

# SUBCLAVIUS AND ANTERIOR SCALENE MUSCLE COMPRESSION AS A CAUSE OF INTERMITTENT OBSTRUCTION OF THE SUBCLAVIAN VEIN\*

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THE FACTORS RESPONSIBLE for the occurrence of intermittent venous obstruction of the upper extremity have long been a subject for much conjecture and some investigative study. Paget<sup>1</sup> reported the first two cases in 1875 and von Schroetter<sup>2</sup> described a similar syndrome in 1884. Since that time a great number of papers have appeared in the world's literature containing reports of similar cases, multiple theories of etiology and varied therapeutic recommendations. Recently Hughes<sup>3</sup> has collected 320 cases from the literature, and in this exhaustive study has organized and collated the existing knowledge of this subject. It is our purpose here to: (a) propose a theory that the majority of these cases are caused by spasm of the subclavian vein secondary to compression by the subclavius muscle tendon or scalenus anterior muscle, or a combination of both; (b) describe an operative attack based on this theory; and (c) report the results of this treatment in five patients.

The syndrome commonly occurs in otherwise healthy, young, active males. The right arm is involved in approximately 66 per cent of the cases and, if the left arm is the affected one, the history reveals that

it has been used in some unusual manner. Most often the first symptom is swelling of the extremity, which may be accompanied by a vague, diffuse pain and/or paresthesias. The onset may be extremely sudden or the swelling may increase gradually over a period of days. The edema is non-pitting and the entire soft tissues are firm and brawny. It is accompanied by a characteristic bluish discoloration of the skin and distention of the superficial veins of the arm and anterior deltopectoral region. Increased venous pressure is a constant finding.

These signs and symptoms in some will disappear with bed rest and elevation, only to re-occur immediately on resumption of activity. In others they will persist for several days and be relieved only by stellate and upper thoracic ganglia procaine block, warm applications, vasodilators, etc. Some of the latter patients also will experience immediate recrudescence, while others may go for months or years without further difficulty. It has been felt that partial recovery is associated with the development of adequate collateral circulation. However, pain and discomfort frequently persist and often prevent the patient from pursuing his usual occupation.

The multiple etiologies proposed are widely at variance from one another as to mechanism, location of the site of action, and terminology. The syndrome has been labeled "intermittent venous claudication" (Loehr<sup>4</sup>), "traumatic venospasm" (MacCarthy<sup>5</sup>), "effort thrombosis" (Kleinsasser<sup>6</sup>)

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and "Paget-Schroetter Syndrome" (Hughes<sup>3</sup>). Most authors believe trauma is responsible and that by some mechanism the intima is damaged and thrombosis may occur. Direct trauma has been occasionally implicated.<sup>7-9</sup> Very commonly the exciting incident is merely unaccustomed or prolonged activity involving the shoulder girdle and arm, particularly in the "overhead" position.

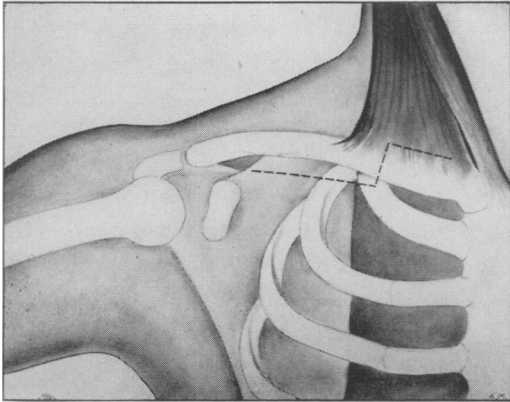


FIG. 1.—Location of incision.

Neij<sup>10</sup> suggested that trauma to the vein occurs at an unknown point in the position of abduction of the arm. He performed an anterior scalenotomy in one of his seven cases. McLaughlin and Popma<sup>11</sup> reported a case in which they believed the vein was angulated as it passed over a "high" first rib. Scalenotomy was performed. In both of the above cases the procedure produced good results. Veal and McFetridge<sup>12</sup> state that in the abduction position the vein is constricted as it passes over the edge of the subscapularis muscle. Wright<sup>13</sup> believed the vein was stretched and twisted, in abduction, around and beneath the coracoid process. Hughes<sup>3</sup> suggested that a pre-venous phrenic nerve might obstruct the subclavian vein. Loehr<sup>4</sup> considered that there was a relative obstruction at the hiatus between the first rib and the clavicle. He assumed that heavy exercise caused a constriction at this point, which was aggra-

vated by the accompanying increased venous pressure. Sampson and associates<sup>14</sup> pointed out that the vein passes through a small space (1.5 cm. wide) between the anterior scalene muscle and the clavicle and that it might easily be compressed at this point. Lowenstein<sup>15</sup> studied 30 cadavers and concluded that with the arm in marked abduction and lateral rotation the subclavius muscle and costocoracoid ligament produced pronounced pressure on the subclavian vein. He also felt that the forced expiration accompanying effort would produce a venous stasis and that the above trauma on the distended vein caused intimal damage. Gould and Patey<sup>16</sup> injected plaster of Paris into the axillary veins of postmortem subjects, with the arm in the abducted position. They reported a groove in the vein in one case where the costocoracoid ligament crossed it. In two others a similar groove was situated beneath the subclavius muscle tendon.

Conservative therapy has included elevation, warmth, sympathetic blocks, vasodilator drugs and anticoagulants. It is accompanied by the disadvantage that the etiology is not removed and it hopes only for development of an adequate collateral circulation.

The operative procedures previously reported—*i.e.*, perivascular sympathectomy, "venolysis," excision of a vein segment, phlebotomy with removal of a clot and scalenotomy—have been either so seldom performed or attended by such widely variable results that in the last decade the proportion of cases operated upon has fallen markedly. That the conservative method is not adequate is attested by Kleinsasser's<sup>16</sup> study, indicating that residual effects persist in 75 per cent of the cases he reviewed.

Consequently it seemed that a new approach to the surgical exploration of these cases was warranted and might be productive. We were impressed by the isolated facts offered by Loehr,<sup>4</sup> Neij,<sup>10</sup> Sampson,

*et al.*,<sup>14</sup> Lowenstein<sup>15</sup> and Gould and Patey.<sup>16</sup> These, when considered in the light of the findings in the five patients explored by us, suggest that in the majority of cases the following sequence occurs: (1) the subclavian vein is compressed between the first rib and the tendon of the subclavius muscle and/or between the posterior edge of the clavicle and the scalenus anterior muscle; (2) venospasm occurs, and if recurrent, interferes with the blood supply of the vein wall giving rise to mural

ing of the arm and forearm following exertion, distention of the superficial veins, and bluish discoloration of the hand and forearm are usually elicited and suffice for a clinical diagnosis (Table I). The diagnosis may be verified by venography, which was done in four of the five patients presented in this paper. Hughes<sup>3</sup> has stated that venograms present little or no information in this syndrome, are of little value, and cannot affect the diagnosis or treatment of this condition. The venograms in these four

