stitional effects which are frequently very much more marked in joint infections than when other and quite as important tissues are involved.

There can hardly be any question as to the value of the appreciation of the principles of the prevention of deformity to the cases under treatment, and the importance of it as an economical measure for the hospital and for the Government is obvious. Later on, undoubtedly, surgeons will have the opportunity of acquiring a more perfect technic in operations for recovering motion in stiffened joints. Arthroplasty is still in its experimental stage, despite certain brilliant results and much literature on the subject. One essential has been already emphasized; this is that a long time, perhaps a year, should elapse between the subsidence of a septic process in a joint, and the attempt to obtain motion by an arthroplastic operation. The field, however, must evidently be enormously widened by the unfortunate lesions of this war.

It may be of some interest to you to see some of the apparatus which is being employed by the Harvard Unit; little of it is original, and it is of value only in so far as it makes war surgery more easy and aids in preventing and correcting deformity and adding to the comfort of the patients.

I wish especially to thank Miss Cassette, in charge of the supply and apparatus department, for her great help. The apparatus work in the Ambulance is already of such a high grade that I fear we have simply brought coals to Newcastle.

Original Articles.

SOME PARALYTIC CONDITIONS RESULTING FROM SURGICAL AND OBSTETRICAL ACCIDENTS.*

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I have been asked to give you tonight a brief résumé of some of the more common paralyses following surgical and obstetrical accidents. None of these conditions are of common occurrence, fortunately, in any one man's experience in general practice, but are frequently seen in hospital clinics. This is especially true of two such conditions as cerebral spastic paralysis and obstetrical paralysis, which are seen in children in considerable frequency in various nerve departments of hospitals.

The other two conditions which I shall take up are Volkmann's ischemic paralysis and paralysis of the musculospiral nerve following fracture of the shaft of the humerus.

Volkmann's Ischemic Paralysis. In 1869 Volkmann first described the clinical picture of a contracted wrist and hand following a fracture, with atrophy of the forearm, known since as Volkmann's paralysis or contracture. His first case, however, occurred in an acute synovitis of the knee, following the application of a ham splint. The gastrocnemius muscle showed diminished electrical reaction and a moderate amount of contracture, which improved without operation. His first paper was followed by another in 1881 in which he emphasized and elaborated certain points.

Lesser, in 1884, reported seven cases of fracture of the arm involving either the humerus or the two lower arm bones, followed by Volkmann's ischemic paralysis. He also attempted to reproduce the condition experimentally in twenty-three rabbits, but was unsuccessful. Others since have tried to reproduce the condition by animal experimentation of various sorts, directed towards the muscles and arteries, but have failed to get conclusive results.

What are the Causes of Volkmann's Ischemic Paralysis? Volkmann has laid down the statement that the condition follows the use of too tight bandages, usually after fractures, particularly on the arm, and occasionally on the leg, and that the paralyses and contractures are ischemic in origin, due to the cutting off of the arterial blood supply. He states that the paralyses and contractures generally come on together, while paralyses due to nerve pressure come on gradually. There is always great rigidity of the muscles from the first, due to great swelling, so that the part has a woody feeling. The ischemia is not complete, in that the part does not become gangrenous. The condition may also be seen after ligation, rupture and contusion of the blood vessels, as seen in a case reported by Astley of Philadelphia in 1908, due to an embolus or thrombus of the brachial artery.

Murphy states that he believes the condition is due to a blood and serum effusion in the subfascial zone, which causes cyanosis of the whole arm from pressure, followed by inflammation of this blood clot. The pressure, caused by this effusion, results in muscle cell destruction and necrosis, aided by tight bandages and splints. He believes that tight bandages, aided by tight skin and fascia, cause the damage, which is practically all accomplished in the first forty-eight hours. In other words, it is a traumatic myositis, resulting in permanent destruction of muscle tissue and so contractures, with or without nerve involvement in the scar tissue so formed. He does not agree with Volkmann, that injury to the artery plays any part in the destruction of the protoplasm of the muscle cells,
but that pressure from the exudate and venous obstruction are the factors which cause the subsequent train of events.

Most frequently the condition is seen following fractures of the lower portion of the humerus and the bones of the upper forearm in children. The supracondylar region seems to be the region of election, and the majority of cases seen are under fifteen years of age.

The irreparable damage to the muscle is accomplished within the first three days, but the full extent of the contracture does not appear at once. The damage is always done on the flexor surface of the part and is a flexor contracture and never an extensor contracture.

