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TREATMENT OF OBSTETRIC BRACHIAL PARALYSIS WITH A REPORT OF FIFTY CASES*.

BY SAMUEL W. BOORSTEIN, M. D., F. A. C. S., NEW YORK CITY.

The great interest recently shown in obstetric paralysis is due to the excellent work of Sever^{13, 14}. Before him, considerable work was done by Kenedy, Clarke, Taylor and Prout⁶, Fairbank⁸ and Platt¹², but the profession at large was somewhat indifferent to this malady. Ehrenfest⁷ in his monograph on Birth Injuries puts this state of affairs in proper light by stating: "Exact information concerning this phenomenon (in the newborn) is deplorably defective on account of the evident lack of interest of the obstetrician in the problem, which indifference in turn prevents the orthopaedist from seeing these palsies in the very early stage."

The family physicians in general not only gave a poor prognosis to the unfortunate parents, but did not even take the trouble to submit the patient to a more thorough examination by those qualified to do so. They were uncertain as to the proper treatments and usually, on their own accord, ordered massage and exercises to be given by the parents, and added, perhaps, the ever-abused electrical treatments.

It was Taylor who aroused the interest of the profession to the proper etiology and the prospects of improvement following nerve suture. His advice has not been followed extensively because of the natural reluctance of the public to submit to operations, especially in the case of infants. Fairbank in England and Sever in this country have again aroused the profession. They have emphasized the improvement that we can obtain by orthopaedic treatment, and, as a result of that, these patients are brought at present to the men best qualified to treat such cases, viz., the orthopaedic surgeons. The large number treated by the orthopaedic surgeons at present, as for instance, the eight hundred cases of Sever, proves that these cases are prevalent but were never brought to the surgeon's attention.

The cause of future treatment may be influenced by the controversies occurring in the methods of observation and conclusions deduced. It is, therefore, of paramount importance to report the results, and where the opportunities offer themselves to help clear up the difficulties.

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While the group here reported is small in comparison to the number of cases reported by Taylor¹⁷ and Sever¹³, I feel, however, that I am in a particularly favorable position to compare some of the different methods, for the reason that I had the good fortune to assist Dr. Taylor in doing nerve suture operations on some of the cases. Some of these cases were under my observation for considerable periods before and after the operation.

In the Fifteenth Report of Progress in Orthopaedic Surgery prepared by Dr. Osgood and his coworkers it is stated: "Taylor still believes in operation on the brachial plexus in most cases of obstetric paralysis, since recoveries, as a whole, have been so unsatisfactory. He thinks the best time for this operation is at about three months." Some of Taylor's deductions have been misunderstood, while Taylor himself has changed the time of operation. It may, therefore, interest the members of this Association to get a report of some of the conclusions based on this work. I do not believe I shall lay myself open to criticism as being biased. In my training I am naturally inclined to orthopaedic methods, but medical interest requires that Dr. Taylor's advice be better understood. I am almost sure that in suitable cases these methods will then be followed. Perhaps more suitable cases will then be found to be operated on.

ETIOLOGY.

Here is not the place to discuss the etiology in detail, but in order to understand the work better, I have to remind you that it has been proven beyond any trace of doubt that the correct theory is the "traction theory," i. e., the damage is done by stretching of nerves of the brachial plexus by forcible separation of the head from one shoulder during delivery, or by direct traction on the arm (stretching, of course, may often result in complete tear of the nerve fibers). The work of Taylor^{17,18}, Sever^{13,14}, Fairbank⁹ and Platt¹² has established this theory. In a few of the cases reported in a previous paper and in some additional cases reported below the damage to the nerves was distinctly found.

There is no need to mention the fallacious theory of T. T. Thomas^{21,22} of congenital subluxation, as well as the theory of Weil⁷ that often there is a truly congenital defect of development of the plexus as the result of continued mal attitude of the shoulders during intra-uterine life.

Fairbank⁹ summarizes the conclusions about the theories briefly as follows:

"Although the occasional presence of definite adhesions in the joint in young infants suffering from birth palsy strongly suggests damage to the joint in these particular cases, I believe the traction theory best explains

the condition present in the vast majority of the cases and that the subluxation of the shoulder joint develops gradually and as a direct result of the paralysis. I hold this view for the following reasons:

"1. Tenderness and thickening over the plexus in the neck has been noted soon after birth in some cases.

"2. The almost constant finding of definite injury, sometimes amounting to complete rupture, of one or more nerve bundles of the plexus during operation. Those most likely to be damaged by separation of head and shoulder, viz.; fifth and sixth cervical, are the ones most found to be paralyzed.

"3. Experimental evidence that traction can produce tearing of these nerves, and that damage to the shoulder joint is extremely difficult to produce, fracture of the humerus or separation of its upper epiphysis occurring first. (Clarke, Taylor and Prout, Thomas and Sever, T. T. Thomas and Stone.)