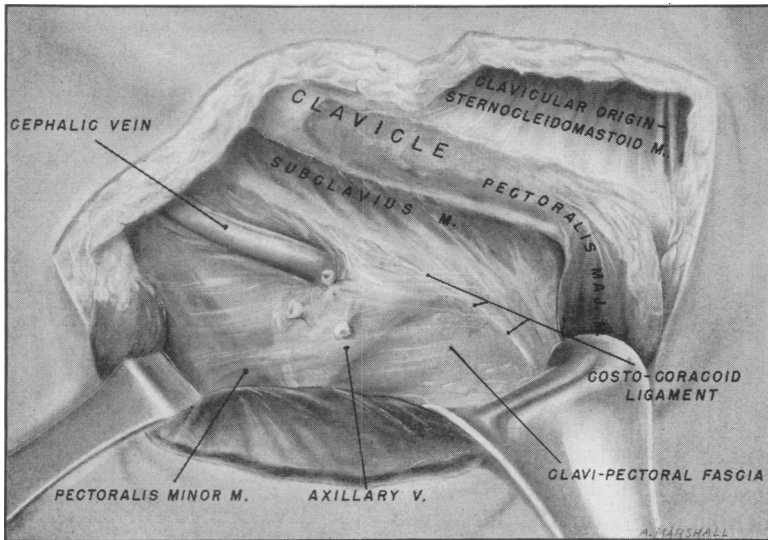


FIG. 2.—Infraclavicular dissection.

fibrosis, intimal damage and perivascular fibrosis; and occasionally (3) if the foregoing is long continued, or if the single initial trauma is great, an actual thrombosis may develop.

The maintenance of the marked improvement obtained by all five patients following excision of the subclavius and division of the scalenus anterior muscles suggests that a revival of interest in the operative approach to this problem is desirable.

DIAGNOSIS

Obstruction of the subclavian vein rarely presents a problem in diagnosis. The typical symptoms and signs of diffuse swell-

patients were of definite value in determining the site and degree of venous obstruction. It is of interest to note that Hughes used only 20 cc. of a 50 per cent solution of contrast medium. We have injected 30 cc. of 70 per cent Diodrast rapidly, with the cephalic vein compressed by a proximal tourniquet. As a result of the latter, the dye is forced into the deep veins. The film thus obtained gives excellent contrast. Furthermore, the repetition of the procedure with the arm in abduction often gives additional information as to (a) the site of venous obstruction, and (b) venospasm in the cephalic, axillary, or subclavian veins. We have not observed aggravation of the

FIG. 3

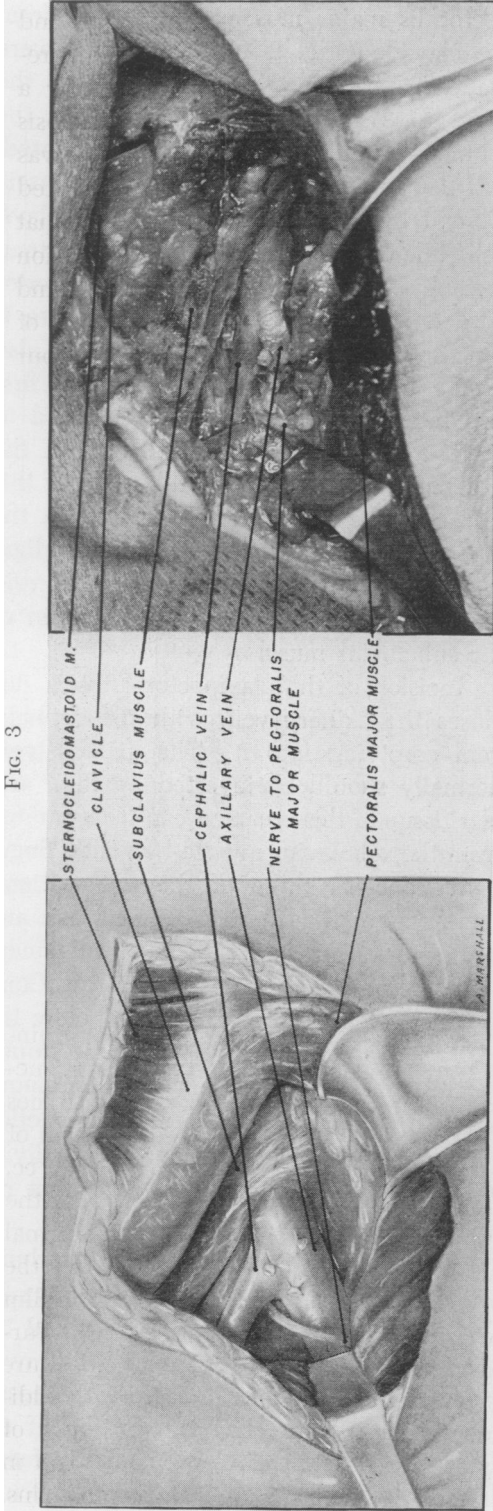


FIG. 4

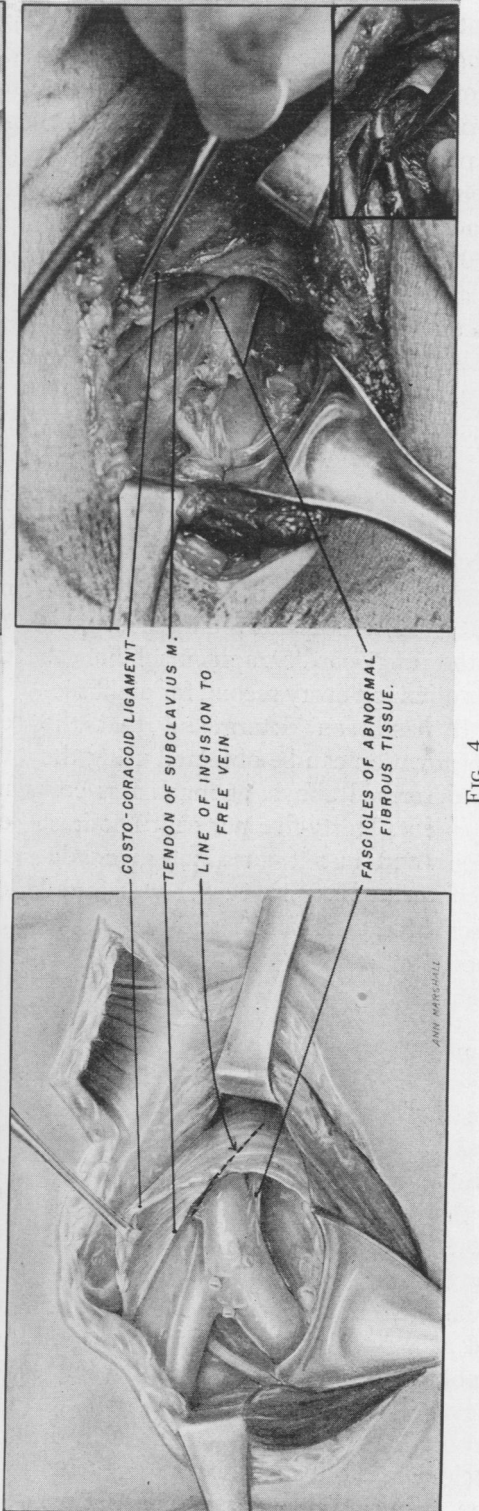


FIG. 3.—Demonstrates marked perivascular fibrosis and actual fusion of the costocoracoid ligament with the vein wall.  
FIG. 4.—Compression of the subclavian vein below the clavicle produced by hypertrophy of the subclavius muscle. Inset: normal. Note thin wall of vein, absence of perivenous fibrosis, and smallness of subclavius muscle. Tip of clamp marks position of first rib.

condition following venograms in any of these patients.

