Pectoralis Minor Tenotomy and Anterior Scalenotomy with Special Reference to the Hyperabduction Syndrome and “Effort Thrombosis” of the Subclavian Vein

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Symptoms referable to the subclavian vessels or lowermost cord of the brachial plexus are frequently seen following repeated or prolonged hyperabduction of the arms. The sites of compression are thought to be the point at which these neurovascular structures emerge from beneath the pectoralis minor tendon and the interval between the clavicle and the first rib. Five patients presenting the hyperabduction syndrome have been subjected to pectoralis minor tenotomy and anterior scalenotomy with a good result in four cases, indicating the potential value of the procedure in this particular shoulder girdle syndrome.

In 1945 Wright described a syndrome characterized by neurovascular symptoms in the upper extremities following repeated and prolonged assumption of the position of hyperabduction. The postural attitude responsible for the symptoms was one in which the arms were brought together above the head with the elbows flexed. This position is frequently assumed in sleep but to lesser degrees is practiced in certain occupations such as grease pit mechanics and painters. With wider recognition of the syndrome it has been extended to include neurovascular symptoms resulting from lesser degrees of hyperabduction than that formerly described by Wright. The syndrome is to be differentiated from the allied causes of shoulder girdle symptoms such as the cervical rib, scalenus anticus and costoclavicular syndromes.

Wright and Beyer and Wright have described two potential sites of compression of the subclavian vessels and the brachial plexus in the hyperabduction syndrome. One site has been the point at which these neurovascular structures pass beneath the tendon of the pectoralis minor muscle and under the coracoid process. The second site of compression is the retroclavicular space between the clavicle and first rib which is diminished to a variable degree in hyperabduction. One of the authors (J. W. L., Jr.3) has previously reported upon experience with a “space making” operation in which a total resection of the clavicle is performed to prevent compression of the subclavian vessels and the brachial plexus between the clavicle and the first rib.

More recently, we have been impressed with the role of the pectoralis minor tendon and its division in the alleviation of vascular compression during hyperabduction. The subclavian artery and vein may be stretched and acutely angulated as they pass beneath the pectoralis minor tendon in the position of hyperabduction. With this factor in mind, a small group of cases with hyperabduction syndrome, refractory to conservative measures, have had section of the pectoralis minor tendon. At the same time, the anterior scalene muscle has been divided through a separate incision. The rationale for scalenotomy is found in the fact that this muscle with its attachment to the first rib serves to hold this rib in a relatively fixed position. By division of the scalene muscle it was felt that the rib might drop away from the clavicle thereby increasing the space between clavicle and first rib. An additional virtue of scalenotomy is the elimi-
nation of pressure on the subclavian vein by the subclavius muscle and clavicle anteriorly and the scalenus muscle posteriorly.

**Operative Procedure**

The patient is placed in the supine position on the operating table with a long, narrow sandbag in the interscapular region. The arm of the side to be operated is abducted to 90 degrees and placed on an armboard. Draping is then performed in such a manner that the arm may be moved freely during the course of the operative procedure, thereby enabling the operator to visualize the degree of compression of the axillary vessels and the brachial plexus by the tendon of the pectoralis minor.

*Anterior Scalenotomy.* A three inch transverse incision is made one half inch above the medial end of the clavicle. The incision is extended through the platysma muscle. The clavicular attachment of the sternocleidomastoid muscle is divided if the muscle is bulky and cannot be adequately retracted. The scalenus anterior muscle is identified and the phrenic nerve mobilized from its anterior surface and retracted. The muscle is then divided approximately 1 cm. from its attachment to the first rib. All bleeding points are ligated with fine silk or cotton ligatures. The operator introduces his finger into the interval between the clavicle and the first rib and evaluates the size of this space. The arm is then abducted to 180 degrees and also depressed downward and backward. The effect of these maneuvers upon the vessels and brachial plexus is noted. If there is marked narrowing of the space between the clavicle and first rib associated with a clinically positive costoclavicular maneuver, then a total claviclelectomy is performed with removal of the periosteum. If there is adequate room, then the clavicular head of the divided sternocleidomastoid muscle is repaired with interrupted sutures of fine silk or cotton. The platysma and skin are closed with nonabsorbable sutures. The wound is not drained.

*Pectoralis Minor Tenotomy.* A three inch oblique incision is made just below the coracoid process. The incision is deepened to the pectoralis major muscle which is incised and split in the direction of its fibers. A tape is passed around the tendon of the pectoralis minor muscle at the point of its insertion into the coracoid process. The arm is abducted to 180 degrees and the degree of stretching of axillary vessels and the brachial plexus under the pectoralis minor tendon noted. The tendon is then divided approximately one half inch from its point of insertion (figs. 1 and 2). The pectoralis major muscle and the skin are closed with interrupted non-absorbable sutures. No drain is used.

