Remarks

ON

INJURIES ABOUT THE ELBOW IN CHILDREN *

BY

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The common treatment of injuries about the elbow leaves much to be desired. We have all had our moments of anxiety in handling them. Even now it is anything but rare to examine patients of all ages who have had prolonged treatment with arms fixed at awkward angles, which allow only limited movements in positions quite incompatible with useful function. This is not always due to negligence; indeed, it is often due to unnecessary and mistaken activities on the part of the surgeon. Although in the vast majority of injuries of the elbow we can expect excellent results, it is a wise precaution to be conservative in our predictions, for failure will be experienced now and again. We should, from the first, try to visualize possibilities and memorize happenings. This is not difficult when the deformities apparent in the neglected cases are recalled; there is limitation of movement in all of them, some being practically ankylosed. The joint is usually held at an obtuse angle, and frequently an obstruction which prevents flexion is found at the bend of the elbow. In cases where the head of the radius is concerned, pronation and supination are limited or completely obstructed; while in others the forearm is displaced backwards or laterally, or the elbow widened by a displaced condyle or epicondyle. Variations and obliteration of the carrying angle are frequently in evidence, and sometimes a deviation inwards (cubitus varus) is noted.

It is needless to emphasize the importance of making an accurate diagnosis, and the necessity of insisting upon good radiographs, taken in two positions. In the adult, the x-ray photograph is comparatively easy to understand; in the child, it may be very difficult, and here our tactile sense is invaluable. The difficulty is due to the fact that in children the articular ends of the bone are cartilaginous and transparent, and apart from an occasional ossifying epiphysis there is merely a clear space of considerable extent between arm and forearm, which certainly may contain fractures or displacements, though they are not distinguishable in the negative.

CENTRES OF OSSIFICATION

In order to facilitate diagnosis I will refer to a few simple anatomical facts. Important among these from their relation to x-ray photographs are the centres of ossification and the fusion of epiphyses. The centre of the shaft of the humerus appears early in foetal life; ossification of the capitellum begins in the third year, in the internal epicondyle in the fifth year, in the trochlea in the eleventh year, and in the external epicondyle in the thirteenth. The upper end of the radius begins to ossify in the fifth year, and is united at the seventeenth; the olecranon unites at puberty. All the centres of the lower humerus fuse to form an epiphysis which joins the shaft at puberty; the upper epiphysis does not join until maturity. The practical bearing of this is that, while we cannot separate our lower epiphysis later than the sixteenth year, our upper epiphysis may be detached up to the age of 21. It will be apparent from this that in making a diagnosis we must depend a great deal upon our eyes and hands in the case of young children with undeveloped epiphyses.

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MOVEMENTS

Normally there is no lateral movement at the elbow, but merely pronation, supination, flexion, and extension. Voluntary extension and flexion are limited by the tension of soft structures and not by contact with the respective fossae of the coronoid and olecranon. The bony structures check forced but not voluntary movement. A point of great practical importance for diagnostic purposes is that if the arm be extended a line drawn from one condyle to another passes over the tip of the olecranon. This is as useful a line to aid us at the elbow as is that of Nelaton at the hip. If the elbow be flexed to a right angle the olecranon lies about an inch below, and not quite half-way between these points, being a little nearer to the internal condyle. While the line of the humero-radial joint is horizontal the humero-ulnar joint slopes obliquely downwards. This fact makes the axis of the extended forearm diverge outwards at an angle of about 6 degrees, giving rise to the so-called "carrying angle" of the elbow. The angle disappears when the arm is pronated. This important anatomical fact will account for the pronated hand being carried towards the face in flexion and to the outer side in supination.

The internal lateral ligament is the most important and resistant. It limits both flexion and extension, and resists lateral yielding. Were it not for the lateral ligaments fractures of the olecranon would exhibit great deformity, but their attachments—more particularly that of the internal to the border of the great sigmoid cavity of the ulna—prevent a wide separation. If a wide separation exists we may be sure that the ligaments have been completely ruptured. Of the capsule we need only remember that its two thin aspects are at the front and at the back, and that effusions present as two pouches each side of the olecranon and also beneath the brachialis anticus. These anatomical points, though elementary, help towards an accurate diagnosis. If, on examination of the injured elbow, there is no lateral yielding it may be concluded that there is no fracture of the condyles or rupture of the lateral ligaments; excepting where there is an impacted intracondylar fracture or a partial condylar crack, conditions only met occasionally. In supracondylar fractures there is usually free lateral movement just above the elbow-joint, but the line I have described will fall normally over the condyles in its proper relation with the olecranon. The elbow will yield laterally in fractures through the condyles into the joint, and in posterior dislocation of the forearm.