There is almost always some impairment of sensation or paralysis of the small muscles of the hand, due to nerve involvement or injury at the time of the accident.

The pathological muscle changes represent typical hyaline degeneration and disappearance of muscular tissue in varying degrees, according to the severity of the original process.

Symptoms and Onset. Now what is the method of onset and what are the symptoms? After a fracture, usually of the upper extremity, which has been splinted and bandaged, there may be noted incipient swelling of the part, with stiffness and cyanosis of the hand and fingers and forearm. There is almost always marked and intense pain, more than can be properly due to the fracture per se. These conditions are soon followed, if the bandage and splint are not removed, by limitation of motion and then complete loss of motion in the hand and fingers. The swelling may subside of itself, if the splint and bandages are not removed, but greater damage will probably be produced, and pressure sores are likely to result. If, on removal of the bandage and splint, great swelling is present with a very tight skin, free incision into the forearm should be made in order to relieve the tension. Probably in some cases this procedure would be of great help and relief.

Following the Establishment of the Contracture, What Is to be Done? Many methods have been tried to relieve the contracture, but none has been wholly successful. As the arm grows, the muscles and tendons become relatively shorter and so lead to greater contractures. The bones of the forearm have been shortened in a number of cases with and without benefit. Tendon lengthening has been tried and again has proved to be of use in certain cases, but is a long and elaborate operation, and is quite likely to lead to more adhesions. The method which seems to offer the best result is the one which divides the muscle bellies by free incisions and so lengthens the tendons.

The after-treatment is of the greatest importance and consists of the use of a palmar and dorsal splint to prevent and reduce the contractures of the wrist and fingers; electricity, galvanic and faradic, if there be nerve involvement, and massage and manipulation. Treatment should be long continued, but in many cases the benefit to be derived from any or all of these methods not very great, and it is only rarely that very useful hand is obtained. The result however, are much better than if nothing has been attempted.

Musculo-Spiral Paralysis. This condition is not very rare, and usually follows fracture of the middle third of the shaft of the humerus. The musculo-spiral nerve, as it passes around the humerus from behind and to the inner side of the humerus, downward, outward, and forward in the musculo-spiral groove to the outside of the humerus, becomes involved in the callus or impinged on by a spicule of bone. Involvement of the nerve and subsequent paralysis may follow fractures of the upper third and lower third of the shaft of the humerus, but its occurrence under these conditions is very infrequent.

Its occurrence is a serious accident and complication, and usually calls for careful study and possibly surgical interference. It is a condition which may be overlooked at first, and is not usually noticed until the splints are removed and the patient attempts to move his hand, when it is noted that there is paralysis of the extensor group of the arm and hand, resulting in the typical wrist drop. The hand is held protracted and there is no power to supinate.

The paralysis is usually wholly motor, even when the nerve is greatly injured. There may be some slight impairment of sensation, but it is never very great. The reason of this preservation of the sensation, when the nerve is so greatly injured, may be attributed to the fact that the cutaneous branches leave the trunk of the nerve above the fracture and probably carry sensation to the radial half of the hand. Sensory symptoms have no relation to the amount of motor impairment; when loss of sensation is present, it may usually be found in the distribution of the radial nerve in the hand, namely, on the dorsum between the metacarpal bones of the thumb and forefinger.

Period of Onset. If the nerve is torn at the time of fracture, there is, of course, immediate loss of function, and paralysis at once appears. If due to involvement in the callus or pressure from bone spicules, the onset is more gradual and will probably not appear until about the beginning of the third week.

The prognosis is usually good if the condition is recognized early. About 50% of the cases require operation. Others get well without one. In cases where involvement in the callus is the only condition present, the result from operation will generally be perfect. In others, where the paralysis is due to tearing, stretching, or complete section of the nerve with separation of the ends, an early operation offers better results than a long deferred one, but even with nerve suture or nerve lengthening, the results
Several years ago I saw in consultation at the Waltham Hospital, a man who had had his arm broken in two places. The fractures were located at about the junction of the middle and upper third of the humerus and at about the junction of the middle and lower third of the radius and ulna. I saw him about four months after the date of fracture, and after the union had become solid. One month after the fracture, it was noted that he had a wrist drop and paralysis of the extensors of the forearm with no voluntary motion of wrist or fingers. Subsequently, he had typhoid fever, from which he was convalescent when I saw him.