**Case Reports**

*Case 1.* N. H., a 50 year old white female, had noted the right arm to be larger than the left for many years. Two months prior to admission there had been an episode of “paralysis” of the right arm which lasted for one week. During this time she was unable to write or perform other fine movements with the right hand. There had been a residual feeling of fullness in the right arm and intermittent tingling in the fingers of the right hand. She had also experienced pain in the right arm, shoulder and supraclavicular region.

Physical examination revealed the right arm to be 2 cm. greater circumferentially than the left arm. Three large veins were present on the inner aspect of the upper right arm and two prominent veins
Fig. 3. (Case 1, N. H.) Venogram illustrating occlusion of the right subclavian vein. The cephalic vein enters below the point of obstruction.

were noted on the anterior right chest adjacent to the axilla. There were no prominent venous channels in the forearm. The brachial, radial and ulnar arteries were palpable. The right radial pulse was obliterated with hyperabduction of 135 to 150 degrees. The scalenus anticus and costoclavicular maneuvers were negative. X-ray films of the cervical spine were negative. A venogram revealed obstruction of the subclavian vein 2 cm. distal to the point of entry of the cephalic vein at the point where it passes under the subclavious muscle (fig. 3).

Anterior scalenotomy and section of the pectoralis minor tendon were performed on Jan. 5, 1953. During division of the scalenus anticus muscle a number of collateral venous channels were observed in the retroclavicular region. In addition a small nodule was excised from the upper outer quadrant of the left breast. This specimen was reported as cystic disease of the breast.

Immediately postoperatively the patient noted relief of pain in the arm and stated that “it felt quite different”. The postoperative course was uncomplicated. When last seen on July 7, 1955 she had no complaints referable to the right arm and stated that she was able to use the extremity much better than preoperatively. Numbness and disability of the right hand had not recurred. The right arm remained 2 cm. larger than the left. The right radial pulse could not be obliterated with hyperabduction to 180 degrees.

Case 2. G. C., a 26 year old white male, gave a history of sudden onset of pain and swelling in the right arm and forearm while sweeping the floor two and one half years prior to the present hospital admission. The patient was hospitalized and under conservative treatment the pain and swelling subsided. Since this episode there had been recurrent attacks of swelling associated with an aching sensation in the arm and stiffness of the right hand. He was unable to abduct his right arm beyond 90 degrees because of diffuse pain. The patient reported that four years prior to the onset of the present illness he had had an infection of the right hand with complicating lymphangitis and lymphadenitis. However, following treatment at that time he had noted no residual symptoms resulting from the infection and did not relate his present symptoms to the prior infection.

Physical examination revealed prominent veins over the right upper arm and shoulder. The right arm and forearm were 1.5 and 0.75 cm. greater circumferentially than the left. All major arterial pulses were present in the right arm. Hyperabduction of the right arm resulted in obliteration of the radial pulse at 90 degrees. The scalenus anticus and costoclavicular maneuvers were negative. X-ray films of the cervical spine were negative. The patient was felt to have a thrombosis of the subclavian vein associated with the hyperabduction syndrome.

On Jan. 14, 1954 anterior scalenotomy and section of the pectoralis minor tendon were performed. Immediately postoperatively patient stated that his arm felt better and the hand had lost its stiffness. At the time of discharge from the hospital the aching sensation in the arm had completely cleared. He has continued to do well during the 17 months that he has been followed. The right arm and forearm continue to remain slightly larger than the left, and he states that he has noted weakness in the right arm when working with this extremity abducted to more than 90 degrees. Oscillometric studies performed on June 5, 1955 are shown in table 1.

Case 3. C. S., a 39 year old white female, was first seen in Aug., 1953. In May, 1953 she had noted redness and swelling of the right arm and a sensation of tightness in the muscles of the arm aggravated by exercise. She consulted a surgeon who reported erythema of the right arm and a one inch increase in its circumference on comparison with the left arm. The veins of the right arm were more prominent than those of the left. The blood pressure was essentially the same in both upper extremities. X-ray films of the cervical spine did not reveal a cervical rib. A diagnosis of scalenius anticus syndrome had been made and a right anterior scalenotomy was performed.

<table>
<thead>
<tr>
<th>Degrees Abduction</th>
<th>Right Arm</th>
<th>Left Arm</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>2.0/100</td>
<td>1.5/80</td>
</tr>
<tr>
<td>90</td>
<td>2.5/120</td>
<td>2.75/80</td>
</tr>
<tr>
<td>180</td>
<td>2.0/60</td>
<td>1.25/60</td>
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The study was performed 5 months after right pectoralis minor tenotomy and anterior scalenotomy for the hyperabduction syndrome. Prior to operation the readings at 90 degrees and above were zero.
performed on July 31, 1953 without relief of symptoms.