*Venogram Technic*—The patient is first tested for sensitivity to Diodrast by means of the ophthalmic and intravenous tests. He is then placed on the roentgen ray table in the supine position, arm at side, with a tourniquet in place on the upper arm. Thirty cc. of 70 per cent Diodrast are injected as rapidly as possible into an antecubital vein through an 18-gauge needle. Eight seconds after beginning the injection the film is exposed. A 14- by 17-inch film is used and the roentgen ray tube is centered over the medial third of the clavicle. The procedure is repeated with the arm abducted 90°, as an additional 30 cc. of 70 per cent Diodrast are injected and a film made.

The first venograms in this series were done at Vanderbilt University Hospital, using the angiocardigraph machine. A film was obtained every second for eight seconds. It has been determined that the same information can be obtained using the technic described above, at much less cost to the patient. Thirty-five per cent Diodrast has been tried but it does not give adequate contrast. Case 1 (H. S.) was found to be sensitive to Diodrast and venograms were not attempted. No sensitivity reaction has been observed in any of the other cases.

#### OPERATIVE TECHNIC

The incision is begun over the delto-pectoral groove (Figure 1), approximately two fingers-breadth below the clavicle opposite the junction of its middle and lateral thirds. It is extended to a point approximately two inches lateral to the sternoclavicular junction. The incision is then carried at a right angle across the clavicle to a point one finger-breadth superior to the clavicle, whence it is extended to the medial border of the clavicular head of the sternocleidomastoid muscle.

The infraclavicular dissection is performed first. The delto-pectoral triangle

and cephalic vein are identified, and the pectoralis major muscle is detached from the clavicle (Fig. 2—all illustrations were made from Case 2). This discloses the nerve to the pectoralis major muscle, the thoraco-acromial veins, which are ligated, and that portion of the clavipectoral fascia pierced by the cephalic vein. The clavipectoral fascia will be noted to extend medially and superiorly to the inferior border of the subclavius muscle, where it splits to invest that muscle. This fascia also extends medially and inferiorly to the first two intercostal spaces, and is attached to the first rib medial to the insertion of the subclavius muscle. The condensation of this fascia extending from the first rib to the coracoid process is the costocoracoid ligament, which crosses the subclavian vein tangentially just inferior to the tendon of the subclavius muscles.

Incision of the clavipectoral fascia discloses the axillary vein with the cephalic vein emptying into it. The axillary vein normally should be invested by thin, areolar tissue in this area and can be separated from the subclavius muscle by gentle finger dissection. In three of the five patients there was marked perivascular fibrosis and actual fusion of the costocoracoid ligament with the vein wall (Figs. 3 and 4). Compression of the subclavian vein below the clavicle may be produced by hypertrophy of the subclavius muscle, by its tendinous edge, or by condensation and contraction of the costocoracoid ligament, especially at the point of its insertion into the first rib (Figs. 4, 5, and 6).

The vein is freed from the overlying costocoracoid ligament and the entire subclavius muscle is excised (Figs. 6 and 7). The subclavian vein should now fall away from the clavicle and lie free in the costoclavicular space. The visualization of the vein beneath the clavicle is greatly facilitated by division of the costoclavicular ligament.

FIG. 5

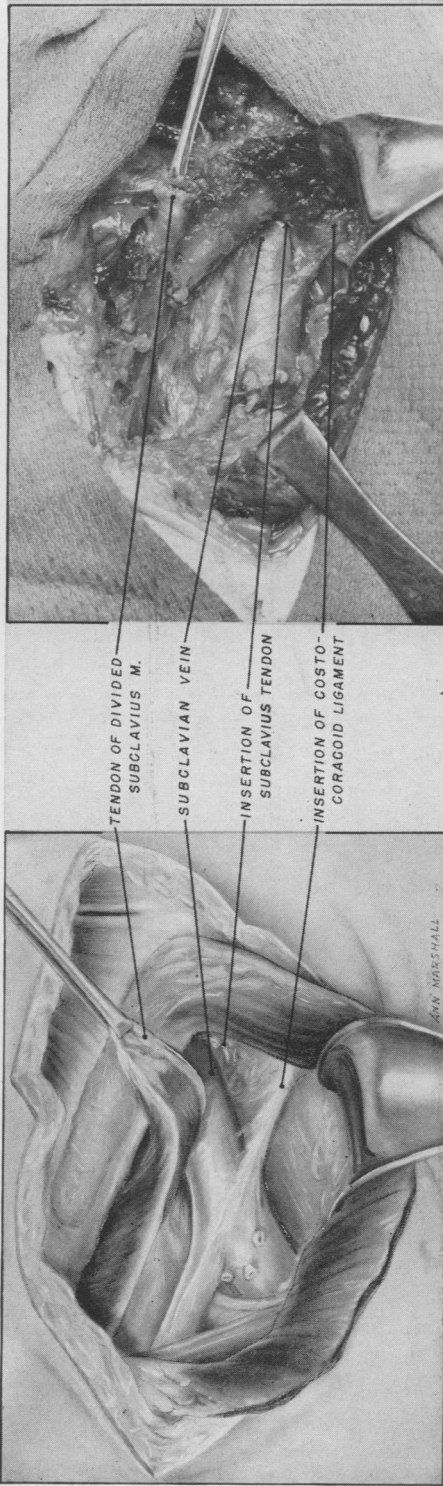
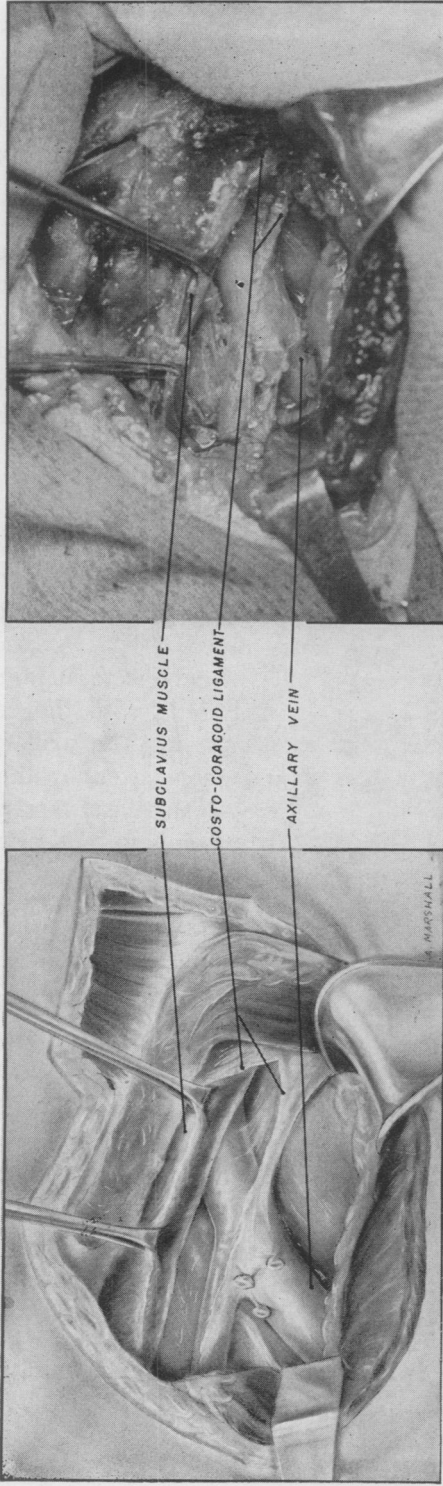


