like any other remedy, act as a stimulus to those defensive powers in the human body which need to be called into play, and that different individuals cannot all be expected to respond to the same stimulus to the same extent or even in the same manner. Analogies with the treatment of syphilis are suggestive in this connexion; it is well recognized that over-treatment of this malady may be as bad as, or perhaps worse than, no treatment at all, and that the problem in the cure of syphilis is not to get as much of the specific remedy into the body as possible, but that amount which is capable of producing the optimum response by the tissue defences in the individual concerned. Such a view of the mode of the specific action, if any, of a mineral water would go far to explain certain difficulties and anomalies which are sometimes encountered.

There is no doubt that there is a vast field for experimental research into the many problems connected with spa treatment, of which only the borders have as yet been explored. Further, there is need for more publication of the results of treatment of series of cases. It is to be regretted that physicians at spas so seldom put on record their experiences. For this there are probably three reasons: first, a natural, but perhaps undue, apprehension that such a proceeding lays the writer open to the charge of advertisement; secondly, the difficulty of following up the after-histories of patients who are only under direct observation for a short time; and, thirdly, the fact that many of the cases met with are of a very chronic character, and that so much damage has been already done that several courses of treatment may be necessary before the complaint is brought to a standstill, and even then full functional restoration may be impossible. I think it was Sydenham who said, "Chronic diseases require chronic treatment," and this is as true of spa therapy as of any other—a point perhaps not sufficiently recognized and insisted upon.

REFERENCES.

- ¹ Orr, J. B.: *Biochem. Journ.*, October, 1914. ² Idem: *Proc. Physical Society*, 1920. ³ Gordon, R. G.: *Arch. Med. Hydrol.*, June, 1923, and May, 1924. ⁴ Burt, J. B.: *Ibid.*, January, 1928. ⁵ Schamberg and Rule: *Journ. Amer. Med. Assoc.*, April, 1927. ⁶ Colebrook, Eidinow, and Hill: *Brit. Journ. Exper. Pathol.*, 1924. ⁷ Sarmiento and Kopaczewski: *Arch. Med. Hydrol.*, May, 1925. ⁸ Ferreyrolles: *Ibid.*, January, 1928. ⁹ Billard: *Ibid.* ¹⁰ Race: *Proc. Roy. Soc. Med.*, 1924. ¹¹ Peskett and Raiment: *Arch. Med. Hydrol.*, August, 1925.

FRACTURES OF THE LOWER END OF THE RADIUS IN ADULTS (COLLES'S FRACTURE AND BACKFIRE FRACTURE).

BY

HAROLD EDWARDS, M.S., F.R.C.S.,

JUNIOR SURGEON AND SURGICAL TUTOR, KING'S COLLEGE HOSPITAL;

AND

E. BELLIS CLAYTON, M.B., CH.B.,

DIRECTOR OF THE PHYSIO-THERAPEUTIC DEPARTMENT, KING'S COLLEGE HOSPITAL.

THE following account is based on an analysis of 424 cases of fracture of the lower end of the radius treated in the fracture clinic of King's College Hospital during the three years 1924-26. Of these fractures 251 occurred in women and 173 in men and youths. Of the latter number, no fewer than 84 were caused by backfire injury from cranking a car. The remainder, and all those occurring in women, with one exception—a backfire fracture—were of the Colles type. Cases of separation of the lower epiphysis of the radius, except those occurring from backfire injury, have not been included within the scope of this article.

THE COLLES TYPE OF FRACTURE.

In all there were 339 cases which might be regarded as of the Colles type, and sustained by falling on the outstretched hand; 250 were in women, and 89 in men. Radiograms, both antero-posterior and lateral, were available for examination in 275 of these cases.

(a) The Radial Fracture.

In the majority of cases the fracture was transverse, and at the upper limit of the radial surface which enters into the formation of the inferior radio-ulnar joint (Fig. 1). In a few cases the fracture was at a higher level (Fig. 2), and in others a shade lower (Fig. 3). In one case the line

FIG. 1.

FIG. 2.