When seen in August, the patient gave the additional history that when she combed her hair or abducted the right arm to 90 degrees or more in the performance of household duties, the arm became heavy and tired quickly. Abduction of the right arm to 90 degrees resulted in complete obliteration of the radial pulse. The scalenus anticus and costoclavicular maneuvers did not dampen the radial pulse. It was felt that the patient had a thrombosis of the subclavian vein and the hyperabduction syndrome. On Nov. 6, 1953 a division of the right pectoralis minor tendon was performed. Immediately postoperatively the right arm could be abducted to 180 degrees without dampening of the radial pulse. Examination one year following operation revealed that she had regained full use of the right arm. The heavy sensation and the easy fatigability had completely cleared. The right arm remained approximately 1 inch greater in diameter than the left, a residual of the subclavian vein thrombosis. A recent letter (July 21, 1955) stated that she had had no further trouble with the right arm.

Case 4. J. S., a 47 year old white male, had noted pain in both shoulders which radiated down the inner aspects of the arms to the hands for the preceding six months. The symptoms had increased in intensity and were worse on the right. He noted a definite relationship between the symptoms and the assumption of certain positions, particularly that of hyperabduction which he frequently assumed while sleeping. He was also known to have a moderate hypertension (170/110) for the preceding six months.

Physical examination was essentially negative except for a blood pressure of 168/100. The clavicles were prominent and markedly angulated in the anteroposterior plane in their middle thirds. The radial pulses were present bilaterally as were the other major pulses of the upper extremities. Abduction of the arms resulted in obliteration of the pulses at 135 degrees. Depression of the shoulders downwards and backwards (costoclavicular maneuver) resulted in complete obliteration of both radial pulses. The scalenus anticus maneuver was negative bilaterally. X-ray films of the cervical spine did not reveal a cervical rib on either side. Because of the more marked symptoms on the right side, it was decided to operate upon this side first and delay surgery on the left until a later date.

On Dec. 22, 1953 a right scalenotomy and division of the pectoralis minor tendon was performed. There was no thrombosis of the major artery or vein and the interval between clavicle and first rib appeared adequate. Postoperatively the right arm could be abducted to 180 degrees without dampening of the radial pulse. However, downward and backward depression of the shoulders continued to produce obliteration of the radial pulse. The postoperative course was unremarkable, but at the time of discharge from the hospital his symptoms were unimproved.

A report dated June 6, 1955 stated that the patient's symptoms persisted.4 On Aug. 6, 1954 a right subtotal clavicectomy and excision of the subclavious muscle was performed by Dr. A. W. Hartman of San Antonio, Texas. The symptoms were relieved in the right arm and hand although he continued to complain of pain in the region of the lateral remnant of the right clavicle. On Jan. 28, 1955 a left total clavicectomy, excision of the subclavious muscle and anterior scalenotomy were performed by Dr. Hartman. The right clavicular remnant was also excised. Following these procedures it has been impossible to obliterate the radial pulse. However, he has continued to experience pain in both shoulders.

Case 5. A. S., a 44 year old white female, was first seen on Oct. 1, 1953 complaining of intermittent cyanosis, coldness and easy fatigability of the left hand. The patient stated that in February of 1953, six days following the spontaneous delivery of a full term stillborn infant, she had developed sudden pain, coldness and bluish discoloration of the left hand. The patient was treated with three stellate ganglion blocks at another hospital and the disability improved over a four month period. However, no further improvement had been noted in the following five months and the symptoms now occurred at frequent intervals. Physical examination revealed atrophy and weakness of the musculature of the left hand and slight cyanosis of the skin and nailbeds. Axillary, brachial, radial and ulnar pulsations were absent. The blood pressure taken on the right arm was 122/74 and unobtainable on the left. Oscillometric studies showed a deflection of 0.5 unit at the left wrist at 100 mm. Hg in contrast to a deflection of 2.5 units at the right wrist at an equivalent cuff pressure. The Landis test was interpreted as showing a marked element of vasoconstriction in both upper extremities.

On Nov. 19, 1953 the left axillary vessels were explored through a supra- and infraclavicular incision. The subclavian and axillary arteries were thrombosed from the medial aspect of the scalenus anticus muscle proximally to the mid-axilla distally. In view of the long segment of thrombosed artery (approximately 15 cm.) and the presence of feeble pulsations in the distal axillary artery, it was felt that resection of this thrombosed segment with graft replacement was not advisable. Section of the pectoralis minor tendon and anterior scalenotomy were performed to obviate additional trauma to the artery by these structures and to relieve as far as possible structural interference with the collateral arterial circulation.