FIG. 6

FIG. 5.—Compression of the subclavian vein below the clavicle produced by the tendinous edge of the subclavius muscle.  
FIG. 6.—Compression of the subclavian vein below the clavicle produced by contraction of the costocoracoid ligament.



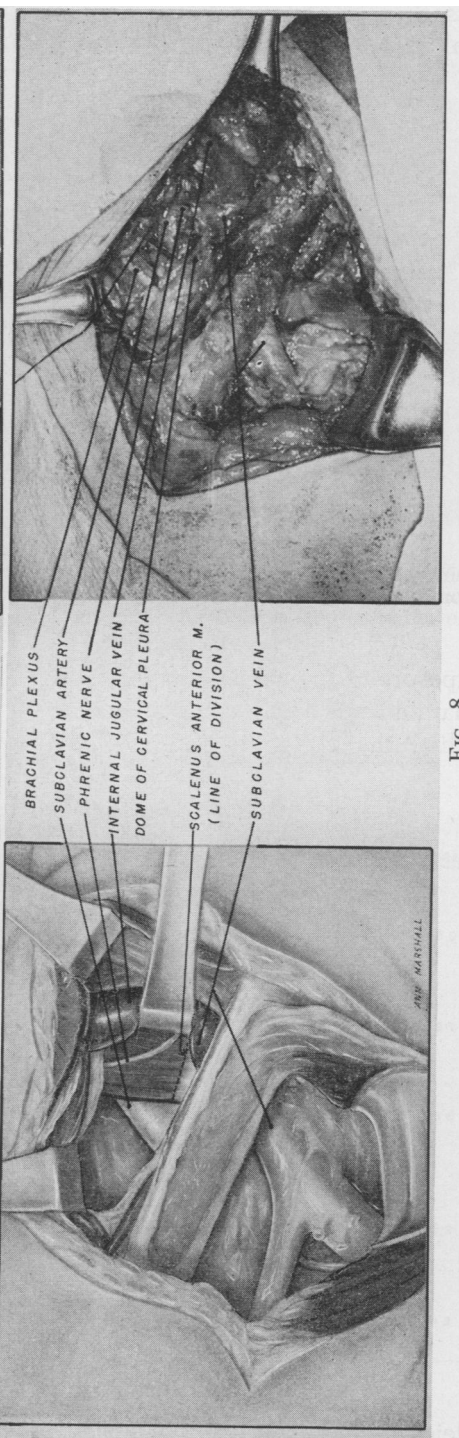
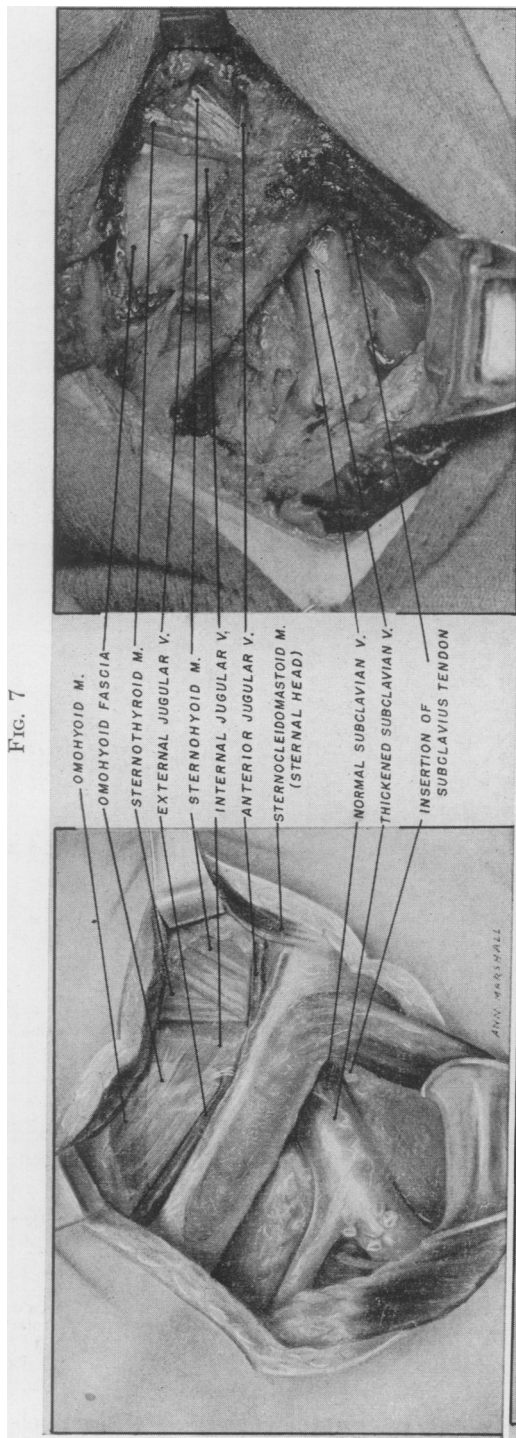


FIG. 7.—Complete excision of subclavius muscle. Visualization of the subclavian vein beneath the clavicle is facilitated by division of the costoclavicular ligament. Division of the clavicular origin of the sternocleidomastoid muscle gives more adequate exposure of the junction of the internal jugular and subclavian veins.

FIG. 8.—Exposure of the scalenus anterior muscle with phrenic nerve, by incision of prevertebral fascia. Subclavian vein is readily seen. Scalenus anterior muscle has been divided.