"4. Taylor actually felt the plexus tear during delivery of a child, and the lesion was proved post mortem.

"5. Subluxation of the joint is rarely seen at birth, but its gradual development and fixation can be traced through cases of increasing age, the subluxation at first being reducible and becoming irreducible later."

About the mechanism of the force producing the injury at birth I will quote Ehrenfest⁷:

"1. The plexus is occasionally injured by the forceps and (2) possibly more often traumatized by a finger during improperly executed traction in the delivery of the aftercoming head. (3) Cervical nerve fibers under special mechanical conditions are injured by compression between clavicle and underlying bone structures, both in vertex and breech labors, and (4) probably less often are actually lacerated by excessive traction."

About the absence of congenital dislocation of the shoulder, Taylor¹⁸ proved in his recent article on "So Called Congenital Dislocation of the Shoulder, Posterior Subluxation" that (1) there is no case on record where in a birth palsy case a posterior subluxation of the shoulder has been found at birth.

(2) No dislocation present up to six weeks of age. The dislocation at that time is sequel to the paralysis.

(3) The posterior dislocation is a sequel to the unbalanced paralysis of the shoulder muscles, and may be prevented in most cases by proper treatment. (Orthopaedic.)

(4) The external rotators (posterior muscles) suffer the most complete paralysis, and are continuously overstretched by the internal rotators, which

are usually not completely paralyzed and eventually develop organic contracture, with the result that the head of the humerus is gradually displaced backward.

SYMPTOMS.

The symptoms of this disease are well known and we will only recall to your mind the deformities present.

In the upper arm type: The arm hangs vertically in full internal rotation and adducted, and with the forearm pronated and the palm looking outwards and the fingers usually clenched, the so-called "policeman's tip position." The muscles chiefly affected: Supraspinatus and infraspinatus, deltoid, biceps, coracobrachialis, brachialis anticus, supinator longus and brevis and teres minor, i.e., the abductors and external rotators of the shoulder, flexors of elbow, and supinators of the forearm, and sometimes the radial extensors of the wrist. The serratus magnus is not uncommonly affected to a considerable extent. The injury to the plexus is located at about the junction of the fifth and sixth cervical nerve roots, just about the points of origin of the suprascapular nerve (Erb's point).

In the whole arm type (called by some lower arm type) all these conditions are found, besides the additional ones due to the paralytic conditions of the lower arm and hand, resulting generally in a useless dangle arm. There is usually wrist drop, paralysis of the flexors and extensors of the wrist and fingers, associated with paralysis and atrophy of the intrinsic muscles of the hand.

The injuries are mainly to the whole of the plexus, or at least the seventh and eighth cervical and the first dorsal roots.

There are rare cases involving the lower roots only, without the upper, (Klumpke's paralysis).

TREATMENT.

Prevention.—As most of the cases are due to delivery, Ehrenfest gives a proper warning to the obstetricians, advising special care in the application of forceps, and emphasizes the methods of managing the shoulders as follows: "In Mauriceau-Smellie maneuver, the tips of index and middle fingers should be forked above the shoulders, not on the sides of the neck, but on the sternum of the infant." He advises that obstetricians with short fingers should keep the ends of these two fingers in extension and not flexed, as would be their more natural attitude in the attempt to pull on the shoulders. If severe traction is necessary, it should be made along the long axis of the child and never against or on the head in lateral flexion.

EARLY TREATMENT.

If the child is brought early to the orthopaedic surgeon, one of three methods is usually followed: (1) Retention in braces or a plaster cast followed by careful exercises. (2) Careful exercises (muscle training) alone without some retention apparatus. (3) Operative, viz., end to end suture of the injured nerves.

(1) Retention in plaster cast or braces.—In order to prevent contraction of unparalyzed muscles, it seems best to put the arm at rest in such a position that the stronger muscles can not contract. The arm is, therefore, put up in right angle abduction and full external rotation of the shoulder, the elbow is flexed at a right angle, forearm in full supination and, if necessary, dorsiflexion of the wrist. I am accustomed to leave the first plaster undisturbed for two or three weeks. Then the arm is taken down twice daily for massage and exercises. The plaster is made for a removable one and re-applied after the exercises. If the arm is kept in the support between massage and gymnastic treatments, one obtains a better subsequent position of the arm. It also takes the drag off the paralyzed shoulder muscles, particularly the deltoid, allowing them to regain their strength more quickly, and prevents subsequent shoulder deformity, such as posterior dislocation and acromion hooking and overgrowth. As the child improves, the plaster is left off gradually. Fairbank and Platt are consistent in using immobilization and retention. Platt even says, "I have little doubt that if this were adopted in every case there would be few cases which show no recovery of the paralytic phenomena, and no case would develop the internal rotation, contracture and posterior subluxation of the shoulder joint."