When an elbow is much swollen it is often very difficult to decide what the prominence we feel represents. Our fingers will assist us by following the subcutaneous border of the ulna to the olecranon, and the subcutaneous border of the radius to the external condyle. The internal condyle is usually easy to palpate. It is of paramount importance to discover at this, the earliest stage, whether there is any nerve involvement; if it is discovered later the surgeon may be accused of having produced it.

DISLOCATIONS

The common dislocation, that of backward displacement of the forearm, is usually quite easy to diagnose and, if not accompanied by much lateral deviation, is easy to reduce.

The relative position of the condyles and the tip of the olecranon can generally be felt. There is a fullness in front just below the bend of the elbow, and the joint is usually flexed at an angle of about 140 degrees. The head of the radius is very superficial, lying to the outer side of the olecranon and behind the external condyle; the forearm is shortened anteriorly and broadened; there is deviation of the axis of the arm, limited flexion and

extension, and a varying amount of lateral movement. The dislocation is commonly due to a fall on the hand, and the elbow is thereby hyperextended and usually abducted. During hyperextension of the arm the olecranon presses into the fossa and wrenches the ulna from the humerus; the lateral ligaments are torn and the coronoid is forced behind the trochlear surface. It will be noted that the olecranon lies behind its normal relation to the humerus; the anterior concave aspect of the olecranon can sometimes be felt. A word may be said of a frequently overlooked displacement of the head of the radius in the small child; it is true subluxation, and the history is definite. The arm can be freely flexed, but there is some limit to supination; in attempting to supinate the arm the head is replaced and clicks. The injury is almost always inflicted by a pull upon the arm, accompanied by abduction or adduction; the mother pulls the child's arm to hurry it along, or to lift it over an obstacle. The displacement is forwards and inwards.

Complete dislocation of the radius forwards and inwards is not uncommon. It occurs in later life, and is often due to a blow from behind while the arm is pronated, to a severe twist, or to a fall on a pronated arm. The three bony points are in normal relation; there is limited supination, the head of the radius moves with the shaft, and flexion of the elbow is sharply checked. One frequently sees old dislocations when the head of the radius lies forward and outward, and generally no limitation of movement exists in any direction.

In this paper I will only deal with: (1) Fractures of the external condyle of the humerus. (2) Fractures of the internal condyle and epicondyle of the humerus. (3) Supracondylar and intercondylar fractures of the humerus. (4) Fractures of the head and neck of the radius.

FRACTURE OF THE EXTERNAL CONDYLE

The line of fracture in the young usually runs along the epiphyseal line between the capitellum and the lower end of the humerus, and enters the joint near the trochlear groove, often carrying with it a small portion of the diaphysis. Thurstan Holland has pointed out the rarity of uncomplicated separation of the epiphysis, although the detachment of bone may be very slight. In the adult the fracture usually carries the epicondyle with it. Fracture of the external condyle is much more common than that of the internal, because the ulna is the main bone of the forearm, while the radius is more closely attached to the wrist—thus force is more easily conveyed to the external condyle. The fracture may, however, result from a fall on the flexed elbow, or from forcible adduction of the forearm due to ligamentous tension upon the condyle. The gunstock deformity is due to a slipping upwards of the condyle. In children the fracture may be difficult to reduce, owing to rotation and flexion of the fragment due to the action of the extensors. There is tenderness and mobility of the condyle and impairment of movement, mainly in flexion. The relation of the three points is altered. The transverse diameter on the injured side is increased, the carrying angle may be increased, and the forearm can readily be adducted and abducted. This injury is usually the result of a fall on the elbow.

FRACTURE OF THE INTERNAL CONDYLE

The signs of this fracture are similar to those of fracture of the external condyle. There is swelling, and displacement upwards and mobility of the fragment; the arm can be adducted and abducted at the elbow. The inner of the three bony points is on a higher plane and the carrying angle diminished. The line of fracture often begins above the epitrochlea to the centre of the joint. The ulna is attached to the fragment, and the condyle is usually saved from much displacement.