INTERMITTENT OBSTRUCTION OF THE SUBCLAVIAN VEIN

The supraclavicular portion of the operation is then done. The platysma and superficial fascia are incised. More ade-

vein, strap muscles, and anterior jugular vein. The prevertebral fascia is then incised, exposing the scalenus anterior mus-

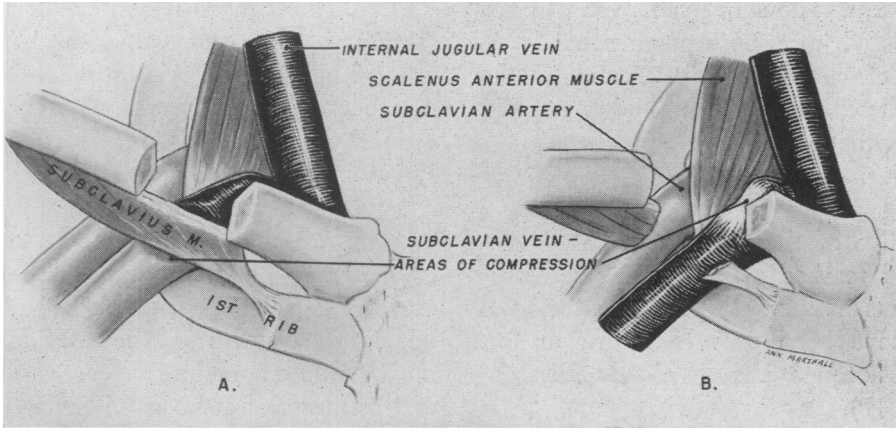


FIG. 9.—(A) Changes in vein wall from compression, ending medial to point where vein was traversed by the tendon of the subclavius muscle. (B) Change in vein wall from compression in area between the posterior edge of the clavicle and the tendon of the anterior scalene muscle.

quate exposure of the junction of the internal jugular and subclavian veins is obtained by dividing the clavicular origin of the

cle with the phrenic nerve lying upon it (Fig. 8). If the subclavian vein is constricted between the scalenus anterior mus-

TABLE I

<u>PATIENT</u>	<u>AGE</u>	<u>SEX</u>	<u>SIDE</u>	<u>CAUSE</u>	<u>ONSET AND DURATION</u>	<u>SYMPTOMS</u>	<u>PHYSICAL SIGNS</u>	<u>PHLEBOGRAPHIC FINDINGS</u>
1. H. S.	28	M	RT.	HAMMERING WITH RIGHT HAND	SUDDEN 8 MO.	SWELLING TINGLING	EDEMA BLUISH DISCOLORATION OF HAND DISTENDED VEINS	NOT DONE (PATIENT SENSITIVE TO DIODRAST)
2. W. B. W.	22	M	RT.	CARRYING CRATE OF POTATOES ON RT. SHOULDER	SUDDEN 50 MO.	SWELLING TIGHTNESS OF FOREARM AND HAND	EDEMA BLUISH DISCOLORATION OF RT. UPPER EXTREM. DISTENDED VEINS	PARTIAL SUBCLAVIAN V. OBSTRUCTION AT MEDIAL BORDER OF 1ST RIB AND POSTERIOR TO CLAVICLE
3. R. S. S.	30	M	LT.	CARRYING STRETCHERS ON LT. SHOULDER	SUDDEN 84 MO.	SWELLING TINGLING TIGHTNESS OF HAND AND FINGERS	EDEMA BLUISH DISCOLORATION OF HAND DISTENDED VEINS HYPER HYDROSIS	PARTIAL SUBCLAVIAN V. OBSTRUCTION POSTERIOR TO CLAVICLE
4. S. R.	26	M	LT.	OVERHEAD WORK AND HEAVY LIFTING	SUDDEN 1½ MO.	SWELLING TIGHTNESS OF ARM AND FOREARM	EDEMA BLUISH DISCOLORATION OF HAND DISTENDED VEINS	COMPLETE SUBCLAVIAN V. OBSTRUCTION AT MEDIAL BORDER OF 1ST RIB
5. F. P.	24	M	RT.	USING ADDING MACHINE WITH RIGHT HAND	SUDDEN 3 MO.	SWELLING NUMBNESS	EDEMA BLUISH DISCOLORATION OF HAND DISTENDED VEINS	PARTIAL SUBCLAVIAN V. OBSTRUCTION AT MEDIAL BORDER OF 1ST RIB

sternocleidomastoid muscle (Fig. 7). The omohyoid fascia and deep cervical fascia are incised, exposing the internal jugular

cle and the posterior surface of the clavicle, this should now be apparent. The phrenic nerve is retracted and the scalenus anterior



muscle is divided near its tendinous insertion. This allows the vein to be rolled laterally, exposes the innominate vein, and allows the vein to be visualized as it crosses the first rib. The subclavian vein can now be palpated in its entire course by the insertion of one finger above and another below the clavicle. The wound is closed in layers without drainage.

RESULTS

All five of the patients operated upon obtained marked relief of their signs and symptoms in the first postoperative week. They have been able to return to their former occupations without disability (Table II).

ceased immediately medial to the point where the vein was traversed by the tendon of the subclavius muscle (Figs. 7 and 9A).

In Case 1 only the infraclavicular dissection was performed and the completeness of his recovery indicates that he had no other area of compression. A similar procedure was followed in Case 2, but his symptoms were only partially ameliorated. A repeat venogram indicated another area of compression and consequently a supraclavicular exploration was later carried out. The space between the sharp posterior edge of the clavicle and the anterior scalene muscle would not admit a finger tip. Section of this muscle has been followed by com-

TABLE II

PATIENT	OPERATIVE FINDINGS COMPRESSION OF SUBCLAVIAN VEIN BY:	OPERATION PERFORMED EXCISION OF:	POST-OP SYMPTOMS	DIFFERENCE AFFECTED AND NORMAL EXTREMITIES IN CM		PHLEBOGRAPHIC FINDINGS	LENGTH OF FOLLOW-UP AND RESULT
1. H. S.	TENDON OF SUBCLAVIUS MUSCLE	SUBCLAVIUS MUSCLE	NO COMPLAINTS NO EDEMA NO DISCOLORATION	PRE-OP. POST-OP.	2 CM. NONE	NOT DONE	9 MONTHS MARKED IMPROVEMENT
2. W. B. W.	A) TENDON OF SUBCLAVIUS M. B) SCALENUS ANT. M.	A) SUBCLAVIUS M. B) SCALENUS ANT. M.	VAGUE UNRELATED COMPLAINTS NO EDEMA NO DISCOLORATION	PRE-OP. POST-OP.	3 CM. 1 CM.	NO OBSTRUCTION OF SUBCLAVIAN V.	8 MONTHS MARKED IMPROVEMENT
3. R. S. S.	SCALENUS ANTERIOR M.	A) SUBCLAVIUS M. AND SCALENUS ANT. M. B) DORSAL SYMPATHECTOMY	NO COMPLAINTS NO EDEMA NO DISCOLORATION	PRE-OP. POST-OP.	2.5 CM. NONE	"	5 MONTHS MARKED IMPROVEMENT
4. S. R.	SCALENUS ANTERIOR M.	SUBCLAVIUS MUSCLE SCALENUS ANT. M.	"	PRE-OP. POST-OP.	5 CM. NONE	"	4 MONTHS MARKED IMPROVEMENT
5. F. P.	TENDON OF SUBCLAVIUS MUSCLE SCALENUS ANTERIOR M.	SUBCLAVIUS MUSCLE SCALENUS ANT. M.	"	PRE-OP. POST-OP.	3 CM. 1 CM.	"	3 MONTHS MARKED IMPROVEMENT

Two of them (Cases 3 and 4) had a change in the vein wall only in the area between the posterior edge of the clavicle and the tendon of the anterior scalene muscle (Fig. 9B). Cases 2 and 5 had compression in this area associated with pressure on the vein from the subclavius tendon. Cases 1, 2 and 5 had similar changes in the subclavian, axillary and cephalic veins, characterized by increase in thickness of their walls, absence of thrombosis and increase in perivascular fibrosis and fixation. It was unquestionably apparent that these changes

plete recovery and the venogram became normal in appearance.