The patient has been followed-up for 20 months and has noted progressive improvement in the left
arm and hand. She still notices fatigue in the hand and forearm but only after prolonged use. The hands are equal in temperature and a faint radial pulse is palpable on the left. Oscillometric studies on July 21, 1955 revealed a deflection of 2.0 units in the right wrist and 0.5 units in the left wrist.

**DISCUSSION**

The results of section of the pectoralis minor and anterior scalenotomy in this small series were good in four cases and a failure in one. Of the successful cases (cases 1, 2, 3 and 5), three presented a thrombosis of the subclavian or axillary veins. Although the symptoms may conceivably have resulted from venous thrombosis, the prompt relief and subsequent freedom from the preoperative symptoms indicate that the disability probably resulted from intermittent compression of the subclavian and axillary arteries. These patients (cases 1, 2 and 3) still present a slightly swollen arm, but this has resulted in no incapacitation.

The failure in case 4 was felt to result from selection of the incorrect operative procedure. Whereas the former cases represented the pure hyperabduction state, case 4 was a mixed syndrome exhibiting the costoclavicular as well as the hyperabduction syndrome. The former syndrome, originally described by Falconer and Weddell is characterized by an extremely narrow interval between the clavicle and the first rib. Relief of subclavian vessel and brachial plexus compression in this condition requires the removal of the clavicle or the first rib. It is apparent as a result of the persistent symptoms and the presence of a positive test for the costoclavicular maneuver that the latter syndrome represented the major difficulty in this case, and the follow-up data confirms this view. This case has also resulted in the placement of a long, narrow sandbag in the interscapular region when the patient is placed on the operating table. The sandbag causes the shoulders to fall down and back so that the operator may better evaluate the size of the interval between clavicle and first rib.

The failure in case 4 further illustrates the importance of accurate preoperative diagnosis if the correct operation is to be performed. Shoulder girdle symptoms resulting from a cervical rib, a hypertrophic scalenus anticus muscle or a narrowed interval between clavicle and first rib must be differentiated from the true hyperabduction state. Frequently, a combination of two or more of these syndromes is encountered. Beyer and Wright have reviewed the diagnostic possibilities and their differentiation.

We have not encountered reports of combined pectoralis minor tenotomy and anterior scalenotomy for the hyperabduction syndrome in the literature. Dr. Frederick W. Cooper, Jr., of Atlanta, has informed us that he has sectioned the pectoralis minor tendon in three individuals with the hyperabduction syndrome and that the results have been excellent in each case. He is of the opinion that scalenotomy is not necessary unless a concurrent scalenus anticus syndrome is present.

**SUMMARY AND CONCLUSIONS**

Neurovascular symptoms, secondary to intermittent compression of the subclavian and axillary vessels and the lowermost cord of the brachial plexus, are sometimes seen following repeated or prolonged hyperabduction of the arms. The primary site of neurovascular compression is thought to be the point at which the vessels and nerves emerge from beneath the pectoralis minor tendon. A secondary site of compression is the interval between the clavicle and the first rib. Five patients presenting the hyperabduction syndrome have been subjected to pectoralis minor tenotomy and anterior scalenotomy with gratifying results in four. It is felt that failure in one case may be attributed to the fact that the patient presented a combined hyperabduction-costoclavicular syndrome and a primary clavicleculectomy would have been a more satisfactory procedure. The good results in the patients with the pure hyperabduction syndrome suggest that the procedure may be of value in the operative treatment of this particular shoulder girdle syndrome.

**SUMMARIO IN INTERLINGUA**

Symptomas neurovascular, secundari a compression intermittente del vasos subelavie e axillar e del infime chorda del plexo brachial, occorre a vices post repetite o prolongate
HYPERABDUCTION del bracíos. Nos opina que le sitio primari del compression neurovascular es le puncto in que le vasos e nervos emerge ab infra le tendine del pectoral minor. Un sitio secundari del compression es le intervallo inter le clavicul e le prime costa.

Cinque pacientes exhibiente le syndrome de hyperabduction eseva subjicite a tenotomia del pectoral minor e a scaleniotomia anterior. Le resultatos eseva gratificante in quatro casos. Nos crede que le disfallimento in le ultime caso es attribuibile al facto que le paciente presentava un combinate syndrome hyperabductioso-costo-clavicular de manera que claviculectomia primari haberea esiste un procedimento plus satisfactori. Le bon resultatos in le pacientes con le pur syndrome de hyperabduction supporta le suggestion que

le technica es possiblemente de valor in le tractamento operative de iste specific syndrome del cinctura scapular.

REFERENCES

4 Personal communication from Dr. Albert W. Hartman, San Antonio, Tex.
6 Personal communication from Dr. Frederick W. Cooper, Jr., Atlanta, Ga.
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