Displacement of the Internal Epicondyle.—The epicondyle may be fractured by a fall on the hand or from a violent stretching of the muscles which arise from it. The displacement is usually forwards. The fractured end is difficult to feel, but stretching of the muscle by flexion of the fingers gives rise to sharp pain over the seat of injury. The ulnar nerve is sometimes injured, either directly or, as will be explained later, from stretching.

SUPRACONDYLAR FRACTURE

This is a very common injury. The signs are distinctive, and the only confusion likely to arise is in distinguishing the fracture from dislocation of the elbow backwards. In both cases there is lateral mobility, a prominence at the bend of the elbow, and a prominence of the olecranon posteriorly. In the fracture the three bony points are undisturbed. Crepitus is usually experienced in reduction, while the deformity is very apt to recur unless the arm is immobilized. There is no hollow immediately above the olecranon; the condyles move with the forearm; pronation and supination are free. In both these injuries there is liable to be much effusion, and an accurate diagnosis should be made by *x* rays. Rough manipulation is distinctly dangerous. This fracture is often accompanied by lateral displacement.

FRACTURE OF RADIUS: HEAD AND NECK

This is an injury which requires very careful handling. The diagnosis is made when we find local pain on pressure with a limitation of pronation or supination, or both, in the absence of the other fractures already described. Fractures of the head and neck of the radius are more common in the adult than in children, but the treatment is not the same. A very common sign is painful spasm when rotation is attempted. When the head is fractured it may be simply marginal, and the fractured portion is displaced into the joint, or a small portion of the neck may be included. Under an anaesthetic, manipulation of the head should be attempted in order to replace the fragment; this is sometimes difficult. If under the anaesthetic good rotation, not necessarily complete, has been secured in the child the arm should be placed in full flexion. If, in the adult, in spite of manipulation, the rotations are not secured the broken fragment should be fixed in position or removed. Delay in doing this means a poor result because function is only partially restored if operation is postponed. The same is true in fracture through the neck. If the upper fragment can be replaced and held it is good; if not, it should be dealt with. The lower fragment, if the upper has been removed, should be smoothed and rounded. This does not apply when dealing with the child. It is unwise to remove the loose piece in fractures of the neck because of the danger of arrest of growth, but if a part of the head is displaced into the joint it should be removed, for it very rarely unites. In time the child very largely recovers from limited pronation and supination; this is not so in the adult.

TREATMENT OF FRACTURES ABOUT THE ELBOW-JOINT

Neglected fractures about the elbow nearly all remain stiff well below a right angle, and any attempt at flexion results in a bony block. In the days of the internal angular splint such deformities crowded out-patient rooms.

Over forty years ago, when *x* rays were unknown and motor cars were not invented, practitioners in the country had to rely upon their own skill in the treatment of fractures. It was difficult to obtain outside help, and fractures of the elbow in particular gave great anxiety. The joint generally stiffened at an obtuse angle. These old cases were treated in the out-patient department by manipulation; an operation was looked upon as a dangerous procedure. The most successful results followed an

attempt to increase the mobility towards flexion; when this was done, a large proportion improved in function, and often the range of movement was considerably increased. The desired change of angle could not always be brought about with safety at once; it had to be secured in stages. After each effort the wrist was slung nearer to the neck for a few days. Taught by the deformities which came for treatment, I kept injured elbows flexed about 35 degrees from the moment of injury, having first reduced the displacements, and the functional results were a favourable contrast to the deformities I saw about me.

With the object of reducing these appalling disabilities in those early days I suggested, as primary treatment, slinging the arm in full flexion after reduction. This reduction is brought about by putting traction on the supinated forearm with the thumb placed just above the bend of the elbow. I explained that this should be done at once, even when a diagnosis was doubtful. On examination of old cases of supracondylar fracture it was found that the prominent lower end of the humerus, assisted by callus and organized exudates, opposed flexion whether the elbow had been treated in the straight or rectangular position; this was the same in condylar fractures and in backward dislocation of the forearm. I therefore instructed my house-surgeons in all cases of fracture about the elbow—with the exception of the olecranon—to put traction on the forearm, press backwards the prominence in the elbow, supinate, and flex fully. In those early days, when *x* rays were not discovered, all who worked with me made this manipulation a routine.