FIG. 3.

of fracture ran obliquely downwards from a point fully $1\frac{1}{2}$ inches above the radial styloid process (Fig 4). In cases where severe comminution was present the radiating line of fracture ran vertically up the shaft, and in some cases down to the joint surface. In a number of cases there was a single vertical split passing from the transverse fracture to the joint surface. Radial rotation of the lower fragment was present in all cases, but varied very much in degree in different fractures.

FIG. 4.

Lateral views showed a varied picture. In some there was no sign of fracture in the lateral plane. In a fair proportion of the cases the posterior lip of the radial articular surface was broken off. In a few cases there was little or no appreciable displacement, but in the vast majority there was backward tilt of the lower fragment, so that the articular surface of the radius faced downwards and backwards. This was usually, but not invariably, associated with bodily backward displacement of the lower fragment. In cases where the posterior lip of the radial articular surface was fractured the backward tilt was very marked. In a few cases the carpus was carried bodily backwards with the fractured posterior lip, so that the condition was actually a fracture-subluxation. It is important to remember that this is likely to be present when the deformity is gross, so that steps may be taken to ensure complete reduction. The articular surface appeared to be involved, usually in the manner described above, in 95 of the cases. It is not always possible to be certain of this point from the radiograms, but the figure indicates that the wrist-joint is involved in a high percentage of the cases.

It is doubtful how often the inferior radio-ulnar joint was involved, it being extremely difficult to determine this point. In some cases the joint was very obviously involved, but in the majority the fracture appeared to be just above the upper limit of that joint. It is a common experience to find pronation and supination the last movements to return fully after fracture, and although no correlation between delay in obtaining these movements and fracture into this joint has been found possible in this series, it appears very probable that joint involvement is the cause of the delay in most instances.

(b) The Ulnar Fracture.

In 158 of the 339 cases the ulna was fractured. In all but 8 of these the fracture was of the styloid process. In one case it was through the shaft fully three-quarters of an inch from the lower end. Fracture of the styloid process occurred in all situations, from the base to the tip. In one case two fragments were broken off.

Whether the ulnar styloid does or does not fracture depends to a great extent upon the amount of radial abduction into which the hand is forced at the time of impact. It would also appear to depend upon the anatomy of the styloid process itself. This varies very considerably. In some cases it is long and narrow, with a curve to the radial

side (Fig. 3). This type invariably fractures. In others the ulna ends in a rounded extremity, with little or no suggestion of a styloid process at all. All degrees are met with between these two extremes. In some cases the process is conical, with a pointed distal extremity and an extremely wide base (Fig. 8). This type rarely fractures.

Fracture of the ulna appears to make very little difference to the end-result. In fact, we have had frequent occasion to note that patients in whom the ulnar styloid is not fractured are more likely to complain of tenderness over the internal lateral ligament than those in whom fracture of this bone has occurred.

(c) Other Fractures.

In only one case was the scaphoid fractured in addition to the radius or ulna.

DIAGNOSIS.

There is little need to discuss diagnosis, which is usually a simple matter. Antero-posterior and lateral radiograms should always be taken, even when the diagnosis of fracture on physical signs is certain. Radiograms should be taken in all cases of wrist injury, for a linear impacted fracture may be present with no well-marked physical signs.

BACKFIRE FRACTURE.

There were 85 cases of backfire fracture, and the radiograms of all were available for examination. They comprised the following types in order of frequency.

1. Oblique fracture through the radial styloid process, with or without fracture of the ulnar styloid. The line of fracture was usually from the outer side to a point about midway along the articular surface, corresponding to the interval between the scaphoid and semilunar bones (Fig. 5). In some cases the line of fracture was longer and more oblique. In extreme cases it ran into the distal end of the inferior radio-ulnar joint (Fig. 6).

FIG. 5.

FIG. 6.

FIG. 7.

Displacement was not marked as a rule. The total number of cases was 28.

