myself with other things, for a few minutes. If the necessary manipulations in applying the instrument cause a rise in pulse beat, it is useless to proceed with the examination until the pulse rate falls to its normal level under the conditions.

When everything is ready, I place the bell of the stethoscope over the brachial artery at its bifurcation into the ulna and radial. Some slight pressure is required to hold the bell in place and to do away with the sound of friction between the skin and the instrument. The bag is then gradually inflated until the compression is just sufficient to overcome the resistance of the arterial wall. At this point the wall begins to give under the compression, and the linear contour of the wall is slightly changed. Now a faint thump is heard. The position of the mercurial column is noted and remembered. The reading immediately beneath the point at which the first faint thump is heard is the diastolic pressure. The bag is now rapidly inflated, and I listen meanwhile to the increasing and then decreasing sounds until they finally cease. At this point, the opposite walls of the vessels are in close contact and the flow of blood is interrupted. Now the mercurial column is run up a few millimeters more, and then the air allowed to escape from the compression bag very slowly. At the point, minus a millimeter, where the first faint thump is again heard, coming down, is the systolic pressure. The air is then allowed to escape rapidly until the thumping begins to grow faint again, when the air is released very slowly to the position where the last thump, coming down, is again heard. This again, plus 1 mm., is the diastolic pressure. The systolic minus the diastolic reading is the pressure pulse. Every reading is recorded to compare with the previous readings. By this means, the two pressures are obtained going up the scale and verified coming down the scale. The process is repeated on the other arm. One should be governed by the arm showing the highest readings. Compression should not be made for a longer period than a minute and a half to two minutes, which is long enough for making the readings.

The Social Worker.—A promoter of social well-being ought to be actuated by the principles, and be governed by the motives, of a scientist. He should be thoroughly cognizant of those factors in human life which make or mar it; which build up or destroy cities, states and nations. His field of vision must include the unborn generations, and his sympathy must not be moved by the physical stimuli of the moment alone, but must be broad enough to comprehend the eternal impulses of mankind.—Harry H. Howett, *Ohio Bull. of Charities and Corrections*.

THE OPERATIVE TREATMENT OF BRACHIAL PLEXUS PARALYSIS

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Injuries to the brachial plexus are common, especially at birth; for this reason the term "brachial birth palsy" is frequently used. The prolonged forcible separation of the head from the shoulder by lateral extension during difficult labor is, in my opinion, the most frequent cause of this distressing condition. In my series of fifty-six cases with operation, it has been difficult to ascertain whether the head was pulled upward to assist the after-coming shoulder to emerge over the perineum, or was pushed downward to allow

the shoulder to slide beneath the symphysis, or whether, in breech presentations, the trunk and shoulder were pulled upward or pushed downward to aid in extricating the head. It has also been hard to ascertain accurately whether there was much difficulty in freeing the after-coming arm, and whether or not the obstetrician was compelled to hook his fingers in the axilla or over the clavicle. These data are frequently overlooked in the excitement of a difficult labor, and when the paralysis of one arm is observed later, the definite cause of it can be only conjectured. The frequency of birth palsy of the right arm, with the usual occiput left anterior position of the head, would point to the perineum as being the obstruction to the delivery of the right shoulder and arm; in 70 per cent. of the

fifty-six cases with operation, the paralysis was of the right arm, and in 28 per cent., of the left arm; 78 per cent. followed head presentations, while 22 per cent. were the result of breech presentations.

In adults, the usual cause of brachial paralysis is a fall on the shoulder, forcibly separating it from the head, and in this manner the plexus is suddenly stretched until its nerve roots are damaged and even ruptured. Direct blows over the lateral base of the neck at the upper portion of the supraclavicular space may also injure the brachial plexus. However, the condition occurring in adults is comparatively rare; besides, it is limited usually to the upper arm type of palsy, and is fortunately in many cases of only temporary duration, that is, merely a nerve stretching, so that the paralysis disappears, under appropriate treatment, within three months.

ANATOMIC CONSIDERATIONS

The brachial plexus, besides being comparatively superficial, is neither covered by any important struc-

Fig. 1.—The normal brachial plexus (diagrammatic) with its five nerve roots (V, VI, VII, VIII cervical, and I dorsal) forming the three cords, which subdivide into six main brachial nerves. The suprascapular nerve is a most important branch and its impairment characterizes the deformity.

tures in the neck, nor in close relation to them, and it can therefore be exposed easily and safely.