As long ago as 1894 I urged surgeons, even when they were unable to make an accurate diagnosis, to adopt the flexed position because it was anatomically correct, and the results were good. I then wrote:

"If the forearm be dislocated backwards we must extend and supinate and fully flex, for in this way only can we reduce the dislocation. Should we be unable to flex the arm we may rest assured by such failure that the displacement still remains. If the radius is dislocated forwards and inwards the same routine is effective. The supination and extension will reduce the luxation, while full flexion will maintain it in position. If the fracture be intercondyloid the flexion has this advantage, it secures at once for the forearm a right of way before exudation of callus and displaced condyles can prove obstructive. Should the injury be a separation of the internal epicondyle, there can be no better way to keep it from downward displacement than by flexion, which relaxes the muscles which pull upon it. In supracondylar fracture the elbow should be acutely flexed only after completely reducing the fracture."

Our work to-day is made easier by the advent of radiography; we can make an accurate diagnosis and accurate replacement of fractured ends. In spite of all this, full flexion of the elbow is found to be the most universally reliable position to maintain the replacement of fractures and dislocations. If the axis of the forearm coincides with that of the upper arm the carrying angle will be maintained.

HOW TO REDUCE FRACTURES AND DISPLACEMENTS

Supracondylar Fracture.—This is the common type; the lower end is drawn backwards and usually slightly outwards, and lies above and behind the lower end of the upper fragment. Our object is to bring the lower fragment downwards and forwards, and at the same time to correct any lateral displacement that may be present. When the reduction is effected the arm should be kept in a flexed position, about 35 degrees, in order to retain the fragments in position.

An anaesthetic is generally advisable. The forearm is firmly held and traction applied in its long axis, while the lower end of the humerus—held just above the fracture—is pushed upwards and backwards. This traction and counter-traction must be maintained while the elbow is

flexed until the hand rests against the neck. *It should be emphasized that mere flexion of the elbow without setting the fracture is not only a useless but a dangerous practice.* No external splints are required, for the tendon of the triceps muscle, arranged like a strap round the back of the joint, is a perfect splint, while the coronoid process of the ulna tucked into the coronoid fossa steadies the lower fragment in front. No obstructive callus can form in front because there is no room for it. The flexed forearm keeps the fractured ends in apposition, just as in fracture of the neck of the femur reduction is maintained by tension of the capsule when the joint is abducted.

Between the second and third weeks, when the fracture is fairly secure, the angle may be increased by lowering the wrist two or three inches, and the patient may practise active movements daily, producing full flexion and then allowing the arm to fall down to the limit allowed by the sling. If the movement can be satisfactorily performed the sling can be lengthened every few days until a right angle is reached, and then it can be discarded altogether.

Fracture of the Condyles.—To reduce the external condyle, which is the more commonly injured, the arm should first be abducted to preserve the carrying angle, and the full flexion method adopted in order to force the condyle backwards, as contact with the head of the radius prevents displacements forwards. Once the condyle has been replaced—and this can generally be effected by manipulation—the triceps and its expansion holds it in position when the elbow is fully flexed. This may be considered as the only anatomically sound fixation.

The internal condyle is manipulated into position and then the forearm is fully flexed, which prevents the condyle from ascending; the triceps keeps it from backward displacement, and so does the weight of the ulna. In this position also the flexor group of muscles are relaxed, and so rotation deformity is prevented. In rare cases where obstructive displacement persists an operation may be needed. A successful setting may be assumed from a clinical aspect if, on grasping the condyles, full flexion and extension can be performed without force.

Fracture of the Internal Epicondyle.—The internal epicondyle is more often displaced than the external. In the adult it is extra-articular, but, being intra-articular and epiphyseal in children, it will sometimes wander into the joint and block the movements. It is sometimes associated with paresis of the ulnar nerve. When displaced into the joint it may be necessary to operate; the other displacements do not, as a rule, call for an open operation. The arm should be kept in full flexion, and subsequent treatment should follow the same course as that laid down for supracondylar fractures.