2. Colles's fracture (16 cases).

3. Injury to the epiphysis, in some cases with separation and backward displacement (12 cases).

4. High fracture (10 cases). The line of fracture was at or just below the junction of the lower and middle thirds of the radius, and was transverse or slightly oblique (Fig. 7). In two cases the ulnar styloid was also fractured. In this type the upper end of the distal fragment is carried just in front of the lower end of the proximal fragment, and the carpus and lower end of the radius are carried backwards.

FIG. 8.

FIG. 9.

5. V-shaped fracture (7 cases). The styloid process was broken off, as in the oblique type, and in addition a fragment of similar size from the ulnar aspect of the radius (Fig. 8). The lines of fracture met at the mid-point of the radial articular surface, corresponding to the interval between the scaphoid and semilunar bones. In one case there was gross displacement of the fragments to the inner side (Fig. 9).

6. "High Colles" (6 cases). Fracture occurred well above the usual site for a Colles (Fig. 10). In one case both bones

were broken at the same level. In the other cases the epiphyses had not yet united. This is of interest in that it suggests that the fracture resulted from a direct blow from the starting handle of the car.*

7. Ulna only, just above the distal end (2 cases).

8. Colles's fracture with inward displacement (1 case).

9. Atypical Colles's fracture, a combination of types 1 and 2 (1 case).

10. Trapezium only (1 case).

11. Radial styloid and scaphoid (1 case).

TREATMENT.

The treatment adopted in this clinic as a routine when deformity is present is reduction of the fracture under gas anaesthesia as soon as the diagnosis is made. The method used is that advocated by Sir Robert Jones—that is, disimpaction of the distal fragment by direct backward force, followed by replacing the fragment by direct force forward. The actual way in which this manoeuvre is carried out varies with the individual operator, but there is never any call for the use of the older method of grasping the hand in order to obtain the necessary extension. Great care is always taken to correct the backward tilt of the lower fragment, and the radial deviation. This is of far more importance than the correction of the backward displacement, though this also should receive attention. When reduction has been obtained the wrist is kept in flexion, and is held in this position until the splint is applied. As has been stated, the carpus may be bodily displaced backwards (fracture-subluxation). This displacement is easily corrected if the wrist is fully flexed. A lateral x-ray photograph is taken immediately after reduction and fixation on the splint, as a routine. If the backward tilt is uncorrected (except in certain instances—*vide infra*), a further attempt at reduction is made.

The results of treatment go to show that unless perfect reduction of the backward tilt is achieved a perfectly functioning wrist-joint is not obtained. In interpreting the radiogram after reduction it should be borne in mind that normally the radial articular surface faces slightly forwards. The only exceptions to the rule of obtaining perfect reduction of the backward tilt are:

(a) In old people, if this has not been effected at the first attempt. Each case is seen by the surgeon at the clinic, and in the aged, rather than submit them to the ordeal of a second anaesthetic, it is usually adjudged satisfactory if the tilt is corrected sufficiently to allow the radial articular surface to face directly downwards.

(b) When severe comminution is present. In such cases, although it may be possible to replace the lower fragments by manipulation, it is often impossible to retain them in position. The bone is so pulped that the splint fails to give the necessary support, and the deformity recurs.

It may well be asked why in this clinic we attach such importance to the correction of the backward tilt. In our experience an uncorrected tilt invariably results in a weak wrist. Reference to the diagram (Fig. 11) will show that when this tilt is uncorrected the flexor tendons cannot act

FIG. 10.

FIG. 11.

along their normal straight line, and this may impair their mechanical efficiency to some extent. The main cause of the weak wrist, as Mr. H. A. T. Fairbank permitted one of us to point out in the previous communication already referred to, lies in the fact that the radial articular

* For a more detailed account of the mechanism of backfire fracture see communication by one of us (H. E.) in the *Journal of Bone and Joint Surgery*, vol. 8, No. 4, pp. 701-717.

surface faces downwards and backwards. The pull of the long tendons passing over the back of the wrist-joint tends to make the carpus slip backwards over the obliquely disposed radial articular surface. For this reason the muscles act tentatively, and not to the full extent of their power, and the natural outcome is a weakened wrist. In late cases of unreduced backward tilt a successful result has attended operative reduction of the deformity by means of a curved osteotomy.