The injury was on October 2, 1908. The paralysis was noticed on November 2, 1908; and on February 28, 1910, I operated on him. X-rays of the humerus showed that there was moderate lateral displacement of the fragments of the humerus, with only a fair amount of callus. The operation showed that the musculo-spiral nerve was stretched tightly over the sharp lower edge of the upper fragment and then became involved in the callus. The nerve trunk was very thin and atrophic, but was continuous. It was freed thoroughly and lifted up, and under it, between it and the bone, was sewed a piece of the triceps muscle to prevent further callus involvement. Following this, the bones of the lower arm were resected as they were overriding. The ends were approximated and held together by kangaroo tendon. He made a good recovery and in three months had a useful arm, but still had some slight paralysis persisting. He was again operated on on May 27, 1910, and a few spicules of bone were removed from the inner aspect of the humerus at the site of the fracture through an incision on the internal aspect of the arm. These spicules pressed on the portion of the nerve as it began to wind about the humerus on its internal aspect. Following this, he made a perfect recovery. In October of 1910, five months later, he was readmitted for a fracture of both bones of the same arm in another location, following a fall. At this time he had completely recovered from his musculo-spiral paralysis.

It is probable that if this case had not been operated on, sooner or later the edge of bone would have completely cut through the nerve and the chances of success then from operative procedure would have been much diminished.

Increasing paralysis demands surgical intervention in these cases, as well as a paralysis which shows no tendency towards improvement. After-treatment is always of the greatest importance and is to be carried out by means of massage, electrical stimulation, baking, and active motion as far as possible.

We will now take up paralysis accompanying obstetrical cases:

OBSTETRICAL PARALYSIS, OR BIRTH PALSY.

Obstetrical paralysis, or birth palsy, is produced by injury to the fibres of the brachial plexus, usually the result of a difficult labor, and caused by forcible separation of the head and shoulder on the affected side. Obstruction to the after-coming head, with a pull exerted on the shoulder, or vice versa, is the accepted method for producing the nerve lesion. T. Turner of Philadelphia states he believes that the paralysis usually results from a laceration of the axillary portion of the joint capsule, following an injury to the shoulder joint itself, occurring at birth. This tear in the capsule produces an inflammatory serous exudate which involves the branches of the brachial plexus adjacent. He believes that there is always in these cases a primary traumatic subluxation of the head of the humerus, accompanied by a laceration of the joint capsule, rather than a primary nerve lesion. He fails to back up his statements with pathological evidence, however; of which there is sufficient on the other side to tend to disprove his theory. It is perfectly true that later, as the child grows older, there is, in many cases, a posterior subluxation of the head of the humerus, accompanied by bony deformity of the clavicle and acromion. Early cases, in mine, and others of larger experience, have never shown this condition. Congenital dislocation of the shoulder is not accompanied by brachial paralysis. Separation or fracture of the humeral epiphysis may be accompanied by paralysis resembling that seen in cases of birth palsy, and I have seen one such lately in an eight weeks' old baby. X-rays will generally show fractures or epiphysial separations or dislocation of the joint, which may be of sufficient severity to cause secondary brachial paralysis.

The condition is usually noticed at once following delivery, and presents the following typical picture. The arm hangs at the side, limp and helpless; the hand is pronated; the elbow extended; and the humerus in extreme inward rotation. There is present a distinct inability to raise or abduct the arm at the shoulder, due to the paralysis of the deltoid and supraspinatus. The arm cannot be rotated out because of the paralysis of the infraspinatus and the teres minor. The internal rotation is marked and constant, due to the unopposed contraction of the subscapularis, latissimus dorsi and the pectoralis major.

This position is due to injury of varying degrees of the fibres of the brachial plexus from stretching or tearing forces, as shown by Clark, Taylor, and Prout, in experimental work and by autopsies on cases. The fibres may be torn, or may be compressed by a surrounding hemorrhage about or within the sheath of the cord, or the stretching may be accompanied by only a serous exudate within the sheath. There are two distinct types of paralysis resulting from this injury, the so-called upper and lower arm types. The upper arm type usually is the more common and is the result of injury to the two upper segments of the brachial plexus, formed by the fifth and sixth cervical segments. When the seventh, eighth and first dorsal segments are likewise involved, the paralysis is more complete, and the so-called lower arm type results.

The upper arm type results in a paralysis of
the deltoid, supra- and infraspinatus, brachialis
anticus, biceps, supinatus longus and brevis.
The lower arm type results in more complete
paralysis, involving practically all the shoulder
and lower arm muscles, as well as those of the
hand.
Sensation is, as a rule, not impaired, due to the
probability of some of the unimpaired
collaterals.