It is formed primarily by the fifth, sixth, seventh and eighth cervical and first dorsal nerve roots. The fifth and sixth nerve roots unite and form, together with a branch from the seventh root, the outer cord of the plexus—the origin of the outer head of the median nerve and the musculocutaneous nerve; the seventh, with a branch from the fifth and sixth and also one from the eighth nerve roots, forms the posterior cord of the plexus—the origin of the circumflex and musculospiral nerves, while the eighth cervical and the first dorsal roots form the inner cord of the plexus—the origin of the inner head of the median nerve, the ulnar and the internal cutaneous nerves. A very important nerve, and one most constantly involved in lesions of the brachial plexus, is the suprascapular nerve; it arises from the outer side of the fifth root or just below the junction of the fifth and sixth nerve roots, and by a rather tortuous course supplies chiefly the external rotators of the upper arm, allowing the characteristic internal anterior rotation of the arm in the brachial plexus lesions. Several small nerve branches arise from the plexus; the fifth sends a branch to the phrenic nerve (chiefly formed from the fourth cervical nerve root) and one to form the posterior thoracic nerve (the external respiratory nerve of Bell) with a branch from the sixth and seventh root; the rhomboid nerve also arises from the fifth nerve root, while the nerve to the subclavius muscle and the anterior thoracic nerves arises from below the junction of the fifth and sixth roots. The subscapular and thoracodorsal nerves arise from the seventh root, while from the union of the eighth cervical and first dorsal roots arise the lesser internal cutaneous nerve and a branch to the intercostohumeral nerve.

The plexus lies directly beneath the deep cervical fascia and on the scalenus muscles at the outer border of the scalenus anticus muscle; the fifth and sixth nerve roots emerge obliquely between the scalenus anticus and medius muscles, the seventh root about 2 centimeters below and almost horizontally, while the eighth cervical and first dorsal roots appear more posteriorly behind the scalenus anticus muscle, where they unite to form the inner cord of the plexus. The cords of the plexus extend outward and downward; they divide to form their respective nerves in definite relations to the subclavian and axillary vessels, the upper portion being above and behind the third part of the subclavian artery, while the lower portion is on the acromial side of the axillary vessels and enclosed in the axillary sheath.

It is interesting from a morphologic standpoint to note that each primary nerve root divides into a ventral and a posterior portion—the ventral division sending a branch to either the outer or inner cord of the plexus, thus supplying the ventral cutaneous areas and ventral muscular groups of the arm, whereas the posterior divisions form the posterior cord of the plexus, and supply the posterior or dorsal cutaneous areas and posterior muscular groups of the arm. Thus, we have the deltoid, biceps brachialis anticus, and the anterior flexor muscles of the forearm and of the hand, all supplied by the branches from the outer and inner cords of the plexus, whereas the triceps and the posterior extensors of the forearm and fingers are supplied by the posterior cord of the plexus. A more detailed description of the plexus and its nerves cannot be discussed in this paper.

TYPES OF BRACHIAL PLEXUS PARALYSIS

The types of brachial birth palsy depend on the site and extent of the lesion to the nerve roots of the plexus. Total paralysis of the arm, including the hand and fingers, persisting for one year after birth, indicates an extensive injury to the entire plexus and a permanently paralyzed arm; in these cases, either all of the nerve roots are completely severed, or, in many cases, only several of the nerve roots are torn, and the remaining ones are so choked by the resulting fibrous tissue formations that they cannot functionate and are thus clinically the same as severed. Naturally, fibrous tissue formations about and in nerve lesions make the results of peripheral neurologic surgery always problematic, especially following an interval of months

and years after the injury. Some of the nerve roots may be torn directly out of the spinal cord itself, even producing a homolateral increase of the deep reflexes and also a Babinski reflex, as suggested by Dr. Taylor.

There are many variations of incomplete brachial paralysis. The upper arm type is the most common, in which the trouble is due to a lesion of the fifth and sixth cervical nerve roots near their union; the seventh nerve is also frequently involved. As the suprascapular nerve emerges at or just below the junction of the fifth and sixth roots, its impairment is almost characteristic of brachial paralysis, in that the external rotators of the humerus are thus paralyzed and the arm is accordingly rotated inward by the unopposed action of the pectoralis major muscle, so that the forearm and the back of the hand are turned anteriorly in the position of pronation.