FLEXION OF THE ELBOW

There should be no delay in reducing a fracture or dislocation. It is a bad rule to wait until swelling disappears, for the replacement of fractured bones is necessary if we are to avoid vascular obstructions. If the swelling is very great the degree of flexion should be modified temporarily; under no circumstances should any force be applied. When it is safe to flex acutely no force is needed, and if flexion is obstructed it suggests that the fracture or dislocation is unreduced. When the elbow is flexed the forearm should not be bandaged to the upper arm, nor the arm to the side, for in this way the circulation is hampered. The normal degree of flexion in an elbow differs, and Ashhurst found in examining forty children that the difference varied from 14 to 40 degrees, the average being 31 degrees. It is necessary, therefore, to test the flexion in a normal arm with that of the injured one. Acute flexion cannot be defined accurately in degrees, but the injured elbow should be flexed 4 or 5 degrees short of normal.

There has been considerable correspondence lately on the dangers of acute flexion; this has arisen because of the fear of ischaemic palsy. In consequence, certain surgeons have suggested rectangular flexion, and some have advised that the arm should be treated in full extension. I wish to make it clear that "acute flexion" does not mean fully forced flexion, but flexion to about 5 degrees short of full normal flexion. When an elbow is swollen and the joint is resistant to full flexion it should not be subjected to force. This resistance is generally due to inefficient reduction, and if the fragment is displaced into the bend of the elbow, force is clearly contra-indicated. Even if there is considerable haemorrhage in the presence of a correct reduction the flexion should be brought about in stages if there is any obstruction. The radial pulse is a reliable indication of this. Ischaemic palsy may occur in any position which the elbow occupies, and it is very unjust to hold a practitioner liable for its occurrence; this will surely happen if it is agreed that acute flexion of the elbow, or tight bandaging, or both, are the only reasons for the occurrence of ischaemia.¹ It is the only position which stabilizes the elbow when the fracture is reduced. It prevents rotation, lateral yielding, or backward displacement of the lower fragment, and the action of the forearm as a deforming lever is prevented. It must be remembered that in fracture of the lower humerus any abduction or adduction causes torsion of the broken fragment. It is true that in full extension torsion of the fragments can be prevented, but the forearm in this position acts as a powerful lever in abducting or adducting the limb at the seat of fracture. If the arm is kept at right angles torsion of the lower fragment is easily produced; when the flexed forearm is kept in line with the humerus the carrying angle is not interfered with. The triceps, when the elbow is fully flexed, forms a reliable splint both for condylar and for supra-condylar fractures. It covers the posterior parts of the condyles and spreads below as a broad aponeurosis. Although I have used the flexed position for over forty years I have never met with an ischaemia, but I have met with many old cases of this paralysis where the arm has never been acutely flexed or tightly bandaged. Ashhurst, in his interesting monograph of the elbow, has confirmed what I say.²

SERIOUS COMPLICATIONS

The serious complications are: ischaemic contraction, nerve complications, and myositis ossificans.

Ischaemic Contraction

Ischaemic paralysis is a most grave complication, and often starts with a dramatic onset. It may follow any fracture of the elbow, most frequently supra-condylar, or it may occur in a backward dislocation of the elbow. Experiments have confirmed clinical experiences that the condition is due to acute venous obstruction; it does not occur when obstruction is gradual. It cannot be insisted upon too often that the calamity may be due to pressure from within, such as haemorrhage into the ante-cubital fossa, pressure from displaced fragments, or pressure from without, such as tight bandaging. Symptoms usually begin in the space of a few hours after injury; the hand is painful, the fingers are discoloured and numb, and voluntary movements may disappear. Irreparable mischief may take place in forty-eight hours. Muscular rigidity, and sometimes intense pain, come on early, and then the contracture; in a few days the fingers become stiff, the muscles hard and resistant. The deformity, if untreated, increases, and the fingers become more and more flexed at the mid-phalangeal and terminal phalangeal joints.

The deformity in the untreated case is characteristic. The fingers are slightly extended at the metacarpo-

phalangeal range and flexed in the distal joints; only when the wrist and carpo-metacarpal joints are passively flexed to the fullest extent can the fingers be straightened. The forearm is fixed in pronation and in a varying degree of flexion. In the slighter forms of the contraction there is usually some power of active flexion of the digits. In the severe type there may be a complete loss of function in the fibrotic muscle group. Both the median and the ulnar nerves may be involved, owing to the shrinkage of the fibrotic muscle bellies, while the median is sometimes pierced by the lower end of the upper fragment in a supracondylar lesion.