Sever^{13,14} in his early articles strongly urged this method but in a paper recently delivered before the orthopaedic section of the New York Academy of Medicine, he said that he does not put up the affected limb in plaster or braces but depends entirely on proper exercises. The reason given by him is that the child forgets the use of the hand.

My experience has been the same as Fairbank's⁹; that the use of the support is of distinctly more advantage than if left off. Several cases of my series have convinced me of the advisability of proper and early support. I remember a number of patients who had no deformity when in the support but whose parents took off the support too early and, while apparently carrying out the exercises regularly, the deformity returned, or rather has not entirely been avoided. Of course, one has to watch for stiffness following the long immobilization, (See Case 29) but watching against deformity is the supreme duty of the orthopaedic surgeon and he can easily guard against adhesions. However, my experience is not as extensive as that of Dr. Sever.

About exercises: Those advocated by J. J. Thomas¹⁹ of Boston seem to answer the purpose well. Lately at the Children's Hospital of Boston, Dr. Sever added the novelty of rhymes to the exercises, thus making it perhaps interesting for the infants. It is a form of occupational therapy that is worth while using. (We may have to give music lessons to our masseuses to have them administer the exercises.)

I also made use of some of the exercises advocated by Steindler¹⁵ in his article "Muscle Educational Treatment and Results in Orthopaedic Work on Upper Extremity."

One must emphasize the fact that exercises or muscle training should be kept up for a very long time, perhaps till the child is ten years of age.

EARLY NERVE OPERATION.

Taylor's Method of Nerve Suture.—Taylor, following his careful observation with Clarke and Prout, advised early repair of nerve injury. He published many articles and showed his results. Some surgeons still doubt whether it is advisable to operate. They maintain that the result is not better than without the operation. Sever emphatically denies the advisability of that operation.

Fairbank⁹, on the contrary, says:

"At what age should exploration upon the plexus be undertaken? If a case has been treated from the first, and after three months there is no sign of recovery by physical examination and electrical tests under an anaesthetic, I think operation is advisable. Many surgeons consider three months too early. The age favored by writers on this subject varies from two to twelve months. I am convinced that, in most, recovery is well advanced by the age of three months, and I think that rarely are the recognizable signs of recovery delayed beyond this period."

Taylor¹⁷ in his latest article states: "The small minority of cases that do recover spontaneously are almost completely well at the end of three months. In cases which are obviously mild at the start one may expect a spontaneous recovery which will be nearly complete by the end of three months. Therefore operation is not indicated. In the more serious group in which almost the entire musculature of the extremity is primarily paralyzed and the lower roots show no tendency to spontaneous recovery in the first few days, it is practically certain that a permanent lesion has occurred, at least in the upper one or two roots, and early operation is indicated. Naturally, in the still severer types of injury, early operation is indicated without question. In the border line cases, operation is more debatable and

one must choose between early exploration and delay for three months to see what degree of spontaneous recovery will ensue. . . . In all cases, whether operation is to be considered or not, the extremity should receive systematic attention. It is of primary importance to retain the extremity in a position which relaxes the paralyzed groups of muscles. . . . This position may be retained by use of a brace such as is used by orthopaedic surgeons in deltoid paralysis. . . . ”

In a personal communication, Taylor gave me a short résumé of his views about the advisability of operating on these cases. I am quoting him exactly.

“Inasmuch as deformities can be prevented by proper postural treatment, and inasmuch as nerves will regenerate even though many months have passed since injury, one may wait safely for a considerable period of time, provided correct treatment is followed during that interval. If sufficient recovery has occurred during the first three months to justify the hope of almost complete spontaneous recovery, then it is legitimate to follow the case along with physical therapy. If, on the other hand, improvement at three months has been unsatisfactory, then, other things being equal, it is wise to do an exploration of the plexus. If there is damage which would not have recovered spontaneously, then the lesion can be repaired at once. If, by chance, the plexus is found not so involved as to demand surgical repair, the wound, which is practically only a skin incision, can be closed and the child's risk has been practically nothing. The advantage of this method is that without material risk one knows early in the case just what he is dealing with and if surgical repair is necessary it is done at the time which gives the greatest promise of favorable results.”

The disadvantages of operation in very early infancy lie in the very small field and small nerves which make the technical part of the suture more difficult. On the other hand, the dissection is easier because the cicatricial tissue has not become so dense.

Are the results of operation better than these treated by orthopaedic methods alone? Cases 3, 23, 25 of my group, as well as other cases, prove that the operation is of distinct value if performed properly. One must, however, remember that the after treatments are of great importance. The operation is often discredited because the very severe cases showed no improvement at all.

When one watches the child from the start so that the deformities are prevented, the results following the operation are, of course, better. It is thus of paramount importance to guard against deformities, and, if present, to correct them by operative means before doing a nerve suture.