The chief significance of an uncorrected radial deviation lies in the remote rather than in the immediate result. The mechanism of the wrist is permanently upset, and though perfect function may be obtained for the patient before he finishes treatment, yet the joint is predisposed to the development of arthritis in succeeding years. Except for the unsightly deformity, an unreduced backward displacement is of little importance, and in no way interferes with the obtaining of a perfect functional result. It is the joint which matters, and be a fracture of the radial shaft anywhere along the course of the bone, near to the wrist-joint or remote from it, minor degrees of mal-alignment do not prejudice the issue.

Splinting.

The essential feature is to keep the wrist straight or slightly flexed to prevent the distal fragment from slipping back into deformity. In this clinic Carr's splint is used as a routine. Used in the correct way, Carr's splint is very efficient, and possesses many advantages over the various splints which have been invented to supplant it. It is very cheap and easily made, and when well applied is comfortable. It is important not to have the splint too wide. It should be a shade narrower than the diameter of the forearm just above the wrist. If wider the wrist will not lie snugly, and lateral movements will be possible. The splint does not hamper finger movements, which we regard as being of extreme importance in preventing stiffness and preserving the tone of the long flexor and extensor muscles. The patient is encouraged to perform them from the outset. Lastly, the splint is made of wood, and permits of x-ray examination after reduction. The splint is applied as follows:

The forearm, after reduction, is placed on the splint, which is covered with a very thin layer of wool. One pad of wool in addition is arranged under the lower end of the proximal fragment. The height of the pad can be varied to suit each individual case, and the extent of palmar flexion required thereby adjusted. A second pad is carefully placed over the distal fragment to maintain its position and prevent it from slipping back. With the arm held on the splint by an assistant fixation is obtained by means of two strips of adhesive plaster one inch wide. One, the first applied, passes over the pad on the distal fragment to secure the latter firmly in position, and a second is placed higher up the forearm to hold the splint in position. A calico bandage is bound over all, one turn passing between the thumb and first finger to prevent wrist movement, and after ascertaining that the circulation in the fingers is unimpaired, a lateral radiogram is taken; this should be examined before the patient leaves hospital. A poor result, particular attention being paid to the backward tilt, will necessitate a further attempt at reduction, unless this is contraindicated by age or the degree of comminution of the fracture. This second attempt should not be delayed for more than a few hours.

We do not adhere rigidly to Carr's splint, however, although it is used in the vast majority of the cases. If there has been very gross backward displacement and tilt, a posterior curved splint of aluminium is occasionally used, which permits of holding the wrist in full flexion. This splint has been found particularly useful in cases of fracture with complete separation of the radial epiphysis—one of the types of backfire fracture, and one often extremely difficult both to reduce and to hold in reduction.

Treatment of the various types of backfire fracture is carried out upon similar lines, with obvious exceptions. In the high type (No. 4) the arm is usually placed in supination on a back splint after reduction, followed by plaster in a few days. In one case in the present series it was found necessary to perform an open operation and plate the bone.

Massage and Movements.

Massage and movements are undertaken chiefly by students training as masseuses, who work under supervision. The interval elapsing between the injury and the time of commencement of massage varies. No hard and fast rules are followed with regard to the time of commencement, but, generally speaking, massage is commenced during the first week in old patients, and delayed for anything up to fourteen days in younger patients. The general routine carried out by the masseuse is as follows:

For the first fortnight after reduction massage is given on the splint, and the only movements permitted are finger movements. These, as stated previously, are very important. When there is much pain and swelling, or stiffness of the joints, or when the patient is nervous, these movements are assisted by the masseuse. Massage consists of effleurage to the fingers, back of hand, and forearm. This is given with the utmost gentleness, since undue pressure over the forearm might result in recurrence of the displacement of the distal fragment. We have found that pain over the internal lateral ligament of the wrist is a common complication. Friction massage is therefore given over the ligament after the seventh day, making this deeper after three weeks. For swelling and stiffness of the fingers friction massage is employed over the joints and dorsal tendons in addition to effleurage. Early in the treatment the shoulder movements are tested. When any limitation is found, the joint is taken through its range of movement at each attendance, and the patient instructed to perform this exercise at home.

