is also advantagous in that the relative rapidity of filling of

the deep circulation may be judged more accurately by visually following the course of the dye upward by fluoroscopy.

Our technique as well as that used by Moore (10) and Massel and Etinger (11) demonstrate much more clearly than the technique used by Baker (9) the location of incompetent communicating veins, primarily because of the use of the tournequet at the ankle, and the filling of these incompetent vessels by reflux. The technique of Baker (9), however, is valuable in studying cases of obstructive phenomena in the superficial and deep systems. His technique, however, may be rather difficult to in-terpret, judging from our own experience, unless one has run a large series using this technique. The contrast is rather difficult, also, in cases of super-ficial varicosities, using the amount of Diodrast which he employs. He points out that the entire venous sys-tem, both superficial and deep, must be studied, as the superficial plexus is of paramount importance in vein pathology of the lower extremity. He contends that all disease processes involving any of the leg veins start in the superfici l system. In many instances the superficial system may be involved with no deep thology, but in every case of deep venous obstruc ion there is always evidence of superficial block. It is

an especially important technique in cases where the deep system may not be visualized by our technique, but by using his technique and studying the superficial system as well, a conclusion as to the presence or absence of deep block may be reached.

APPLICATION

There are several clinical conditions in which the venogram, using either Baker's (9) technique or our own, may be utilized to advantage. (1) Acute deep venous thrombosis. Using either Baker's technique (9) or our own, the apex of the obstruction may be outlined, and the diagnosis definitely made. The condition may be studied both before and after treatment to evaluate the results of therapy and determine prognosis. It may be helpful in determining the type of therapy, especially if a therapeutic ligation is to be considered to reduce the risk of embolic phenomena, in that the superficial system, by using Baker's (9) technique, with it's obstruction may be visualized. It may be deemed inadvisable if the venogram shows complete deep venous block also. (2) Chronic swelling of the leg of venous origin. Using Baker's technique(9) the area of involvement and the collateral vessels may be demonstrated. This may assist in diagnosis and therapy. (3) Varicosities.

Here two things must be considered and ascertained. The venogram, using our technique, may demonstrate both better than clinical tests. One is the competency of the communicators, the other the patency of the deep system. If either consideration is omitted before therapy instituted, the results may be poor, and may even augment the symptoms present, especially if the deep venous system is occluded. In cases where the patency of the deep system is in doubt, Baker's (9) technique may be employed. The method of treatment of the varicosities may be influenced greatly by these findings. (4) Venous Anomalies. These may be studied either academically or with the purpose of treatment of the condition if it produces marked symptoms to the patient by means of the venogram.

DANGERS

The procedure of venography is not entirely with impunity as regards the patient, and these attendant dangers must be borne in mind when doing the procedure. There is always the danger of drug sensitivity which should be obviated by using the routine precautionary measures outlined above, and not using diodrast if a positive reaction is observed. In cases of obstruction, there is a tendant danger of dislodging a thrombus during such procedure. Infection is always possible, but should be avoided if aseptic technique is employed.

Thrombus formation presents perhaps the most important attendant danger, and although rare, does occur. Homans (13) reported a case of thrombophlebitis after using 50% solution of Diodrast. The patient was described as being "thrombophilic", having a family history of thrombophlebitis, and who himself had had an earlier attack of thrombophlebitis with embolic phenomena. He presented mild pain upon dorsiflexion of the foot, in the region of the upper right calf, and the venogram was attempted in order to establish the diagnosis. Within 24 hours after the venogram was made, the patient had severe calf pain, a swollen right leg, and a palpable mass in the greater saphenous vein. Saphenous ligation was done in order to prevent embolic phenomena. Twenty seven days later this patient had an infected molar removed, and n d another episode of thrombophlebitis. Homans (13) regarded this as sufficient evidence of e irrita ing nature of the drug in this concentration to conclude that it was the precipitating factor in the pathogenesis of thrombus formation in this patient. As precautionary measures, one should conscientiously obtain a history of thrombophlebitis from the patient in screening them for this diagnostic aid. In the event that it does occur, heparinization and saphenous ligation may be used.

Thrombus formation may be induced by the irritating nature of the drug, and must be borne in mind as a distinct possibility in certain patients.

CONCLUSIONS

The venogram of the lower extremity has become of paramount importance in the accurate evaluation of venous pathology. Only by this method of assistance in diagnosis may certain of the features characteristic of the pathology be ascertained. The biggest advantage of using this means of study is the ability to visualize directly the disease process in question. By so doing, many of the inaccuracies of other clinical tests may be obviated.

Two techniques in particular of performing the venogram have been considered, with reference to their advantages and applicability to various venous problems of the lower extremity. One is that used by Baker (9) of Youngstown, Ohio, and the other the one devised here at the University Hospital. Baker's technique is essentially one of injecting Diodrast into the dorsum of the foot without the use of a tournequet at the ankle, and following the course of the dye up the extremity by taking serial x-rays. He points out that it is particularly useful in studying obstructive phenomena because both the superficial and deep systems must be visualized

to be able to properly evaluate the condition. By this method one can determine whether the process is acute or chronic and superficial or deep or both. This information is helpful to the clinician in determining the type of therapy as in thrombophlebitis and phlebo-thrombosis, as well as determining the patency of the deep venous system if a saphenous ligation is being considered. This technique, however, in our own experience is difficult to interpret because of the dilution factor, especially in varicosities, and because the pattern of the overlying superficial veins make the evaluation of the deep system difficult.

The other technique primarily considered is the one used here at the University Hospital. This consists essentially of injecting Diodrast into the dorsum of the foot of the patient with a rubber tubing tournequet at the ankle, thereby shunting the dye directly into the deep venous system, then following the course of the dye upwards visually with the fluoroscope. This technique has the following advantages: (1) Being able to take the x-ray when filling is at a maximum and the pathology most demonstrable. (2) Visualizing incompetent communicating vessels which fill by reflux from the deep to the superficial system which is of utmost importance when considering varicosities. (3) An idea

as to the competency of the deep circulation is gained by visualizing the rapidity of filling and contour of the deep vessels. (4) Eliminating the possibility of error in technique which may occur due to improper timing when serial exposures are taken without knowledge of the location of the dye. (5) Better contrast is obtained, because with one of the systems of veins ocncluded with a tournequet, the dilution factor is negligible. The patient is not subjected to the hazard of increased amounts of contrast medium to obtain the same functional results with the other technique.

From the foregoing one may conclude that Baker's (9) technique may be most helpful in the accurate diagnosis of obstructive phenomena for the reasons mentioned, and that the technique used here at the University Hospital may be used in diagnosis of deep venous obstruction as well as varicosities to the best advantage.

SUMMARY

1. A brief history of some of the workers in the field of venography is presented.

2. Several techniques of venography in the lower extremity are presented. Those of Moore(10), Baker (9), Massel and Ettinger (11) and our own here at UNH.

3. Interpre ation of the films using these various methods is presented with emphasis on the difference in results and comparing advantages as well as disadvantages of each as regards their applicability to various clinical problems involving the veins of the lower extremity.

4. Clinical conditions in which the venogram is of definite value are given, as well as the reasons for using i .

5. Some of the at endant dangers of using the venogram are given.

6. Conclusions are drawn as to the relative value of the two main techniques considered.

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