Method of Taylor's operation: "Oblique incision at the base of the neck from the posterior edge of insertion of sterno-cleido mastoid through skin, platysma and the underlying fat pad. When these are retracted the damaged nerves and adherent cicatrix are exposed. The various nerves are then dissected out and such repair work done as is found necessary."

LATE TREATMENT.

Correction of Deformities.—The most prominent deformity is at the shoulder, giving it adduction and internal rotation. If child is seen when the deformity is also present, it could be operated on by Sever's method of tenotomy of the contracted muscles.

When there is a hooking of the coracoid process, this could be corrected by a subperiosteal osteotomy. The acromion process often needs an osteotomy.

There is one deformity which is very persistent and that is the pronation of the forearm. For some reason the full supination is not attained. I have tried in many ways to prevent that but have not succeeded in all cases. In some I was fortunate enough to regain full power. This deformity can be corrected later on by an open tenotomy of the pronator radii teres.



Fig. 1.—Case 1.—Herbert A., Dec. 27, 1922—Showing extent of abduction of right arm. The elbow was kept in flexed position thus giving the impression that the arm is shorter. Note that there is no contraction of pectoralis major.



Fig. 2.—Case 1.—Herbert A., Dec. 27, 1922—Showing good power to rotate outward. This photograph shows that there is no shortening of the arm. Note the good muscular development and the excellent position of the wrist.



Fig. 3.—Case 1.—Herbert A., Dec. 27, 1922—Showing the extent of supination possible in the right hand.

Tubby suggests transforming the pronator radii teres into a supinator as follows: The pronator radii teres and flexor carpi radialis are defined and the tendon of the latter severed one and one half inches above the wrist. The pronator radii teres is put at full stretch and is joined to the proximal end of the flexor carpi radialis as low down as possible. The conjoined tendon is then pulled through the interosseous membrane, carried round the back of the radius and inserted on the outer side. A modification lately made by Tubby consists in a section at the same time of the interosseous membrane through its entire length. Sir Robert Jones is content to insert the pronator radii teres into the tendons of the extensor carpi radialis longus and brevis in order to destroy the power of pronation and strengthen dorsiflexion and correct ulnar deflection. One may transplant the muscle into the dorsal aspect of the radius.

If there is some rotation of the radius or ulna, an osteotomy has to be done. Among the other operations used, one has to consider the stretching of the



Fig. 4.—Case 23.—Donald McC., Aug. 15, 1920—Before Treatment:—showing the typical position of adduction and inward rotation of the right arm. (Front View.)

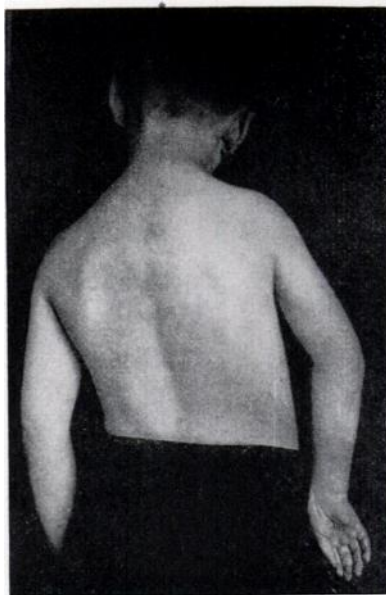


Fig. 5.—Case 23.—Donald McC., Aug. 15, 1920—Before Treatment:—showing the typical "Policeman's tip position." (Back View.)

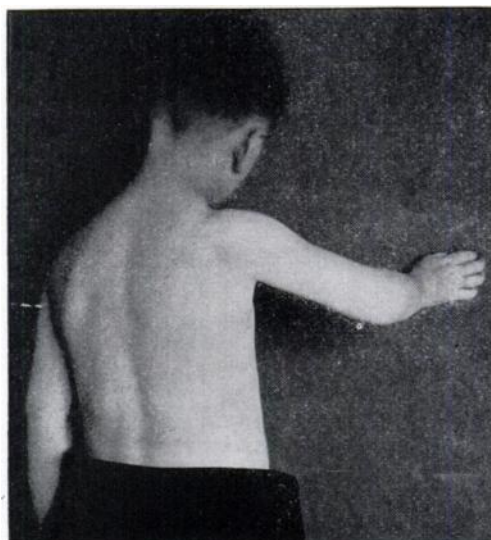


Fig. 6.—Case 23.—Donald McC., Aug. 15, 1920—Before Treatment:—showing power of abduction when the hand is supported on the wall.



Fig. 7.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatment:—showing power of abduction.

shoulder or elbow joint under deep anaesthesia and immobilization, but it is doubtful whether one obtains the desired results.

Report of a few cases to demonstrate certain features in the treatment.