After fourteen days the forearm is lifted off the splint on to a table. The anterior surface of the forearm is now massaged as well as the posterior, kneading massage being employed as well as effleurage. Flexion and extension and rotation movements are usually commenced at this stage. The wrist is gently flexed and extended over the edge of the table, either passively or assisted, the masseuse placing one hand over the lower end of the radius to support the fracture. It is important that the distal fragment be firmly supported to prevent movement occurring at the site of fracture instead of at the joint. Flexion and extension movements are followed by very gentle passive or assisted supination and pronation. The hand is held in ulnar deviation to avoid strain on the internal lateral ligament while these various movements are being performed. The splint is worn from three to four weeks, and followed by a sling for a few days, when active wrist, pronation and supination, and full finger movements are practised by the patient at home.

Duration of Treatment.

The average duration of treatment for all cases is nine and a half weeks. This figure takes into consideration a number of chronic patients who attended the physio-therapeutic department for upwards of nine months. If these be excluded it is found that the average duration is about six weeks. In the winter months it tends to be longer than in the summer months. This observation suggests that radiant heat may be of some value in the treatment.

We do not propose to enter into a discussion of the merits and demerits of immediate massage and movement as advocated in some clinics, this article being intended as a simple review of the treatment of cases as carried out at King's College Hospital Clinic. It would not be out of place, however, to point out the reasons why, at this clinic, the after-treatment of the fractures described above is followed.

In the first place, great emphasis is laid upon obtaining and maintaining a good reduction of the fracture. Experience shows that a good alignment affords the best prospect of obtaining a perfect wrist. It cannot be denied that good function often follows a poor reduction. Neither can it be denied that an occasional perfect reduction is attended by a relatively poor function. In the main, however, when a large series of cases are reviewed, there is no doubt that good reduction yields the higher percentage of good results. It must be borne in mind, also, that a malunited fracture, in respect of the radial deviation and the backward tilt, predisposes the wrist to the development of arthritis, and this may mar what had been regarded as a good result in the first year or so after the injury. Massage and movement in the first few days—especially movement—is attended by a very real risk of the distal

fragment being redisplaced. Doubtless the skilled surgeon can safely perform early passive movement, but in the busy rush of hospital practice, where this type of fracture is of such frequent occurrence, this is impracticable, and the work must be done in a department wherein students are being instructed. Apart from this there is a very cogent reason for the postponement of movement. The wrist-joint has been subjected to very severe trauma, and for the first few days it needs complete rest. Movement at the outset probably does more harm than good, and possibly favours the development of traumatic arthritis. The period of complete rest must not be too long, however, especially in old people, for fear of obtaining a stiff joint. A happy mean between too prolonged rest and too early movement is the ideal, and in this clinic we try to attain it. With regard to massage itself, we are convinced that it is not of great importance in the younger patient. Active finger movement does far more to preserve the tone of the long flexor and extensor muscles than massage can possibly do. In old patients the soothing effect of massage is of value, and, as stated, is usually employed during the first week.

It is difficult to give full credit to the very high percentage of good results claimed by some clinics for Colles's fracture. There are so many factors which tend to deprive the surgeon of a perfect result in every case. Not the least of these is the personal factor. We have had frequent occasion to note how two identical fractures undergoing identical treatment vary in the end-result. One patient may obtain a wrist sufficiently sound to admit of his discharge at the end of four or five weeks, while the other drags on for many months with stiffness of the joints, and perhaps pain over the internal lateral ligament. Another factor which is an absolute bar to obtaining uniformly good results is pre-existing arthritis of the wrist and fingers. Examination of this series of radiograms shows this to be of very frequent occurrence. It was present in 26 out of 360 cases (7.2 per cent.). The injury always makes the arthritis worse and the fingers more stiff, despite the fact that in such cases massage is employed at the outset.