Subsequent to this, all cases have been explored by a combined supra- and infraclavicular approach.

Case 1.—(H. S.) This 28-year-old white male laborer was admitted complaining of swelling and paresthesia involving the right upper extremity. These symptoms had been present for 8 months prior to admission and became apparent following exercise or undue use of the right arm. There was a mottled, bluish discoloration of the hand. Swelling occurred approximately one to 2 times a week and subsided in 24 to 48 hours with rest and

INTERMITTENT OBSTRUCTION OF THE SUBCLAVIAN VEIN

elevation of the extremity. The patient's last attack occurred 48 hours prior to admission following an episode of hammering. On admission the right hand was seen to be 2 cm. larger than the left. There was no difference in the size of the forearm and arm. Examination on admission revealed distention of the veins of the right upper extremity and a mottled, bluish discoloration of

Venograms could not be done because of the patient's sensitivity to Diodrast. On March 21, 1950, under general anesthesia, the patient's subclavian vein was explored. The subclavian vein was seen to be constricted by the tendon of the subclavius muscle. The wall of the vein in this area was white, thickened and markedly adherent to the subclavius muscle, and to the costocoracoid liga-

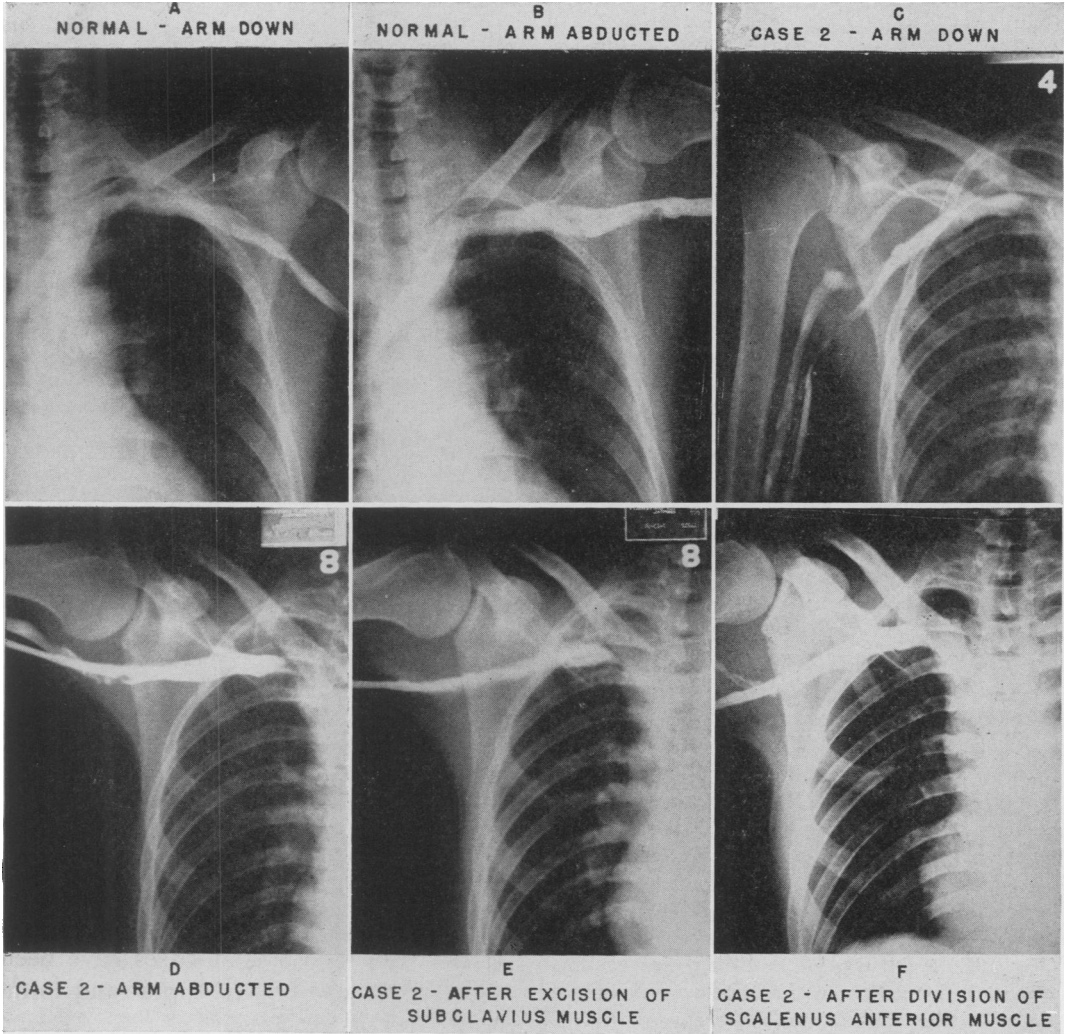


FIG. 10.—Venograms of normal arm, and of arm in Case 2.

the right hand and fingers. There was no difference in the pulses of the two upper extremities. The above swelling subsided in 24 hours following admission. When the patient worked with a hammer for 30 minutes in the Occupational Therapy Department he again developed typical signs and symptoms, with a 2.5 cm. swelling of the arm.

ment. The vein was freed from the muscle and its tendon with some difficulty and the subclavius muscle and costocoracoid membrane were excised. The patient's postoperative course was uncomplicated. On examination, 3 months following operation, there was no difference in the measurements of the upper extremities. He returned for

follow-up examination 9 months postoperatively and had no complaints. There had been no swelling of the arm at any time and there was no difference in the measurements of the upper extremities. He has been able fully to resume his former occupational activity.

**Case 2.**—(W. B. W.) This 22-year-old white male laborer was admitted to the hospital complaining of swelling of the right upper extremity. While the patient was in the military service in February, 1946, he noted the sudden onset of swelling of the right elbow, entire forearm, and hand after carrying a crate of potatoes on his right shoulder. There was no associated redness, tenderness or systemic manifestation. The patient was hospitalized for 3 weeks and treated conservatively and the swelling gradually subsided. Since then he had noted recurrence of swelling when he used the extremity. This was associated with a mottled, bluish discoloration of the entire right upper extremity and a sensation of tightness. Swelling and discoloration would disappear within 24 to 48 hours following rest of the extremity. The examination on admission revealed the right wrist and forearm to be 2.5 cm., and the right arm to be 3 cm. larger than the left. There were distended, tortuous veins in the epitrochlear region and over the pectoralis major muscle. Arterial pulsations were equal and normal in both upper extremities.