Case No. 23.—Donald McC., male, age 8 years when first seen. History.—Child is the sixth in the family, instrumental delivery. Immediately after birth complete paralysis of right arm and forearm was noticed, with evidences of local trauma. Practically nothing was done for the child till seen by me on Aug. 12, 1920.

Physical Examination showed a well nourished and robust child. Right upper extremity held adducted and internally rotated with the elbow flexed to an angle of 160 degrees. Shoulder could not be abducted more than an angle of 5 degrees when he had to use the scapula. When patient lay on back, could abduct shoulder to an angle of 75 degrees. Outward rotation—markedly limited. Elbow flexed at an angle of 140 degrees. Can be flexed to an angle of 90 degrees. Forearm—pronated and could not be supinated. Wrist motion—fair. Finger motion—almost nil. Motor power of hand—right, 5 lbs.; left, 22 lbs. Slight atrophy of arm and forearm muscles. There was some asymmetry of the face. (Fig. 4, 5, 6.)

One can thus see that the nerves involved were probably CV, CVI, CVII, CVIII and DI.

Treatment.—Brace applied and massage and careful exercises begun. The boy is very intelligent and coöperated in every way. This course was followed for three months with very little improvement.

Patient was admitted to the First Surgical Division of Fordham Hospital and operated on by Dr. A. S. Taylor and myself on October 29, 1920. At the operation Sever's tenotomy was done, cutting only the pectoralis major. The shoulder was then released. There was hooking of the coracoid process and this was removed subperiosteally. The plexus was then exposed and the following condition found: fifth cervical and sixth cervical were torn off at the lower end of their junction, seventh cervical was torn off almost completely just where it inserted into the plexus, eighth cervical and first dorsal were not damaged but surrounded by heavy scar tissue.

Operation.—The distal ends of the nerves (fifth, sixth, and seventh cervical) dissected and end to end sutured with chromic cat gut. The scar



Fig. 8.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatments:—showing power of abduction when the elbow is flexed. Note ability to rotate arm outward.



Fig. 9.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatment:—showing power of supination of forearm.

tissue surrounding the eighth cervical and first dorsal removed and dissected freely the nerves.

After Treatments.—The hand was put back on the brace but the abduction was increased. Wound healed by first intention.

Nov. 20, 1920.—Began massage and exercises.

June, 1921.—Examination showed marked improvement. Brace discontinued.

Present Status (January 15, 1923).—(Which is the same as one year ago.) Patient can raise the shoulder to an angle of 110 degrees even when standing. If he desires to abduct the shoulder farther, he has to flex the elbow (showing therefore that there is contraction of biceps). Rotation outward—good. Extension of elbow—permitted to an angle of 120 degrees. Supination—limited. Wrist is slightly hyperextended. Finger motion—very much improved. (Fig. 7, 8, 9, 10).

Comment.—This patient illustrates that there was at birth distinct tear of 5th, 6th and 7th cervical and probably a tear of sheath of 8th cervical and 1st dorsal. He received orthopaedic treatment for a while but had not

improved enough. Since the nerve operation, the improvement has been marked. Would it not be better to operate at an earlier age than eight years?

One cannot attribute the entire improvement to the tenotomy, as the muscles supplied by the 7th and 8th cervical and 1st dorsal have shown marked improvement. The improvement in the deltoid is also marked.

January 19, 1923.—Patient was operated on by Dr. Taylor and myself at Fordham Hospital. An open tenotomy of the pronator radii teres was done. Forearm put in supination.

Case No. 25.—John S., male, age 6, when he came under my observation on November 11, 1920. No instrumental delivery. Complete paralysis of both upper extremities (whole). When the child was eighteen months old, a plexus operation on the right side was performed by a neurological surgeon. On June 4, 1921 a second operation was performed on the same side by the same surgeon. No after treatment was carried out. The result was nil. That discouraged the mother somewhat and she refused to have another

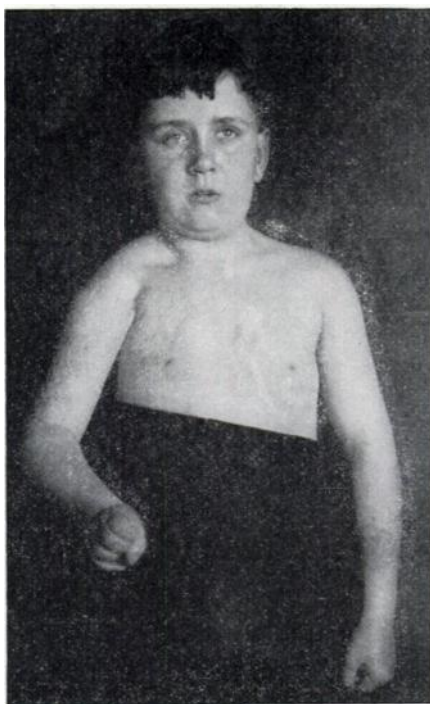


Fig. 10.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatment:—showing power in closing the fingers.