The following table has been compiled from the notes of the cases, and gives some indication of the relation borne by the time of commencement of massage and movement to the result obtained. It will be seen that the percentage of good results remains fairly constant irrespective (within reasonable limits) of the time of commencing massage and movements.

	No. of Cases.	Average Duration of Treatment (days).	Percentage of Perfect Results.
Massage commenced—			
Under 10 days	92	67	70
Over 10 days	95	69	78
Wrist movement commenced—			
Under 14 days	65	68	75
Over 14 days	116	62	77
Splint discarded—			
Under 21 days	31	66	84
Over 21 days	155	67	73

These figures are not to be regarded as absolute, and are not intended to be final arguments for or against early massage and movement. They are merely mathematical calculations based upon the material available. For instance, the fact that of 31 cases in which the splint was discarded before three weeks the proportion of good results is 11 per cent. higher than those in which the splint remained on for a longer period in no way indicates that this is the optimum time for splint removal in every case. Of these 31 cases many were linear fractures without displacement, and probably would have done equally well had they not worn a splint at all.

LATE RESULTS.

When it comes to making a definite standard of results difficulties at once arise. It is impossible to set a standard of efficiency beyond which all results are declared good and the others poor. What would be considered a good result in an old arthritic patient might be deplored as a comparative failure in a young working man. Moreover, the following results are based upon answers to a questionnaire. One patient with a determination to be well will submit a satisfactory report. Another, determined to make the most of it, will discover some complaint even if he has every reason to be satisfied with the result obtained.

The number of copies of the questionnaire sent out was 416, and the replies totalled 321 (this includes the backfire fractures). In 235 of these (73.2 per cent.) there was no complaint of any kind, and no degree of incapacity to carry out the normal occupation. Many of these cases were in old people, who were obliged to do little or no work, and the fact that they admit being able to carry on with their normal occupation means nothing. For them, however, the result was satisfactory, and they are therefore included in the perfect results.

In the next category are placed all patients who put forward minor complaints, such as "feels stiff in cold or damp weather," "aches after use," "rheumatism in the fingers," "occasionally swells after use." The number of these cases is 74 (23.1 per cent. of the total). All are able to carry out their normal occupations. It is not easy to find causes for every one of these minor complaints: 23 of them had arthritis of the wrist or finger-joints, or both, before the injury; some of them, no doubt, have developed arthritis since. (The cases, it will be remembered, are those of from two to four years ago.) In some of the older patients reduction was not perfect, and they were left with a minor degree of backward tilt. Two of the patients developed small localized thickenings of the palmar fascia; one was a rheumatic subject, but the other was definitely not so; the thickenings were tender. It may be that they arose from irritation of the cross-piece of the splint, or from being bound too tightly in the splint after reduction.

A fairly common complaint is tenderness over the internal lateral ligament. This occurs early after fracture, and has been referred to previously. It appears to be more common in the female than in the male patients. The tenderness usually disappears after treatment, but in a few cases persists. In some of the cases there is some degree of limitation of both flexion and extension, and of rotation at the time of discharge, but this appears to clear up very quickly on the patient's return to work. Occasionally the limitation is very marked both in the wrists and fingers, and persists in spite of treatment. A few of these cases are functional, for the joints become quite mobile under anaesthesia without forcing. An anaesthetic usually cures all but the worst cases of this type. Limitation of movement in one plane only is invariably due to adhesions. Such cases are manipulated under gas anaesthesia. One manipulation is usually sufficient to cure the condition, but occasionally it has to be repeated, for the tendency to relapse is a very strong one. Limitation of rotation is more common than that of flexion and extension, and a certain number of these cases are manipulated. The delay in the return of full pronation and supination probably depends upon involvement of the inferior radio-ulnar joint in the fracture.

The type of work the patient has to do is a factor. Swelling and aching after use are more likely to occur if the occupation be a hard manual one than if it be, say, clerical. Some of the patients write to say that they have no discomfort with ordinary work, but notice pain or weakness after playing tennis. Such patients are mostly of the typist class. The majority of the female cases are occupied in housework, with its varied and manifold duties, some light, some heavy. It is after a day at the wash-tub that their wrists are most likely to make themselves felt.