The two muscles which are usually spared are
the subscapularis and the pectoralis major,
the latter causing adduction of the humerus, and the
former holding it in marked inward rotation.
The reason for this is that the subscapular
nerve is usually given off from the posterior cord
of the brachial plexus and receives filaments
therefrom at the fifth, sixth, seventh, and
eighth cervical segments. It is because of this
liberal supply largely from the seventh and
eighth cervical segments, that it continues to
functionate, even if some of its fibres are de-
stroyed which come from the upper segments,
which are the ones most frequently injured.
The pectoralis major is also supplied by a nerve,
known as the external anterior thoracic, which
comes out from the outer cord of the plexus, made
up of the fifth and sixth cervical segments, but
also receives collateral branches from the
seventh and eighth.

The fact that the supra- and infraspinatus are
practically always paralyzed, points toward a
primary injury to the plexus, for the supra-
scapular nerve which supplies them, comes off
from the plexus too far above the shoulder joint
to be involved in any exudate which might be
present about it as a result of a tear in the cap-

The Arm Being Found in the Condition above
Described, What is to be Done? It must be de-
termined whether or not a fracture, dislocation
or epiphysial separation is present. This can
usually be determined by the customary methods
of examination, supplemented by x-ray exami-
nation. Tenderness and swelling about the
joint are of importance, and tenderness on pres-
sure above the clavicle over the course of the
brachial plexus should be determined. Tendern-
ness and swelling in the axilla might also in-
dicate an exudate about the lower portion of the
plexus.

Inequality of the pupils should be noted, if
present. If there is an inequality, it means that
there has been, without question, an injury to
the inner cord of the brachial plexus, high
enough up to cause stimulation of the sympa-
thetic branch of the cervical sympathetic plexus,
which sends off a communicating branch from
the fifth cervical segment of the cord. The
paralysis of the muscles involved should be de-
termined as carefully as possible. As one of the
commandments of orthopedics, I believe that it is
essential to prevent deformity and contracture
in any case. Therefore, it would seem best, in
any case, to elevate, outwardly rotate, and ab-
duct the arm and hold the hand supinated. This
can be done easily, and the position maintained
by means of plaster of Paris, or by a wire splint.
This position should be maintained at all times,
except when the arm is released for massage and
exercises, which should be done daily and for a
long period, say, at least, several years. The
maintenance of this position prevents contrac-
tions of the subscapular, latissimus dorsi and
pectoral muscles, and stretching of the paraly-
zed ones. The principle is no different from that
which we use in the early treatment of cases of
infantile paralysis to prevent deformity. One
good argument or the other side should be con-
sidered, however. Persons with long experience
and good success in the treatment of these cases,
say that it is not wise to fix the arm of a young
baby in such an apparatus as has been described,
for the fact that the child will forget to use it,
and so it will be more difficult to make it use it.
The child will become obsessed with the fact
that the arm cannot be used and progress will
be delayed and the end-result will not be so
good. They believe that such contractures and
malpositions as may occur or persist, are to be
discharged in favor of early and constant use
and training, rather than the possibility of no
contractures and less ability to use the arm freely.

Personally, I have not become convinced of
the logic of this last argument, and still think
that an arm in as good an anatomical condition
as it may be possible to make it, will eventually
be a more useful arm than one which has been
allowed to become fixed in inward rotation
through contraction, together with more or less
posterior subluxation of the shoulder joint, as is
almost always seen in the older cases. Correc-
tions of these two deformities, together with os-
teotomy of the acromion, which frequently
grows down in front of the head of the sublux-
humederus in older cases and prevents its full
replacement, generally results in a much better
and more useful arm. Why not prevent the
necessity for these procedures by taking the
proper precautions at the beginning?

Probably subluxation posteriorly usually oc-
curs, because of the excessive pull of the con-
tracted subscapular and latissimus dorsi muscles,
which pull the upper end of the humeral shaft
backward, helped to a certain extent by the
foible adduction and inward rotation forces
applied by the contracted pectoralis major.

Patience and perseverance are needed in the
treatment of these cases, besides careful super-
vision over a period of years—accompanied by
constant exercises and massage. The results in
the past have been fairly good. The future prom-
bises better ones, in view of increased knowledge,
or better, our different point of view and clearer
understanding of the problem.

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