The lower arm type of brachial birth paralysis is very infrequent alone, owing to the fact that in head

Fig. 2.—The lesions producing the most common form of brachial paralysis—the upper arm type of birth palsy (Erb's paralysis). The site of the tear is at or just above the emergence of the suprascapular nerve, the function of which is therefore impaired in almost all of the patients. Connective fibrous tissue (the shaded areas) may impair the lower nerves of the plexus in varying degree.

presentations, the greatest tension is exerted on the upper roots of the plexus rather than on the lower ones, and thus a brachial paralysis of the upper arm type results; and in breech presentations other roots than merely the lower ones are injured, owing to the more extensive damage and greater tension on the entire plexus in this position. Therefore, the lower arm type of palsy alone is rare, and it is usually associated with the upper arm type in varying degrees. In it, the hand and some of the forearm muscles are paralyzed by a lesion of the lower nerve roots of the plexus—the eighth cervical and first dorsal, and frequently the seventh cervical roots. As the sympathetic nerve fibers of the deep cervical ganglionic plexus enter the spinal cord through the first dorsal and at times through the eighth cervical roots, there is frequently a resulting ipsilateral enophthalmos and a narrowing of the pupil, owing to the unopposed action of the motor oculi nerve.

Then again, there are the mild types of brachial plexus paralysis resulting usually from an overstretching of the roots with only a small amount of connective tissue formations. Clinically, various degrees of awkwardness, usually of the upper arm type of impairment, may be the only indication of the plexus lesion.

The atrophy of the arm muscles in brachial plexus paralysis is rarely so extreme as that occurring in the severe forms of poliomyelitis involving the entire arm. Even in the upper arm type of brachial palsy, the atrophy of the deltoid and the external rotators seldom reaches that degree of wasting so characteristic of infantile paralysis affecting the same muscle groups; the "flail" shoulder joint only infrequently occurs in the brachial birth palsies. I believe this is due not only to the fact that in poliomyelitis there are usually more than just one spinal cord segment affected primarily, so that the nerve cells of the adjacent anterior horns are also involved and thus a more extensive atrophy of the neighboring muscle groups, but also to the fact that in almost one half of the cases of brachial birth palsy, the nerve roots are found at operation not to be completely severed but merely choked by masses of scar tissue formations which prevent in varying degrees the normal afferent and efferent impulses from passing through this mechanical nerve block; it may be that in these cases, trophic impulses do succeed in passing through the obstruction, and thus the atrophy is not so marked as in similar cases of poliomyelitis. There is usually, however, a definite shortening of the arm. In this series of fifty-six patients on whom operation was performed, it is interesting to note that when the atrophy was not

extreme (in 64 per cent. of these cases), all of the nerve roots had been not entirely severed, but rather blocked by scar tissue formation.

The impairment of sensation varies for the same reason. It is most unusual, even in the more extreme cases of brachial birth palsy to demonstrate anesthesia and even a marked hypesthesia except over the outer upper third of the arm. In the milder cases, especially when the atrophy is not extreme, little if any sensory impairment can be demonstrated. Naturally, in small children, impairment of sensation is always most difficult to elicit with any degree of accuracy; even in adults, however, sensory impairment may not be ascertained, except in the more severe types of plexus paralysis.

Dislocation of the shoulder joint is of fairly frequent occurrence. To be sure, any mechanical force

sufficient to rupture the brachial plexus may cause a dislocation of the head of the humerus at the shoulder joint; then again, a dislocation of the shoulder joint alone may, in itself, simulate an injury to the upper roots of the brachial plexus with resulting apparent paralysis of the arm—of the upper arm type of palsy; but to maintain that the dislocation of the shoulder joint is the cause of the brachial birth palsy is in my opinion decidedly misleading. It must also be remembered that the paralysis and atrophy of the deltoid and external rotators, with a relaxation of the joint capsule due to a lesion of the upper roots of the plexus, permits the unopposed action of the pectoralis muscles to the extent that an anterior dislocation of the head of the humerus frequently results. There is no ques-

tion that dislocation at the shoulder joint does occur alone in children, and frequently following difficult labors; but I do contend that if a careful examination is made, these cases of simple dislocation of the shoulder joint can be differentiated from the cases of brachial paralysis due to a lesion of the brachial plexus, and also when the dislocation is merely associated with brachial paralysis due to a lesion of the plexus; the associated dislocation may occur at the same time the plexus was injured, or it may be the result of the nerve injury.