Such complications as those enumerated are treated upon the following lines. Radiant heat, constant current

or diathermy, is used in addition to massage for pain over the wrist; when this is associated with stiffness, faradism to the forearm muscles is sometimes tried, also sinusoidal current arm baths. When stiffness of the joints persists after eight weeks without pain, the masseuse gives movement of the stiff joints with a steady pull on the resisting muscles. The patient also performs active mobility exercises—pronation and supination with a weighted stick, and wrist flexion and extension by means of a pulley, the patient assisting movement by pulling on the rope with the sound hand. To lengthen the lever arm, the hand is fixed in a clamp and the rope attached to a bar projecting from the distal end.

The remaining 12 cases (3.7 per cent. of the total) may be regarded as bad results. This group is at once the most interesting and instructive, as it gives some indication of loopholes in the treatment. The cases are given in detail.

Ref. No.	Sex.	Age.	Type.	Notes.
C15	F.	57	Colles	Open operation at another hospital.
D46	F.	50	Colles	Median paralysis; stiff wrist and fingers. Attended clinic 9 months after injury with marked backward tilt. Pain and stiffness of wrist and fingers.
A30	M.	61	Backfire, Type 1	Attended for 78 days. Pain and stiffness in wrist; no displacement. Commenced massage on sixth day and wrist movement on thirteenth.
C5	M.	40	Backfire, Type 2	Painful weak wrist, with marked limitation of movement. Marked osteo-arthritis before injury. (There was severe comminution in this case.)
D12	F.	53	Colles	Painful weak wrist; grip poor; fingers stiff. Marked osteo-arthritis before injury.
D3	F.	45	Colles	Painful stiff wrist; third and fourth fingers stiff. Very marked comminution with severe backward tilt before reduction. Massage commenced ninth day, and wrist movement on eleventh. Splint discarded on eighteenth day.
E2	F.	41	Colles	Marked limitation of rotation; wrist painful. Massage commenced on third day, wrist movement on sixteenth.
E26	F.	56	Colles	Always stiff and very painful after use. Osteo-arthritis present before injury. Massage commenced on third day, wrist movement on sixteenth.
F12	F.	42	Double Colles	Right wrist: Weak, with marked backward tilt. Operation by Mr. Fairbank, 1926. Now satisfactory. Left wrist: Perfect result.
J16	F.	52	Colles	Wrist and fingers very stiff. Attended for 18 months. Slight unreduced backward displacement.
K11	F.	52	Double Colles	Right wrist: Constant pain in wrist; swollen at night. Marked unreduced backward tilt. Left wrist: Perfect result. Slight backward displacement, but no tilt.
L9	M.	38	Backfire, Type 2	Backward tilt with a weak stiff wrist.

It will be noted that in three of the cases arthritis was present before injury, and was probably responsible for the bad result. One case (C15) came to the clinic after an open operation at another hospital. Another (D46) attended for a few days after injury, and was then not seen for a period of nine months.

An instructive case is that of F12. Both left and right wrists were fractured. In the left the position was good, and a perfect result was obtained. In the right there was marked backward tilt and a weak wrist in consequence. This was operated upon by Mr. Fairbank, the tilt being corrected by a curved osteotomy. Two years later the patient reports that the wrist is satisfactory, and gives no trouble with housework. K11 also had a double fracture. On the left there was a slight degree of backward displacement, but no tilt, and a perfect result was obtained. On the right there was backward displacement with tilt, and a bad result was obtained. L9 was also left with an unreduced backward tilt. These three cases well illustrate the importance of correction of the backward tilt. In the four remaining cases, no cause for the failures can be assigned.

We wish to thank Mr. H. A. T. Fairbank for the very kindly interest he has taken in this article, and both Mr. Fairbank and Mr. St. J. D. Buxton for allowing us to make free use of the material upon which it is based. Our thanks are also due to Dr. Grace Batten for looking up the very numerous radiographs.

MINERS' CRAMP.