Venograms (Fig. 10D) revealed a partial obstruction of the right subclavian vein beneath the subclavius muscle at the medial border of the first rib. On April 10, 1950, under general anesthesia, the patient was explored. At the time of operation the subclavius muscle was seen to be markedly enlarged and fibrous and it constricted the vein as it crossed the first rib (Fig. 9A). The subclavius muscle and the costocoracoid membrane were excised. Supraclavicular dissection was not known to be necessary. The patient's symptoms were slightly improved following operation but he still had a moderate amount of swelling following activity. Again venograms were done (Fig. 10E) and it was felt that the patient still had a partial obstruction in the subclavian vein posterior to the clavicle probably caused by the scalenus anterior muscle. Subsequently, on July 21, 1950, the patient had a supraclavicular exploration of the subclavian vein and it was seen that there was a second constriction (Figure 9B) between the anterior surface of the scalenus anterior muscle and the posterior surface of the clavicle. Following this procedure, the patient was markedly improved. He has been able to work without swelling of the right arm. Repeat venograms (Fig. 10F) revealed no evidence of obstruction

in the subclavian vein. The right upper extremity remains 1 cm. larger in the wrist, forearm and arm, but at no time has there been any edema. The patient has had no further bluish discoloration of the right hand following use. It is felt that the patient is markedly improved and is able to carry on a gainful occupation without difficulty.

**Case 3.**—(R. S. S.) This 38-year-old white male farmer was admitted to the hospital complaining of swelling of the left upper extremity. While the patient was in the military service in 1943 he noted the onset of this swelling following the carrying of stretchers on his left shoulder. It was associated with a sensation of tingling in the ring and little fingers on the left hand. He noted a heavy sensation in his left arm, accompanied by swelling when the arm hung in a dependent position. These symptoms have become more severe in the past several months. On admission the left arm and hand were 2.5 cm. larger than the right. The arterial pulsations were normal in both upper extremities. There were dilated veins over the deltoid and pectoral muscles on the left. There was a bluish discoloration of the left hand when it was held in a dependent position. Venous pressure was increased on the left side. There was profuse sweating of all extremities following slight exercise, most marked in the left upper extremity. Venograms revealed a partial obstruction of the subclavian vein posterior to the clavicle. It was felt that the patient had a subclavian vein obstruction in the region of the scalenus anterior muscle. On July 31, 1950, the subclavian vein was explored. The subclavian vein was normal beneath the clavicle in the region of the subclavius muscle, but the vein was constricted in the region of the scalenus anterior muscle. This muscle was divided and the subclavius muscle was excised. Postoperatively, the patient has been markedly improved. There has been no swelling of the left upper extremity. Postoperative venograms revealed no obstruction to the subclavian vein. However, the patient continued to have marked sweating of the left upper extremity and on November 20, 1950, a dorsal sympathectomy was carried out with complete relief of this symptom. Even before the sympathectomy, the patient was able to work a full day without swelling.

**Case 4.**—(S. R.) This 26-year-old white male was admitted to the hospital complaining of swelling of his left arm. Six weeks before admission the patient noted onset of swelling associated with a sensation of tightness. There was slight pain and bluish discoloration on exertion. The patient operates a small business in which he has to do over-

head work, as well as heavy lifting. Examination on admission revealed a 5 cm. swelling of the left upper extremity. There were dilated, tortuous veins over the left arm and the anterior chest wall. The axillary vein was markedly dilated but was compressible. Venograms revealed what seemed to be a complete obstruction in the subclavian vein as it passed behind the clavicle. The subclavian vein was explored on August 16, 1950. The vein, below the clavicle, was markedly dilated but was normally thin-walled. It was freed from the subclavius muscle, and the latter was excised, along with the costocoracoid membrane. The scalenus anterior muscle was also divided just above its insertion on the first rib. The vein in this area, between the clavicle and scalenus anterior muscle, was white and thickened over a distance of only 1 cm. The patient's postoperative course was uncomplicated. The arm measurements have returned to normal and postoperative venograms reveal no obstruction to the subclavian vein. He now has no swelling or cyanosis and is able to carry on his work without difficulty.

**Case 5.**—(F. P.) This 24-year-old white male was admitted complaining of swelling of his right upper extremity. He had worked from July until December, 1949, carrying heavy meat carcasses on his right shoulder. He then changed to an indoor job, using an adding machine with his right hand, and in April, 1950, the patient's right arm became suddenly swollen. He noted dilatation of the veins over his right shoulder, bluish discoloration of the hand, and a sense of numbness in the hand. On admission the right upper extremity was 3 cm. larger than the left. There were dilated veins over the right deltoid and pectoral muscles and there was a mottled, bluish discoloration of the right hand and fingers. Venograms were done which showed a partial obstruction in the subclavian vein in the region of the first rib, with marked collateral circulation. On September 7, 1950, the subclavian vein was explored. At the time of exploration it was impossible for the operator to put his finger in the costoclavicular space, but after division of the scalenus anterior muscle and excision of the subclavius muscle, the subclavian vein dropped away from the clavicle. A finger could then be easily passed behind the clavicle and into the superior mediastinum. There was marked increase in the fibrous tissue in the vein wall beneath the subclavius muscle and also out along the axillary and cephalic veins. The postoperative course was uneventful. The right arm is now 1 cm. larger than the left. Postoperative venograms show no obstruction to the subclavian vein. The patient has returned to work without swelling or cyanosis.

#### DISCUSSION

It has been mentioned that approximately three-fourths of the patients, given conservative therapy, have residual disability.<sup>6</sup> In spite of this the two latest reviewers<sup>3, 6</sup> recommend it, instead of operative intervention, since the latter has been previously attended by such equivocal results.

The relative inaccessibility of the subclavian vein has been a deterrent to surgical exploration. Indeed Hughes<sup>3</sup> states that he doubts that the vein has ever been satisfactorily explored in this condition. Using the method herein described, we feel that the vein can be seen and palpated in its entire extent (Fig. 8). Hughes also feels that important collateral veins may be detrimentally ligated in the course of an operative procedure. Results in our patients do not indicate that this is of practical importance.

The belief that thrombosis has occurred in most of these cases has been enervating to the adoption of a vigorous surgical approach. Exploration has frequently disclosed no sign of thrombosis. If thrombosis be common, then it is remarkable that no definite instance of embolism has been reported.<sup>3</sup> In none of our cases was thrombosis present, although the venogram in Case 4 suggested complete obstruction. However, the appearance of the vein at exploration, the postoperative venogram, and the rapid loss of swelling postoperatively suggest that if thrombosis was present, it did not appreciably occlude the lumen.

Venograms have real value in establishing diagnosis and in locating the site of the affecting mechanism. We do not believe, however, that any such evidence of complete obstruction is sufficiently conclusive to militate against surgical exploration. It would seem justifiable to explore all patients having constant swelling and disability or recurrent bouts interfering seriously with their usual occupation.