Fig. 11.—Case 25.—John S., Nov. 23, 1920—Before Treatment:—Note the position of both hands and the deformities.

operation on the left side, but used massage and exercises, with no improvement.

Patient examined by Dr. R. Sayre and myself on Nov. 11, 1920. Physical examination showed: Right hand—marked wrist drop, very little power to flex the fingers. Forearm kept pronated and could not be supinated. Elbow—extended, could not be flexed (due to a fracture of humerus). The head of the humerus was found anteriorly and an interval of $\frac{1}{4}$ inch present between head of humerus and acromion process. No power in the deltoid, internal or external rotators. Slight power in the pectoralis major (as tested when child bends forward permitting the arms to drop). Marked wasting of the muscles of arm and forearm.

Left hand—wrist hyperextended. Very little power in the flexors of the fingers. Some power in the extensors of the fingers. Elbow in position of flexion at right angle and could not be extended. Could flex the elbow so that the forearm touched the arm throughout its entire extent. Forearm—pronated and could not be supinated. Shoulder—Head of humerus dislocated backward. No interval between head of humerus and coracoid process. Shoulder rotated inward. Patient could raise shoulder slightly (to an angle of 20 degrees) could not rotate it outward. Some power in the pectoralis



Fig. 12.—Case 25.—John S., Nov. 18, 1922—After Operation and Treatment:—Note ability to raise the left shoulder. The right hand was resting on a support.



Fig. 13.—Case 25.—John S., Nov. 18, 1922—After Operation and Treatment:—showing power of abduction in right arm and power of flexion in left elbow. Note hyperextension of wrist.

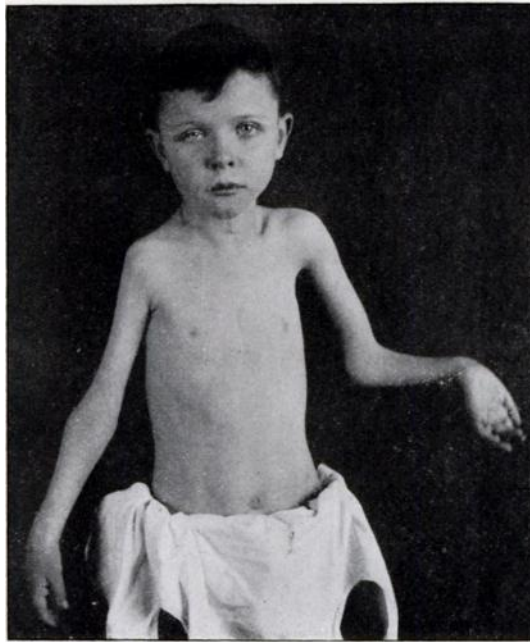


Fig. 14.—Case 25.—John S., Nov. 18, 1922—After Operation and Treatment:—showing power of extension of left elbow. The deformity in the arm is due to a fracture of humerus.

major (Fig. 11).

Treatment.—A double deltoid brace in the usual position applied and massage and regular muscle training ordered.

This treatment was faithfully continued till January, 1922, when it was decided to operate. The physical examination showed some improvement in both shoulders, particularly the left, but the improvement was not enough to permit him to use them to an appreciable extent. We believed that he had all the chances with the conservative treatment and therefore decided to operate.

He was operated on at the First Surgical Division of Fordham Hospital by Dr. A. S. Taylor and myself on Jan. 20, 1922.

At the operation the following was found: fifth cervical root torn apart with the two ends connected by scar tissue, 6th, 7th, and 8th cervical seemed to be in good condition. The 1st dorsal absent. A larger incision was made to find the peripheral end of the 1st dorsal but could not be found.

Treatment.—The damaged portion of the 5th cervical was resected about one cm. and an end-to-end suture of chromic catgut passed through the good bundles and tied. Braces reapplied. After treatment carefully carried out.

He improved considerably. In June, 1922, he sustained a fracture of middle of left humerus which healed in time, though somewhat delayed.

Present examination, January, 1923, shows: *Left shoulder* when sitting—can raise to normal extent even without the brace; rotation outward better. Elbow flexed to an angle of 90 degrees and can be extended to an angle of 115 degrees; can be flexed to an angle of 45 degrees. Good power in the biceps. Forearm is supinated. Wrist is hyperextended. When the wrist is supported and kept in straight position can use the fingers fairly well even to feed himself. *Right shoulder*—Slight improvement but not as much as the left; can abduct the arm only to an angle of 10 degrees. Rotation—nil. Elbow is in position of extension. No power in the biceps. There is wrist drop. Forearm is pronated and marked deformity of radius present. (Fig. 12, 13 and 14.)