Careful electrical tests for the reaction of degeneration in the older children, roentgenoscopy at the shoulder joint, and a thorough neurologic examination usually suffice to distinguish a simple dislocation from a simple plexus lesion. In doubtful cases, especially in the associated lesions of shoulder dislocation and plexus paralysis, it is better judgment to expose the plexus through a small skin incision than to allow the condition of nerve injury to persist for months and even

Fig. 3.—The lower arm type of brachial plexus lesion resulting from breech presentations and pulling on the affected arm. The entire plexus is usually involved in these cases, choked by a mass of resulting fibrous tissue, as in the shaded areas.

years; the longer the duration of the nerve lesion, the greater is the difficulty of anastomosing the nerve ends, the larger is the amount of scar tissue formation and the less marked the improvement ultimately. In only seven of this series of fifty-six cases with operation did the associated dislocation at the shoulder joint render the diagnosis of a brachial plexus lesion doubtful, and yet in each of the doubtful cases, an injury to the plexus was confirmed at operation. In only one case, that of a bilateral brachial paralysis of the upper arm type, a history of difficult labor and the paralysis of both arms observed by the midwife, father and the mother immediately after birth, did I not find at the operation a lesion of the plexus; there was a subluxation at both shoulder joints, reaction of degeneration of the deltoid and the external rotators and no sensory impairment elicited. As I could not demonstrate that the upper roots had been evulsed from the spinal cord within the dura, or that the roots had been torn within the vertebral foramina (which may have been the condition, although most unusual bilaterally), I now feel that this condition was one of poliomyelitis; bilateral brachial plexus paralysis is most uncommon.

Naturally, when permission for a skin incision to expose the brachial plexus cannot be obtained in doubtful cases associated with a shoulder dislocation, the impairment of the arm should be treated by all means as one of shoulder dislocation in the hope that the condition will improve; my experience with these cases, however, has not been encouraging from the end-results obtained. Improvement frequently occurs, but if the plexus is injured, not a useful arm. The fact that a dislocation at the shoulder joint in cases of brachial plexus paralysis is more frequently observed in the older children, those over 4 years of age, is of great importance in tending to show that the associated dislocation at the shoulder is merely secondary to the paralysis and atrophy of the shoulder muscles supplied by the upper roots of the injured brachial plexus; in children under 3 months of age, the dislocation of the shoulder is not so frequently observed, except alone as a simple dislocation. Besides, it is most uncommon to observe a brachial plexus paralysis of the lower arm type which is associated with a dislocation at the shoulder joint; naturally, in this type of paralysis there is little or no impairment of the muscles about the shoulder joint, and consequently a later subluxation at the joint does not occur; and yet the mechanics of this type of plexus injury by breech presentation would be more liable to produce a dislocation at the shoulder joint than in the upper type of plexus injury by head presentation.

TREATMENT

It is frequently asserted that the condition of brachial birth paralysis is cured either by immobilizing the affected arm in a sling or bandage and elevating the adjacent shoulder, thus allowing the nerve roots to unite, or by reducing the shoulder dislocation (when present) and treating the arm and shoulder in the same manner as for a simple shoulder dislocation. This statement is perfectly true regarding many mild cases of paralysis of the arm following birth in which either the brachial plexus has been merely overstretched, thus causing a temporary paralysis of the arm, or where the impairment of the arm is due to a simple dislocation at the shoulder joint. Naturally, immobilizing the affected arm and elevating the shoulder

will permit the overstretched nerve roots to recover their function most readily, and even, in some cases, small tears of the nerve fibers themselves may unite, so that this treatment should be a routine procedure. Again, the reduction of a simple shoulder dislocation will cause a disappearance of the apparent paralysis of the upper arm. But to assume, therefore, that the condition of brachial plexus paralysis with rupture and separation of the nerve roots can thus be cured by this treatment in any considerable percentage of the cases is in my opinion not warranted by the end-results. I have yet to see cured by this method of treatment one case of brachial plexus paralysis in which at birth there was total paralysis of the arm, hand and fingers. No doubt improvement will occur in many cases with or even without any treatment at all, but *that* improvement rarely continues beyond 1 year of age, and the end-result is an impaired arm of greater or less severity; a useful arm is seldom obtained.

