three days. There was also a great deal of oozing of blood and serum from the tube but no pus. On the fifth day the drainage tube was removed and on the twenty-eighth day the wound was soundly healed. On January 3rd, 1900, it was noted that the limb was not so straight as desirable, there being a considerable amount of genu valgum and the knee-joint was stiff. So on January 8th the boy was anaesthetised, the limb was straightened, some adhesions were broken down and the leg was put up in plaster. He was discharged from the hospital on January 12th, wearing a plaster-of-paris splint. The right leg measured 23½ inches from the anterior superior spine to the internal malleolus and the left leg 24½ inches, so that there was a difference of half an inch. In April the boy was readmitted, the plaster-of-paris taken off, and gentle movements of the knee commenced. Since then he has worn a trough splint applied to the outer and posterior aspects of the knee until now. The final result is that the left leg is straight, does not require support, has 25 degrees of flexion at the knee and is only half an inch shorter than its fellow, and the screw has given rise to no trouble whatever and is still *in situ*.

In this particular instance a nickel-plated screw was employed, but the ingenuity of the surgeon is often considerably exercised in deciding as to whether he should use wire or screws, and how he should put the binding material in to the best advantage. There are, however, some cases of mal-union which seem to defy successful operation. Such a one is seen in the case of cross union of the bones of the forearm with ossification of the interosseous membrane.

COLLES'S FRACTURE AND ITS TREATMENT.

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THE variety of Colles's fracture which I wish to speak of is the one in which the lower articular extremity, whether comminuted or not, is driven upwards and backwards upon the shaft of the radius. Other varieties of this fracture are occasionally seen, and each requires a special treatment of its own. This form is often found to be difficult to set, and frequently the displacement which accompanies this fracture is only partially corrected. This difficulty, which is a very real one, occurs so often that some surgeons go so far as to say that a Colles's fracture if deformity exists is rarely if ever properly set. Such a view receives substantial support from the fact that a large number of persons who have sustained this injury show permanent deformity with considerable limitation of movements in the wrist, and of supination and pronation of the forearm and hand; also, in a lesser degree it is true, from the numerous specimens in which the original deformity persists that are to be found in different pathological museums in this and other countries. The difficulty in the proper reduction of the displaced fragments is usually attributed to impaction, which causes fixation of the fragments one to the other. I hope to show that in the majority of instances impaction, such as is enough to defy manipulation with or without an anaesthetic, does not occur, and that it is not difficult to set the fracture properly, and that it is easy to redisplace and again to reset the fragments. When the fracture is properly set the several fragments fall into their natural positions, and the lower articular surface of the radius regains its normal contour and inclination, and owing to this the movements of the wrist-joint are not to any material extent interfered with. Under ordinary treatment, however, interference with the movements of the wrist-joint after this fracture is often considerable, and massage, early passive movement, and other manipulations are resorted to in order to reduce the degree of such interference to its smallest limit. Further reference will be made to this at the end, so I will at once proceed to review the methods now in use for the treatment of this fracture, leaving out of consideration the mechanism of its production.

The methods now employed in the reduction of the displacement may be classified as follows: (1) pull the hand straight out; (2) pull and flex the hand towards the ulnar side; and (3) pull the hand and flex the wrist-joints. To what extent the first two methods are effective in the hands of other persons I cannot tell, but I know that I have quite failed to produce any satisfactory impression upon the displaced fragments whenever I have adopted one or the other, or both in succession; pulling, as a rule, proves quite useless, and even when combined with ulnar flexion of the hand in my experience it is equally ineffectual. With the last method, on the contrary, I have invariably succeeded, and found no

impaction, or, I should say, no such degree of impaction as to defy ordinary manipulation. I now, however, find that a simple and full flexion forwards at the wrist-joint without any pulling suffices to reduce the deformity and to give back the natural contour to the broken radius. I have lately had an opportunity of testing this in a right forearm in which there was a recent Colles's fracture. During life—the man being in an unconscious state from injury to his head—as well

Fig. 1.—Taken from cast of hand and forearm, showing the usual deformity in Colles's fracture.
Fig. 2.—Section of radial half of radius and carpus as reflected in a mirror, showing the ordinary displacement of the lower fragment and carpus in Colles's fracture.

as after death, it was easy to reduce the displacement, which was of the ordinary kind, but by letting the hand go the fragments at once regained their displaced position. A plaster cast was made with the hand straight out, and another with the wrist fully flexed. In the former (Fig. 1), the deformity is seen to be marked and of the usual kind, but in the latter (Fig. 3) it is reduced and the natural contour of the wrist is seen.