Operation on January 19, 1923 by Dr. Taylor and myself in Fordham Hospital. The right plexus was exposed and it was found that all fibers of the 5th, 6th, 7th and 8th cervical were of normal size and showed no evidence of tear. It is therefore evident that there was an avulsion of the nerves from the cord. An osteotomy was also done on the right radius, and forearm put in supination.

Comment.—This patient had a distinct injury to the nerves. The result of the first operation was not satisfactory, either through improper operation or through neglect of after treatment. He received conservative treatment for more than one year with very slight improvement. Following the plexus operation on the left side, however, with the same treatment, the improvement was marked. This was also a very bad case of whole arm paralysis in a child seven years of age. How much better would it have been to operate early, though some claim that there is no use in operating on severe cases.

Case No. 20.—Charles D., male, age 7. Came under my observation on May 8, 1920. Paralysis of right side (upper type) with marked contraction of the pectoralis major and teres major; can not abduct voluntarily the shoulder more than an angle of 25 degrees.

He was operated on May 19, 1920, on the First Surgical Division of Fordham Hospital by Dr. Taylor and myself. Sever's operation was done (tenotomy of the pectoralis major and subscapularis). The plexus was then exposed, and only two small neuromata over 5th and 6th cervical roots found; freed the fascia but no nerve suture performed. There was, therefore, distinct evidence of nerve injury.

Result.—Child has perfect use of the entire upper extremity. (Fig. 15 and 16.)



Fig. 15.—Case 20.—Charles D., Dec. 16, 1922—After Operation and Treatment:—showing good power of rotation outward and supination.



Fig. 16.—Case 20.—Charles D., Dec. 16, 1922—Showing good power of abduction after the operation and treatment.

Comment.—This case demonstrates the nerve injury but proves that the lack of motion was due to contraction of the pectoralis major and subscapularis. Had the child been treated properly from the beginning with orthopaedic measures, he would have made a perfect recovery, as the nerve regeneration was good.

Case No. 3.—William B., (This case was reported in my previous article from which I quote); male, came under my observation when six months old with right side whole arm paralysis. Treated by me for a short time by a brace, massage and exercises. Very little improvement resulted. Operated on by Dr. Taylor and myself at Fordham Hospital. Sever's operation performed, cutting the pectoralis major, teres major, and subscapularis. The brachial plexus was then exposed and the fifth and sixth roots were found seriously damaged, forming two masses connected by a narrow isthmus of connective tissue. The scar tissue was excised for a distance of 3 cm. until good nerve bundles were found. An end-to-end anastomosis was then done. Brace reapplied and after-treatment carefully carried out. The child made a perfect recovery with the exception of supination of forearm. He can not supinate it freely.

Comment.—This case demonstrates that the plexus was injured extensively and would not have recovered by conservative treatment. Shows also the excellent result that one obtains from combination of Sever's and Taylor's operation at one sitting.

Case No. 1.—(Reported before, but case has been kept under observation since that time). Herbert A., (Referred by Dr. Ballin) male, age 3 weeks when brought to me in 1918 with right sided whole arm paralysis. Treated with a plaster cast. Made a complete recovery in one and one half years, with the exception of supination. Though he cannot supinate the forearm completely, he can use the hand to eat and write. (Fig. 1, 2, and 3.)

Comment.—This patient demonstrates that with proper orthopaedic treatment, viz., support and muscle training, one can obtain perfect result, with the exception of supination. I have had several cases in which in spite of excellent orthopaedic treatment, the full supination could never be obtained. This is probably due to inability to hold the forearm in good position. I have tried different devices in the plaster and the brace but so far have not perfected a method to prevent the deformity.

Case No. 32.—Sydney S., male, brought to me at the age of three weeks with upper arm paralysis. There was marked tenderness at the shoulder. A plaster cast was applied, which was changed after three months to a brace. Patient made a good recovery, but there were adhesions at the shoulder joint, thus giving him a prominent scapula. The adhesions had slowly to be broken up and then the full use was obtained.

Comment.—This case demonstrates that adhesions may occur in cases due to injury of the capsule. This can easily be foretold by the marked tenderness directly at the joint. The adhesions must be guarded against. I have had a few cases similar to this.

Case No. 27.—Alvin A., (Referred by Dr. Rubinstein) male, whole arm paralysis. Distinct history of impacted shoulder. Was seen by me at the age of four weeks. Put in a plaster cast for two and a half weeks; then instituted the usual treatment. After treating the child for two months found that the child kept the arm continuously in an abducted position (about 90 degrees with torso), due to adhesions formed. It took about four months before the shoulder was loose. Child made a perfect recovery.

Comment.—The adhesions in this case were evidently due to the injury of the capsule at birth and to the fact that I kept it in the abducted position for a long time to prevent stretching of the muscles. This case is reported as a warning to guard against adhesions where there is evidence of injury to the capsule. It also shows the inadvisability of keeping such cases in the abducted position without bringing the arm to adduction more frequently after the first two weeks.