It is now my practice in cases in which there was complete paralysis of the arm, hand and fingers at birth to advise a skin incision, exposing the brachial plexus at 1 month of age. In each case in which the paralysis of the arm and hand was complete at birth, there was found at operation a rupture of two or more roots of the plexus. I feel that a total paralysis of the arm and hand indicates an extensive injury and tear in the plexus, and although an improvement frequently follows even without the special treatment of immobilization and elevation of the shoulder (which should be used in all cases, operation or no operation), yet the ultimate result will be an impaired arm. Usually, movement of the fingers occurs first, and then of the hand; possibly even the forearm can be flexed and extended with difficulty; but a perfect recovery is, in my opinion, most unusual.

In those cases of total paralysis of the arms, I advise the exposure of the plexus at 1 month of age for several reasons:

1. The child will stand the operation at that age better than at an earlier date, and as well as at any time several months later. Little if any anesthesia need be used at one month of age, and, in most operations on children under 1 year of age, the danger of the anesthetic is the greater risk.

2. The earlier the anastomosis of the nerve roots, the more perfect the union of the nerve fibers and consequently a greater improvement ultimately.

3. The earlier the operation, the less the formation of fibrous tissue, so that the operation of plexus exposure and nerve anastomosis is less difficult technically. The surrounding connective tissue resulting from the rupture of the plexus and the neighboring tissues with the associated hemorrhage of varying degree, and so forming the future scar tissue, can at this early date be dissected away with comparative ease and safety. Less resection of the nerve ends is necessary to remove the fibrous tissue formation and future scar tissue within the nerve sheaths—a very discouraging factor in peripheral nerve anastomoses after long duration and the one most frequent cause of poor results.

4. There is little or no retraction of the nerve ends at the age of 1 month, whereas, months later, the distal nerve roots may be retracted downward even beneath the clavicle, and in one case I was obliged to bisect the clavicle in order to expose the distal nerve end in the axilla and thus attempt its anastomosis with the proximal stump; in the less severe cases, the ends

may be buried in the surrounding tissues, requiring much patience, time and dissection to free them or even find them; this is particularly true of the distal end of the suprascapular nerve, which has normally a very tortuous course.

THE TECHNIC OF THE OPERATION

The exposure of the brachial plexus is a much less difficult procedure technically than is commonly believed. Not only is the plexus situated quite superficially from a surgical standpoint, but also the skin incision may be so placed in the supraclavicular space of the posterior triangle of the neck that the large blood vessels with the vagus and phrenic nerves are all internal to the pathway of approach to the plexus and are usually never seen; the spinal accessory nerve lies far above. Only the external jugular vein, occasionally unimportant superficial nerve filaments of the cervical plexus and the transverse cervical artery and vein are encountered as a rule, and these structures are frequently so placed that they may not require ligation or section. The subclavicular vessels rarely require exposure.

A transverse skin incision is advisable in that it can be placed in one of the natural horizontal folds or creases of the skin just above and parallel to the upper border of the clavicle, so that little if any scar is visible. Besides, the after-treatment of approximating the shoulder to the head by a bandage tends to hold the skin edges together, whereas this position would tend to keep the edges of the vertical skin incision separated, and a wide scar would ultimately result. Then again, a transverse incision permits a better retraction of the muscles and tissues in order to obtain a good exposure of the plexus; skilled retraction in this operation is most important. As in all peripheral neurologic anastomoses, absolute hemostasis is essential to obtain good results; the less oozing of blood, the fewer the adhesions — the bane of all nerve suturing. Warm saline compresses are possibly the most efficient means of controlling the oozing of blood, while careful, blunt dissection and gentle separation of the neighboring tissues tend to avoid the unnecessary loss of blood. It is usual to perform this operation on babies without the loss of more than 1 tablespoonful of blood, and if the blood that does stain the surrounding tissues is thoroughly removed by the application of warm saline solution before the incision is closed, adhesions and fibrous tissue formations will be practically avoided. The operation should not require more than one hour in even the more extensive injuries of the plexus, and in the younger children before the fibrous tissue has become firm and adherent the duration of the operation should be within forty minutes; if only the fifth and sixth nerve roots are involved, then twenty minutes may be sufficient. Naturally, in children of 3 months of age and younger, the less the amount and rapidity of the loss of blood, together with a light anesthetic of short duration, the better will be the assurance of an uncomplicated recovery. Then again, in ward cases, I feel it is very important following operation on these children under 1 year of age that the mother should nurse and take care of the child as under its normal conditions at home — conditions to which it has become accustomed and has adapted itself accordingly. This is particularly true following operations in selected cases of spastic paralysis due to an intracranial hemorrhage at birth, and also in conditions of spina bifida and hydrocephalus.