Treatment.—This should be immediate; every minute is important. The arm should be released from all restraint likely to cause vascular obstruction; it should also be elevated. The child's future is so jeopardized that an attempt should be made to evacuate the blood clot by an incision on the antero-ulnar side of the forearm, and all blood expressed from the ante-cubital space. This prompt action may save the situation; it rests on a sound pathological foundation, and successful cases have been reported. When the fractured upper fragment projects it should be reduced without trauma, even if the arm has to be kept at an obtuse angle. When contractions have already developed, correction should be attempted by the method of gradual extension. With the wrist and metacarpo-phalangeal joints in full flexion each finger is separately strapped to a little gutter splint. The metacarpo-phalangeal range is then gently stretched, and a flat metal splint applied on the palmar aspect of the hand. From day to day the position of the wrist is gradually altered until dorsiflexion is obtained. By this simple procedure the scar tissue is stretched in order of tension, and it is the only mechanical method which will correct the deformity. As the contracture yields the hand improves in function; the circulation is better, and the fingers often show some return of power. Where the ischaemia has produced a complete obliteration of muscle fibres good function cannot be obtained, but the correction of the unsightly claw deformity is always appreciated by the patient.

Operative Treatment in the Old Case.—I have no great hope from operative treatment, such as tenoplasty and bone shortening, although the separation of muscles from about the epicondyle, suggested by Page, appeals to me as being sound. Cases which will benefit from operation are likely to yield to mechanical treatment. If the muscles have been transformed to fibrous tissue no functional success is possible whatever is done. If the elbow is stiff, excision will give much-needed space to slacken the muscular tension and give function to the joint if the muscle tissue is not altogether destroyed.

Prophylaxis.—Avoid circular compression, and reduce dislocations and displaced bones. Avoid all kinds of splints, and use no force in flexing the elbow. All cases of fracture about the elbow should be watched for the first few days; the danger signals are great pain (usually), stiffening and swelling, cyanosis and lividity of the fingers. Ischaemia may result without obliteration of the radial pulse, but this symptom is at least evidence of pressure. Loss of voluntary movements is a serious omen. The prognosis is always grave. I have never met with perfect function in the hand where ischaemia symptoms were pronounced, but improvement can generally be secured.

Injuries of Nerves

Although injuries to the median and post-interosseus may occur and require operation, the occasions are rare. It is better to perform a tendon transplantation than a nerve suturing if the post-interosseus has been irreparably damaged. The ulnar nerve is often injured directly, or after a long interval. Direct injury occurs sometimes in

cases of damage of the internal epicondyle or in the condylar groove, and the nerve should be exposed only if symptoms persist. It may be necessary to transpose it anteriorly.

Late ulnar palsy not infrequently follows fracture and displacement of the external condyle. The fracture dates nearly always from early childhood, and the neuritis occurs many years later. It is a traction lesion predetermined by a cubitus valgus deformity. The nerve trunk, being destined to take a longer course, is stretched in the process. It will be necessary to transpose the course of the nerve from its groove to the front of the joint, and then recovery may be expected.

The median nerve is occasionally injured in supra-condylar fractures by the sharp projecting angle of the lower end of the diaphysis, and this may occur as an immediate complication of the fracture, or may follow a rough attempt at reduction. Direct injury to the musculo-spiral nerve is rare, but when it occurs the prognosis after operation is good.

Myositis Ossificans

This alarming complication may arise after any fracture about the elbow, but is most commonly associated with dislocation of the elbow backwards. Its onset is gradual, and, when established, may result in a complete or partial ankylosis of the elbow-joint. It is generally due to tearing of the muscular and periosteal tissue from bone accompanied by haemorrhage. Fragments of periosteum and osteogenetic tissue are pulled away, and probably in this way the formation of new bone takes place along the interfibrillary and intermuscular septa. The symptoms are insidious. An elbow which is doing well begins to get stiff in the third or fourth week, and, omitting to take an x-ray film, a practitioner prescribes passive movements. This is a dangerous procedure. The film shows a suspicious cloudiness about the attachments of some muscle—usually the brachialis anticus. In two or three weeks this shadow becomes more dense, and traces of bone structure are noted. It is a mistake at this stage to operate, because further osteogenesis often occurs. The elbow should be kept quite still until evidence is obtained that bone deposit has ended—a fact which is easily ascertained by successive radiograms—and then only should active movements be allowed. In rare instances the bone may be completely absorbed, but in many cases partial absorption occurs. If the deposit remains and is inactive, but causes disability, it can now be removed, but if the movements of the elbow are free it should be ignored. These deposits may remain for many months, sometimes years, and ultimately be absorbed.