Case No. 29.—Martin F., (Referred by Dr. Lenetzka) male, brought to me at the age of two and a half months with the typical deformities. Child received up to that time electricity and massage.

Arm was put in plaster cast, which was kept on for three weeks, then changed for a brace. Massage and exercises instituted. After receiving treatment for three months, the deformities were corrected and patient had fair use of the limb. The parents then discontinued the brace of their own accord but continued the exercises used by me. The mother was an intelligent woman and carried out the exercises regularly. I have not seen the child for a full year. When seen by me again, I found exactly the same deformities as at the first examination, though the child had fair use of the muscles.

Comment.—This case brings out the fact that the plaster or brace will correct the deformity in early stages; but deformity will return if the support is not continued long enough. If no brace has been used from the beginning, it stands to reason that the deformities will develop in spite of proper exercises. I have had a few similar cases where I had prevented the deformities when I had a chance to see these children early, but if the plaster or brace was discontinued too soon, either through my own order or through the parents' neglect, some deformity, though not so severe as in the usual run of cases, resulted.

Case No. 17.—Robert C., (Referred by Dr. Clurman) male, age 7 weeks when he came under my observation. Whole arm paralysis of the right upper extremity. Deformities—evidence of hematoma and adhesions of the right sternocleido mastoid, shoulder abducted and internally rotated. There was distinct laxity of the shoulder joint. Dislocation of head backward. Elbow joint extended. Forearm pronated. Some power in the fingers.

A plaster cast applied and left on for three weeks, then treatment instituted. Child made a good recovery in one year. The only deficiency left is inability to supinate freely.

Comment.—This was a case where I suspected that a nerve operation would be necessary. However, with the proper treatment the result was very good.

CONCLUSIONS.

1. Obstetric brachial paralysis should be treated by the orthopaedic surgeon as early as possible.
2. If treated early and properly, one may expect in the mild cases a good recovery in three or four months.
3. The more severe cases will require about six or seven months for a complete recovery.
4. Nerve operations are indicated if no improvement results in four months.
5. If sufficient improvement is noticed in four months, one may wait for four months more.
6. The shoulder should be put immediately in a splint or brace to prevent stretching of the paralyzed muscles and contraction of the unopposed muscles.
7. The support must be kept up for a very long time, for about eight to nine months, as deformities may occur.
8. Adhesions may occur due to slight injuries of the capsule, but these can be prevented.
9. The only deformity that it is hard to prevent is the pronation of the forearm.
10. The posterior dislocation is a sequel to the unbalanced paralysis of the shoulder muscles and may be prevented in most cases by proper orthopaedic methods.

11. The obstetricians can prevent the condition in many cases by proper management of the shoulder.

12. Taylor's procedure seems to be the most suitable for the nerve operations.

13. After-treatment must be carefully carried out after Taylor's operation.

14. Sever's operation is the best for correction of the shoulder deformities.

15. Hooking of the coracoid process should be corrected by a subperiosteal resection.

16. Pronation should be corrected by a tenotomy of the pronator radii teres. One may also transplant that muscle to use it as a supinator.

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TABLE NO. 1

Analysis of the fifty patients (53 cases)

Boys	29
Girls	21
Right arm affected	32
Left arm affected	15
Both arms	3
Upper arm type	23
Lower arm type	24
Both upper arm type	1
Both lower arm type	2
<hr/>	
Total	50
History of normal delivery	12
History of difficult labor	15
History of forceps	18
Unknown	5
<hr/>	
Total	50
Head Presentation	43
Breech Presentation	7
<hr/>	
Total	50

TABLE NO. 2

Results of Treatments

No. patients who had no treatment before coming to me	23
No. patients who received improper treatment	6
No. patients who received incomplete orthopaedic treatment	9
No. patients who received proper orthopaedic treatment	12

TABLE NO. 3

Results in Relation to Deformities

	mark. def.	mod. def.	slight	none
1. No treatment before coming	8	2	5	
2. Improper treatment	3	0	2	
3. Incomplete orthopaedic treatment	2	3	4	
4. Proper orthopaedic treatment		1	4	

TABLE NO. 4

Results of Cases Treated by Writer*	
Of the fifty cases only 21 submitted to real treatment	
Perfect Result (95 plus)	9
Good Result (80 ")	9
Fair Result (60-70)	1
Poor	none
Unknown	2

* Results of proper orthopaedic treatment are based on a percentage basis giving Function 75%, contour and shape—25%.

TABLE NO. 5

Treatments used:

1. Plaster, 13.
2. Braces, 3.
3. Operation—
 - (a) Taylor's (performed by some other surgeon with complete failure)
 - (b) Taylor's operation performed by Taylor
 - (c) Sever's alone
 - (d) Sever's and Taylor's
 - (e) Stretching
 - (f) Tenotomy of pronator radii teres

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