BY

E. M. BROCKBANK, M.D., F.R.C.P.,

HONORARY CONSULTING PHYSICIAN, ROYAL INFIRMARY, MANCHESTER;
MEDICAL REFEREE FOR INDUSTRIAL DISEASES.

A CASE of miners' cramp which has lately been under my care is, I think, of sufficient interest to record as the complaint is not uncommon, although references to it in literature are very scarce, and whilst it arises out of and during the course of employment and may make a man lose time for a couple of weeks or more, it is not a scheduled disease under the industrial section of the Workmen's Compensation Acts.

A miner, aged 44, was sent to me by his doctor for curious attacks of cramp, which came on while he was working. They began suddenly in the fingers and toes (in tetaniform manner), increasing in severity and gradually ascending the limbs to the back and neck. The cramp in the trunk and limbs lasted a few minutes, then eased somewhat in the limbs, but the hands and feet still remained more or less contracted and would continue so for three to four days. He would then feel well enough to return to work, although not in his former vigour. He has vomited with the severity of the pain. He has had about six or seven attacks during the last two years. He works in a mine, which he says is very hot and dry, and perspires to a considerable amount whilst working, and also when walking about after recovering from an attack of cramp.

During his working hours (one shift 5.30 a.m. to 2.30 p.m.) he drinks five to six pints of water, followed by about a pint of tea with his dinner, and half a pint for tea, and he takes about four glasses of beer in the evening—that is, about 8½ pints of fluid in the day. He does not take salt except with his food, and has no particular desire for salt food, as some miners who suffer from the cramps have. His other workmates have complained of similar troubles, but not to such a marked degree. He had been a miner since sixteen years of age, except for fourteen months in 1919-20, when he worked in a bleach-works. He is below the average stature and the robust physique of a miner. Two years ago a large piece of coal fell on his head, and he was laid up for seven to eight weeks, septic poisoning following in the wound. A few weeks after resuming work his face became swollen for nearly a week, and he was off work about three to four weeks with this illness. It was shortly after this that the cramp commenced.

There were no objective signs of any organic disease. The urinary chloride content was not investigated because I must confess to have not known what was the cause of the man's illness until I looked up the very scanty literature on the subject, and then it was too late for thorough clinical examination. The cerebro-spinal fluid was normal. There was no evidence to show that the injury had anything to do with causing the cramp, unless it had debilitated his system and made him more liable to it than he had previously been.

Descriptions of fireman's or stoker's cramp in medical literature are fairly common, but I have only been able to find two references to miners' cramp anywhere. One is of a somewhat popular but striking nature by J. B. S. Haldane.

"Perhaps the hottest place in England is about a mile underground in a well-known Lancashire coal-pit, where the miners work in boots and bathing drawers, and empty the sweat from their boots at lunch. One man sweated eighteen pounds in the course of a shift, and it is probable that even this figure has been exceeded. This sweat contained about an ounce of salt—twice what the average man consumes in all forms per day. The salt loss was instinctively made up above ground by means of bacon, kippers, salted beer, and the like. And as long as they did not drink more than a quart of water underground no harm came to the miners. But a man who has sweated nearly two gallons is thirsty, and coal-dust dries the throat, so this amount was often exceeded, and the excess occasionally led to appalling attacks of cramp, often in the stomach, but sometimes in the limbs or back. The victims had taken more water than was needed to adjust the salt concentration in their blood, and the diversion of blood from their kidneys to their muscles and skin was so great that they were unable to excrete the excess. The miners in question were offered a solution of salt in water, which was of about the composition of sweat, and would be somewhat unappetizing to the average man. They drank it by quarts and asked for more. And now that it has become their regular beverage underground there is no more cramp, and far less fatigue. It is almost certain that the cramp of stokers, and of iron and glass workers, which is known to be due to excessive water drinking, could be prevented in the same way."

The other paper is by K. Neville Moss, professor of coal-mining, Birmingham University, and is so important from a medical point of view that I take the liberty of quoting freely from it, and recommend all interested in the subject to read it in its complete form. Its title is "Some effects