While, therefore, we have every right to expect a good result from injuries of the elbow, we should be alive to possibilities and dangers. We should carefully note any nerve involvement at the moment of injury; we should speak of the possibilities of myositis ossificans, and warn the parents of the dangers of energetic massage and movement campaigns. We should also recollect that the practitioner is not necessarily to blame if an ischaemic palsy occurs; it may have nothing to do with tight bandaging, and it has occurred without flexion of the elbow, without splints, and without bandaging. At the same time we should, if we can, prevent pressure from within by reducing displacements which cause acute venous obstruction, and avoid pressure from without. By no argument can the practitioner be held guilty of the origin of a myositis ossificans, and neither can he be blamed for its development, provided that he does not prescribe passive movements during the period of bone formation. If myositis ossificans appears and any error is to be made let it be on the side of rest; I have seen many tragedies occur from too early movement. Finally, do not fully flex an

elbow without first reducing the fracture or displacement, and, having flexed the elbow, do not obstruct the circulation of the arm by bandaging it in the flexed position.

REFERENCES

- ¹ Jones, Sir Robert: Volkmann's Ischaemic Contracture, with Special Reference to Treatment, *British Medical Journal*, 1928, ii, 639.
- ² *An Anatomical and Surgical Study of Fractures of the Lower End of the Humerus*. The Samuel Gross Prize Essay. Lea and Febiger, New York.

THE TREATMENT OF TETANUS

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Tetanus is now a comparatively rare disease in civil practice, and this is largely due to the prophylactic use of antitoxin. In agricultural districts such as East Anglia, however, it still occurs too frequently, often after wounds which are not seen by a doctor, or which seem so trivial that antitoxin is not given. Ten cases have been admitted and treated at Addenbrooke's Hospital during the last three years, and five of these have recovered. These are recorded to emphasize the danger of tetanus that still exists, and for any light that they may throw on the best methods of treating the disease.

CASE I

Male, aged 11 years. Fourteen days before admission a sharp splinter of wood entered the skin below the left knee and penetrated 1/2 inch to the bone. This was removed by a doctor, and the wound healed normally. Three days before admission he complained that the left leg was rather stiff. The stiffness spread in a few hours to the right leg, and he found that he could not open his mouth.

State on Admission.—Risus sardonicus; rigidity of the neck and spine; board-like abdomen. The teeth could only be separated a distance of 1/4 inch, but he could speak and could swallow fluids. Severe spasms occurred with opisthotonos about every half-hour. The only sign of a wound was a small healed scar, and this was not touched.

Treatment and Progress.—On the day of admission 70,000 units of antitoxin were given intrathecally, 60,000 intramuscularly, and 30,000 intravenously. (International units are used throughout.) This was done under chloroform anaesthesia. Bromide and chloral were also given. The next day he was definitely better, and from this time steadily improved, the spasms gradually becoming less frequent and less severe. In the following six days 74,000 units in all were given, the dosage being gradually reduced: 44,000 were given intrathecally and 30,000 intramuscularly. At the end of one week he was well but for slight stiffness of the jaw and of the abdominal muscles, which had quite disappeared in fourteen days.

CASE II

Male, aged 23 years, horsekeeper. No history of injury or illness. Quite well and at work until fourteen days before admission. He then complained of stiffness of the back. Two days later his jaw also became stiff. These symptoms continued, but he did not send for the doctor until he had had them eight days. The stiffness gradually increased, and spasms of pain in the back and chest and neck came on after eight days. He used to get out of bed and walk round the room in an attempt to work off the stiffness.

State on Admission.—All the muscles of the chest, neck, and abdomen were in a state of severe spasm, which was made worse by any stimulus, such as movement. Board-like rigidity of the abdomen was present; risus sardonicus marked. The teeth could not be separated more than 1/4 inch. Sweating was profuse.

Treatment and Progress.—On the day of admission 40,000 units were given intrathecally, and the same amount intravenously under chloroform anaesthesia. A