Fig. 3.—Cast of same hand and forearm as shown in Fig. 1, showing complete disappearance of deformity in Colles's fracture by simple flexion at the wrist.

Fig. 4.—Section of ulnar half of radius and carpus, showing reduction of displacement when wrist is flexed (opposite half to that seen in Fig. 2).

The forearm and hand after their removal were sectionised in a median antero-posterior plane: one half was left with the hand straight out, but in the other the hand was bent forwards on the forearm in the positions corresponding to

those seen in Figs. 1 and 3, under which they are respectively placed. One half was hardened with the fragments in their displaced positions; in the other half the wrist was fully flexed forwards to reduce the displacement of the fragments and to restore to the radius its natural contour. In the former the characteristic displacement and impaction are well exhibited (see Fig. 2), whereas in the latter the broken fragments are replaced and the articular surface of the radius is in its proper position (see Fig. 4). It may here be observed that in the natural radius the lower end is carried forwards and is surmounted by the articular surface, which looks slightly forwards as well as downwards; but in a radius, the seat of Colles's fracture, the lower end is, on the contrary, carried a little backwards and the articular surface looks not only downwards but decidedly backwards. As shown in Fig. 5, the lines joining the hinder and the fore part of the articular surfaces cross one another at an angle of 37° in these two specimens, the articular plane in the normal radius being 15° below, and that in the radius the seat of Colles's fracture 22° above the horizontal as the bone is held erect. This is the chief deformity which is present in a recent Colles's fracture and which persists, and is indeed the one that is difficult to remove by pulling and flexing the hand to the ulnar side. On the contrary, an outline in a transverse vertical section of a normal radius, and one in which there had been a Colles's fracture shows that the articular surfaces run in this direction in each specimen almost parallel to one another (Fig. 6), there being no tilting up-

Fig. 5.—Mesial antero-posterior sections in outline of (a) normal radius, and of (b) radius after a Colles's fracture.

Fig. 6.—Transverse sections in outline of (a) normal radius, and of (b) radius after a Colles's fracture.

wards and outwards of the outer end of the articular extremity of the radius that had been broken. The specimen from which this drawing was taken was selected from a large collection of specimens of ordinary examples of Colles's fracture, and it only shows what each of the others does namely, that there is no important displacement in an outward and upward direction of the lower fragment.

Hitherto it has been generally thought that, when the usual method of reducing Colles's fracture, namely, pulling the hand straight out, fails to produce dissociation of the displaced fragments, the broken parts were jammed into one another—impacted—the shaft being driven into the expanded, and may be split, lower end. That difficulty in dissociation of the fragments often occurs under these circumstances I am quite convinced of and have demonstrated it to my pupils and others on several occasions, but that firm impaction does exist in such cases is, however, clearly disproved by the adoption of another method of reduction, namely, flexion of the wrist, which immediately replaces the fragments and restores to the radius its natural outline and contour. I am as convinced as was Dr. Alex. Gordon that impaction, which may be said to occur to a more or less degree in most ex-

amples, can with ease be overcome by manipulation with or without an anæsthetic. What is there, then, that prevents reduction of the displaced fragments by a fair steady and straight pull, and gives rise to the idea of a firm impaction of the fragments into one another? I would venture to offer the following explanation, and, in order to make matters easier, I will first refer to some anatomical points. Take a median antero-posterior section through the forearm and hand in which the joints of the wrist and carpus are sectioned, the joint surfaces being no longer kept together by the influence of atmospheric pressure. In such a specimen traction upon the hand will separate the lower row of carpal bones from the upper and the upper from the radius to a distance of at least one-sixth of an inch respectively (see Fig. 7). The anterior and posterior ligaments of these two

Fig. 7.—Diagrammatic mesial sections of bones of wrist. A, normal. B, Separation of bones when hand is pulled upon.

joints are naturally a good deal longer than is necessary just to join the bones together; and this extra length is in order to allow of the great range of movement which may take place in the carpus itself, and in the wrist joint proper.