The mother's milk, the warmth of the mother's breast and a careful avoidance of soiling the operative area, especially in cases of spina bifida in the lumbar region, are of the greatest importance in the obtaining of good results. The usual ward treatment of these babies operated on under 1 year of age is bad. In ward children under 1 year of age, if the mother cannot remain with the baby in the hospital before and after the operation, it is safer, in my opinion, to have the mother bring the child to the hospital on the morning of the operation, and then take it home several hours after the operation; naturally, if the child is not in the best of condition following the operation, then the mother and child would remain together in the hospital. Young babies accustomed to sleeping with their mothers will frequently "catch cold" if separated from them before or after an operation.

An excellent position of the patient for the operation is usually obtained by placing a firm, flat pillow, or small sand bag beneath the shoulder of the impaired arm; the anesthetist turns the head and face toward the other side, while a nurse depresses the shoulder by exerting a steady pull on the affected arm; in this manner, the supraclavicular space is freely exposed. The usual preparation of the operative area is now made, the skin incision outlined and dry sterile towels pinned to the skin so that only the skin incision is visible. The incision is a transverse one, 4 cm. in length, in a crease of the skin, about 2 cm. above and parallel to the upper margin of the clavicle. It lies in the lower part of the posterior triangular space with the external jugular vein usually as its center point. This vessel is either ligated or retracted, and then by blunt dissection and retraction of the deep cervical fat, sternomastoid and omohyoid muscles, the deep cervical fascia is exposed overlying the plexus and the scalenus muscles. The transverse process of the sixth cervical vertebra lies at the level of the junction of the fifth and sixth nerve roots, so that it can always be used as a guide. It is very easy to become "lost," if the retraction is exerted too much anteriorly or posteriorly. The deep cervical fascia is now incised over the plexus until a complete exposure of it is obtained. Normally, the deep cervical fascia is very thin and transparent, so that the underlying plexus, especially the fifth and sixth roots, can be seen glistening through it; but in these cases of injury to the plexus, the deep cervical fascia is thickened, whitish and nontransparent, owing to the fibrous tissue formation following the oozing of the blood at the time of the nerve tear; naturally, the earlier the operation, the more normal is the appearance of the fascia.

The location and course of the suprascapular nerve should now be ascertained; usually it is embedded in a mass of fibrous tissue, fat and connective tissue just external to the junction of the fifth and sixth nerve roots, and unless it is carefully dissected out, there is great risk of cutting it unknowingly so that it may be then very difficult to find the distal end. Besides, if the suprascapular nerve has not been primarily injured, but is merely unable to functionate owing to an injury of the fifth nerve root above the point of emergence of the suprascapular nerve, to cut it accidentally would only lessen the chances of a good result. I feel, therefore, that it is always advisable to locate the suprascapular nerve at the very beginning of the dissection.

In extensive lesions of the plexus, the fibrous tissue formation may be quite large, so that the nerve ends are entirely buried in a mass of scar tissue. In the

hope that the continuity of all of the nerve roots has not been destroyed anatomically, this mass of constricting fibrous tissue should be carefully dissected away, first from the fifth and sixth roots, then from the seventh, and finally from the eighth cervical and first dorsal nerve roots. It is rare for all of the roots to be torn, and if there are still normal nerve fibers in continuity within this mass of scar tissue, it is better judgment to save them, even though it does require more time, than to remove the fibrous tissue *en bloc* in the belief that all the nerve roots were completely severed, and then to find that there were still good nerve fibers within this fibrous mass, and that if they had been free from the constriction of the surrounding scar tissue they would have undoubtedly functionated.