The role of venospasm in producing this syndrome has been widely debated. The rapid onset and rapid recovery so often seen lend some support to the belief that spasm is common. The frequent relief obtained by sympathetic block also is suggestive. Some of our venographic studies imply such a mechanism. For example, in Figure 10C, with the arm at the side, the subclavian vein appears perfectly normal. When it is abducted a deformity appears in the area of the subclavius muscle (Fig. 10D). This should be compared with a normal venogram (Figs. 10A and B) in which no such deformity appears when the arm is similarly abducted. Note that in Figure 10C there is retrograde filling of the cephalic vein but that there is none in Figure 10D. The explanation was apparent at the time of surgical exploration—when the arm was abducted the cephalic vein went into a state of marked spasm. Figure 10E demonstrates that the previous deformity was abolished following removal of the subclavius muscle, but another, more medial, area of constriction is seen where the vein lies between the clavicle and the anterior scalene muscle. Here also, there is no retrograde filling of the cephalic vein. Following section of the latter muscle there no longer is spasm in the cephalic vein and the subclavian vein retains its normal diameter, even though the arm is markedly abducted (Fig. 10F).

It would seem that the changes in the vein walls might be explainable on the following bases: (a) direct trauma by the above muscles could produce a localized area of fibrosis, as a result of direct interference with the mural blood supply (Cases 3 and 4), and occasionally lead to gradual thrombosis; (b) also, rarely the initial trauma to the intima might be severe enough to cause immediate thrombosis; and (c) the extensive vein wall thickening and fibrosis seen in Cases 1, 2 and 5 (Figs. 3 and 5) might occur in response to repeated

venospasm with participation of the vasa vasorum in this spasm. Such recurrent interference with the blood supply of the vein walls could lead to alternate periods of cellular destruction and healing, and finally to widespread fibrous tissue formation.

The principle on which this operative technic is based implies removal of structures imprisoning the vein at the "bottle-neck" where it leaves the axilla on its course to the superior mediastinum. The good results from scalenotomy alone reported by Neij<sup>10</sup> and by McLaughlin and Popma<sup>11</sup> are of interest. However, three of our five cases had definite changes in the walls of the subclavian, axillary and cephalic veins, below the subclavius muscle. We feel, therefore, that the combined infra- and supraclavicular approach is necessary in all cases. The infraclavicular dissection will permit, not only a complete visualization of the subclavian vein, but also excision of the subclavius muscle and its fascial attachments to the vein. This will then allow the vein to move backwards or forwards, in the costoclavicular angle, with a freedom that scalenotomy alone cannot accomplish (Figs. 3 and 5).

We do not believe that all cases are explainable by this theory of pathogenesis. However, in the vast majority of cases, the extent of exposure obtained by this procedure will permit an individualized approach to the surgical alleviation of a syndrome for which conservative therapy offers so little. The marked improvement obtained by all five patients following excision of the subclavius and division of the scalenus anterior muscles suggests that a revival of interest in the operative approach to this problem is desirable.

#### SUMMARY

1. Five cases of intermittent obstruction of the subclavian vein are presented.
2. An operative technic is described which affords complete visualization of the three portions of the subclavian vein.

3. The obstruction was caused by the subclavius muscle or anterior scalene muscle, or a combination of both.

4. Complete obstruction due to thrombosis was not present in any of these patients.

5. All showed marked improvement following division of the anterior scalene muscle and excision of the subclavius muscle.

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#### BIBLIOGRAPHY

- 1 Paget, Sir: *J. Clin. Lectures and Essays*. London, 1875. Longmans, Green and Co. (As quoted by E. S. R. Hughes.)
- 2 Schroetter, von L.: *Erkrankungen der Gefasse. Nothnagel Handbuch der Pathologie und Therapie*. Wein: Holder, 1884. (As quoted by E. S. R. Hughes.)
- 3 Hughes, E. S. R.: *Venous Obstruction in the Upper Extremity*. *Surg., Gynec. & Obst., Internat. Abstr. Surg.*, 88: 89, 1949.
- 4 Loehr, W.: *Über Die Sogennante "Traumatische" Thrombose der Vena Axillaris und Subclavia*. *Deutsche Ztschr. f. Chir.*, 214: 263, 1929.

- 5 MacCarthy, H.: *Traumatic Axillary Venospasm*. *Brit. M. J.*, 2: 298, 1946.
- 6 Kleinsasser, L. J.: "Effort" Thrombosis of the Axillary and Subclavian Veins. *Arch. Surg.*, 59: 258, 1949.
- 7 Kaplan, T.: *Thrombosis of Axillary Vein; Report of 5 Cases with Comments on Etiology, Pathology, and Diagnosis*. *J. A. M. A.*, 110: 2059, 1938.
- 8 Pelter, L., and I. Cohn: *Primary Thrombosis of Axillary and Subclavian Vein*. *Am. J. M. Sc.*, 203: 340, 1942.
- 9 Rixford, E.: *Thrombosis by Effort*. *West. J. Surg.*, 43: 233, 1935.
- 10 Neij, S.: *Traumatisk Armstas*. *Nord. med.*, 20: 1956, 1943.
- 11 McLaughlin, C. W., Jr., and A. M. Popma: *Intermittent Obstruction of the Subclavian Vein*. *J. A. M. A.*, 113: 1960, 1939.
- 12 Veal, J. R., and E. M. McFetridge: *Primary Thrombosis of the Axillary Vein*. *Arch. Surg.*, 31: 271, 1935.
- 13 Wright, I. S.: *Neurovascular Syndrome Produced by Hyperabduction of Arm*. *Am. Heart J.*, 1: 29, 1945.
- 14 Sampson, J. J., J. B. Saunders and C. S. Capp: *Compression of Subclavian Vein by First Rib and Clavicle*. *Am. Heart J.*, 19: 292, 1940.
- 15 Lowenstein, P. S.: *Thrombosis of the Axillary Vein—An Anatomic Study*. *J. A. M. A.*, 82: 854, 1924.
- 16 Gould, E. P., and D. H. Patey: *Primary Thrombosis of the Axillary Vein*. *Brit. J. Surg.*, 16: 208, 1928.

*DISCUSSION.*—DR. J. ROSS VEAL, Washington, D. C.: This subject has been of interest to me for some time. I have examined some 30 cases of effort thrombosis of the subclavian and axillary veins. We attempted one time to demonstrate the anatomic structures which might possibly cause compression of the subclavian and axillary veins. We used fresh cadavers and manipulated the arm in all positions to determine the effect upon the course of the veins. Casts of the vessels were made and we were unable to demonstrate any compression of the vessels. In live subjects we did show definitely that when the patient raised his arm above his head, the head of the humerus constricted the axillary vein to a marked degree. Under forced respiratory effort there was a tremendous rise in the subclavian venous pressure in these patients. We felt that with the compression of the axillary vein, a sudden inspiratory and expiratory effort could produce overloading of the veins and

cause sufficient damage to the valves or tributaries which might lead to thrombosis.

I agree with Dr. Kirtley that most of these patients do have residual symptoms. They are not able to use the hand and arm as rapidly for long periods as before occurrence of the venous occlusion. Under exercise there is an increase in the local venous pressure and damming back of the venous blood flow. This in turn produces such congestion that pain and fatigue result. Venograms seem to indicate that these involved veins are only partially recanalized. I wonder if Dr. Kirtley found any of his cases to have complete recanalization.

I think the operative procedure described by Dr. Kirtley should be tried. So far as this is concerned, I have had no experience with it. One should consider the possibility that more scarring will result from the extensive surgery and that further venous occlusion will follow.