In the living person traction of the hand upon the forearm is accompanied by an appreciable "give" in the carpus and in the wrist joint, and this, it seems to me, can be fully accounted for by the laxity of the anterior and posterior ligaments of these joints, so that when the hand is pulled upon the bones of the forearm and the first carpal and second row of bones are separated from one another to a certain distance, the ligaments being at the same time indrawn into the intervals thus created between the adjacent articular surfaces just as they are in the interphalangeal joints when the fingers are pulled upon, and a pull upon the hand is first expended in distancing the two rows of carpal bones from one another and the carpus from the radius and the ulna covered by the triangular fibro-cartilage. This seems to me to be a satisfactory explanation of the "give." Further traction upon the hand by a straight pull sets up a state of contraction in both flexors and extensors, a state in which it is very difficult even by the aid of considerable force to elongate the muscles. The "give" which occurs in pulling upon the hand is equivalent to the distance the bones can be separated from one another owing to the laxity of the ligaments and to the degree of extension the muscles of the forearm and wrist are accustomed to allow but beyond this limit they offer great resistance.

Now in Colles's fracture a similar result follows traction (straight pull) of the hand upon the forearm for something "gives," but the displaced fragments remain unaffected and the deformity uncorrected. The "give" is what the limit of simultaneous extension of the flexors and extensors of the forearm and of the ligaments allow but beyond that the yielding is so small as to be for all practical purposes insignificant, further traction proving ineffective. In other words a pull upon the hand in a case of Colles's fracture is followed by a "give" which is like that obtained in an uninjured limb, a further pull causes simultaneous extension of the opposing groups of muscles, flexors and extensors, which extension throws each group into a state of contraction such as will scarcely yield to any moderate force. The ineffectiveness of simple traction upon the hand in reducing the displacement

in an ordinary Colles's fracture is, I believe, thus accounted for.

When the hand is bent forwards, however, the extensors readily yield and the dorsal ligaments of these two joints are soon put on the stretch and afterwards any pull upon them by further flexion at the wrist is communicated to the turned-back fragment of the radius, to which the posterior ligament is attached, causing it to yield and turn forwards to its proper position, all deformity thereby disappearing. When the hand in this injury is bent forwards the dorsal ligament of the wrist and mid-carpal joint soon become stretched, that is, before the full limit of flexion is attained, and in order to obtain a proper degree of bending the hand must pull the displaced fragments of the radius downwards and forwards full flexion of the wrist joint necessitating complete replacement of the broken articular end of the radius.

To resume the main theme, the difficulty in the treatment of this fracture no doubt chiefly results from inability in effecting reduction which, as has been demonstrated above, can be accomplished with comparative ease by flexing the wrist-joint but not by pulling the hand straight out. Now once the fragments are reduced and the normal position is acquired by flexion of the wrist-joint, recurrence of the displacement can only be prevented by fixing the hand in this new position. For as soon as the hand is again pulled into the straight line with the forearm the fragments become displaced even in spite of moderate or considerable traction upon the hand; and if displacement does not recur immediately it is almost certain to show itself as the swelling subsides to the great disappointment of the surgeon. The hand

Fig. 8.—Splint as applied on right side. Fig. 9.—Splint for right hand and forearm.