If the nerve roots are found to be completely torn, their respective stumps should be secured, and their fibrous ends resected with a knife by slicing off transversely thin layers until the cross section of the nerve root of both the proximal and distal portions reveals the normal distinct nerve fibers in their bundles within the sheath—not the homogeneous whitish appearance of the scar tissue formation. The older the children, the more extensive is this scar tissue formation within the nerve sheath, and unless this fibrous tissue is removed (even if an inch or more of the nerve end must be resected), a good result cannot be obtained. It would be impossible for the proximal nerve fibers to grow down through the mass of fibrous tissue within the sheath of the nerve, and unless these fibrous ends are completely resected, a marked improvement cannot be expected. I believe the poor results reported in peripheral neurologic surgery are due chiefly to this mechanical obstruction to the anastomosis of the individual nerve fibers. If this obstruction is removed from each end of the torn nerve roots, it is merely a matter of technical approximation of the nerve ends, sheath to sheath, and the maintenance of this position for a period of three months until a firm anastomosis has been obtained. By elevating the shoulder and inclining the head toward the plexus, it is possible to “bridge” gaps in the resected nerve roots of 3 cm. and even greater without the tension on the nerve root becoming unduly high. When the separation of the nerve ends is greater than 3 or 4 cm., it is usually better judgment to unite the ends by one of the methods of “splicing” now used, or even “bridging” the gap by several strands of silk in the hope that the nerve fibers will be thus permitted to grow down to the distal portion of the nerve. A portion of a nerve removed from another part of the body may be used for the purpose, and the anastomosis carefully wrapped in Cargyle membrane, fat, muscle, etc. These, however, are minor considerations, when compared with the desirability of suturing the nerve ends themselves, end to end, and sheath to sheath, as carefully and as accurately as is possible, and the necessity of removing all the fibrous tissue from the ends of the nerve roots, resecting them until normal nerve fibers are visible. Fine black waxed silk is used to suture sheath to sheath, usually three sutures at one-third intervals around the nerve root. After the suture of the roots have all been “placed,” the ends are brought together by approximating the head and shoulder, as described above, and the sutures carefully tied. The tissues are now carefully washed with warm saline solution, and if there is no oozing of blood, two or three catgut sutures are used to unite the subcutaneous tissues, and

three or four fine silk sutures for the skin. No drain is necessary. A small sterile gauze compress is applied and retained in position by several strips of adhesive plaster, and then the usual gauze dressing. The arm is raised over the head, being made to grasp the opposite ear, if possible, and a gauze bandage with adhesive plaster holds it in position. I find this method of approximating the head and shoulder and then firmly securing the arm in position much more comfortable, safer and efficient than the various braces that have been used.

RESULTS

It is only within the past year that I have had the opportunity to operate on children with brachial plexus paralysis at the age of 3 months and younger. Before 1915, the children operated on by me were all over 1 year of age, the majority being between 4 and 6 years of age. Naturally, the older the child, the less the ultimate recovery; and yet I believe that with the improved technic even these older children can be greatly benefited. My oldest patient operated on for a brachial birth palsy was 14 years of age; the condition improved, but a good arm was not obtained. The children operated on at 3 months of age have made excellent recoveries; this is due partly to the fact that in them there was not a complete tear of all of the roots of the plexus, whereas, in the children operated on at 1 month of age, the plexus had been practically torn apart in that the arm, hand or fingers could not be moved at all, and thus the nerve lesion was always a more severe one. About half of these children operated on at 1 month of age, however, have shown a marked improvement; in four it may be possible to obtain a normal arm. As a rule, however, the children operated on at 3 months of age have shown a more constant improvement; and yet, if they had been operated on at 1 month of age, I am confident that a greater ultimate improvement would have occurred. The operation itself is not a dangerous one; there have been no deaths in this series of fifty-six cases. Two children had slight skin infections with no ill effects.

This report is made in order to emphasize the advisability of early diagnosis and anastomosis and repair of the injured brachial plexus, with the knowledge that unless the injured nerve roots of the plexus are so treated a normal arm cannot be obtained, whereas with the operation at an early date, the child has the chance of obtaining a useful arm or at least an improved arm.

20 West Fiftieth Street.

Bottled Waters.—The Bureau of Chemistry of the United States Department of Agriculture has been making an investigation of bottled waters sold in interstate commerce, which are subject to the Food and Drugs Act. After conferring with a large number of sanitarians and bacteriologists regarding a desirable standard for judging the sanitary character of bottled waters, the bureau has determined that the tolerances established by the Public Health Service of the Treasury Department for water served by interstate carriers is properly applicable to bottled waters sold in interstate commerce and imported from foreign countries. These standards are as follows:

1. The total number of bacteria developing on standard agar plates, incubated twenty-four hours at 37 C., shall not exceed 100 per cubic centimeter; provided, that the estimate shall be made from not less than two plates, showing such numbers and distribution of colonies as to indicate that the estimate is reliable and accurate.
2. Not more than one out of five 10 c.c. portions of any sample examined shall show (by the method of the Public Health Service) the presence of organisms of the *Bacillus coli* group.