The splint is prepared by laying on its upper surface a single or double fold of lint cut to shape and stuck to the metal with gum along the middle. When the injured hand is flexed the splint is applied on its under surface where it is secured by the straps. The straps should not be drawn tightly on the first occasion, as swelling is certain to take place in and around the seat of fracture. A sling to support hand and forearm is next adjusted and the limb laid comfortably in it. The splint is made by Mr. Offord, Cambridge, at a cost of 6s. 6d.

can be easily fixed in this flexed position upon an ordinary Carr's splint by placing a large pad in front of the lower end of the shaft of the radius and strapping the forearm and hand to the splint—a dorsal splint being unnecessary. This forms a good makeshift and serves its purpose well. The dorsal splint devised by Dr. Alex. Gordon, of Belfast, serves a similar purpose, that is, it maintains flexion at the wrist and

he obtained good results in all the cases thus treated. Modifications of Gordon's splint, to which I need not refer, have since been invented.

The splint which I have designed (Fig. 8) seems, however, better adapted to effect this purpose, and its use is attended with good results. The splint itself is light, comfortable and not expensive. After a few trials it was found that the same splint with the help of a little padding could be made to fit the forearm of almost all adults and consequently the same splint may if necessary be used over and over again—a considerable economy. It may be constructed of copper, brass, aluminium, etc., and it is made in such a way as to fit pretty accurately on the front of the lower part of the forearm and palm of the hand when the wrist is almost fully flexed; a strap across the back of the forearm at a level where the bellies of the muscles thin out secures the upper end and a Y-shaped strap across the metacarpals, one limb going to the outer side of the wrist above and the other below the thumb secures the hand. In copper-nickel it weighs only 6 ounces. The thumb and fingers are thus left free and nothing more is required except a sling of the ordinary kind. When the hand is thus flexed without restraint of any kind it is of interest to note that it is carried slantingly to the ulnar side and the splint was modelled with the hand in this position. Accordingly there is in addition to simple flexion at the wrist a slant given towards the ulnar side. At the end of 14 days and after several inspections and adjustments of the straps if necessary the splint should be taken off and the wrist moved freely in all directions, the lower end of the radius being at the same time gently supported by the hand of the surgeon. This manipulation is usually almost painless. In seven days more the wrist and fingers should be freely moved and at the end of four weeks the splint should be discarded for the sling and the patient allowed free use of the hand, movement being then as a rule quite free. At first extension at the wrist joint is limited but this is apparent not real, and it is, I presume, due to keeping up a flexed position for so long a time.

The results obtained by this method of reduction of the displacement in Colles's fracture and of fixing the broken limb are very satisfactory. For at the end of four weeks—a time when the uniting medium in a cancellous bone has generally undergone consolidation—the movements at the wrist are free in all directions, there is no stiffness and no pain—just what we should expect if the fragments were apposed in a proper position.

Of late years much attention has been paid to massage as a dispeller of stiffness and as a freer of joints after fractures in their neighbourhood. The advantages gained by early massage in fracture of articular extremities of bones are undoubtedly great, but proper setting and the maintenance of complete reduction of the displacement until firm union of the fragments occurs practically does away with the necessity for it. For when broken parts are properly replaced, healing takes place with but little if any deformity, and normal movements can be resumed without pain or discomfort—the two most important factors in controlling the instinctive or involuntary movements of a joint. Do away with these deterring factors and the patient is soon seen to be using and exercising the damaged joint and, almost imperceptibly, a free and full range of movement is quickly re-established. By this, I do not desire to disparage anyone in the use of massage after these and similar injuries, but all I wish to emphasise is, that it is of far greater importance to reduce the displacement and to maintain the reduction and thus to restore the original contour of the articular surfaces than to practise early movement. The stiffness of the joint results from incomplete reduction of the displaced fragments and consequent distortion of the articular surfaces, which throws the carpus backwards, and causes the most serious interference with the joint movements. Replace the fragments, and massage, except of a very trifling kind, is unnecessary. If treatment fails to replace the fragments then massage will prove of great service, and the sooner it is begun the better will be the result in avoiding permanent stiffness of the wrist joint in a Colles's fracture. Before concluding, I desire to express my thanks to Mr. Scaping, house surgeon at Addenbrooke's, for valuable hints and suggestions, and for the care he has taken in the treatment of the cases that came under my care.