A contribution to the surgery of fractures and dislocations of the upper extremity : based upon an analysis of about seven hundred consecutive cases observed at the Manchester Royal Infirmary / by J. E. Platt.

A CONTRIBUTION TO THE SURGERY OF FRACTURES AND DISLOCATIONS OF THE UPPER EXTREMITY

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OF THE

UPPER EXTREMITY

BASED UPON AN ANALYSIS OF ABOUT SEVEN HUNDRED CONSECUTIVE CASES OBSERVED AT THE MANCHESTER ROYAL INFIRMARY

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ILLUSTRATED BY 23 DRAWINGS AND SKIAGRAMS

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PREFACE.

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THE analysis of the cases which are recorded in the succeeding pages will, I trust, add to our knowledge of a frequent, but at the same time often obscure, class of injuries.

This work is almost entirely a reprint of a series of papers which I contributed to THE MEDICAL CHRONICLE during the latter part of 1898 and the early part of the present year, and I am indebted to the Editors of that Journal for their kind permission to reproduce the papers in their present form.

My thanks are also due—

To Messrs. P. McDougall, R. T. Hughes, J. S. Dockray, T. V. Cunliffe, R. D. Cran, F. C. Moore, E. W. Battle, J. P. Hall, B. V. Watkins, J. A. K. Renshaw, A. V. Davies, and J. H. Renshaw, who successively acted as House-Surgeons at the Manchester Royal Infirmary during the time in which the patients came under observation, and who gave me much assistance in recording the details of the cases.

To the Honorary Surgeons of the Manchester Royal Infirmary for their kind permission to make use of all the cases of fractured and dislocated arms which were admitted as In-patients during the time in which I was keeping these records.

To Mr. G. A. Wright, F.R.C.S., for the loan of a considerable number of skiagrams.

To Professor A. H. Young for permission to publish drawings of two specimens in the Anatomical Museum of Owens College.

And to my friend, Mr. W. P. Stocks, F.R.C.S., for much assistance in correcting the proof-sheets, and for many valuable suggestions whilst the work has been passing through the press.

The skiagrams from which the great majority of the illustrations have been reproduced, were taken by Mr. W. I. Chadwick, of Manchester.

J. E. PLATT.

ST. JOHN STREET, MANCHESTER,
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A CONTRIBUTION

TO THE

SURGERY OF FRACTURES AND DISLOCATIONS OF THE UPPER EXTREMITY.

INTRODUCTION.

DURING a recent period of two years—October, 1894, to October, 1896—whilst holding the position of Resident Surgical Officer at the Manchester Royal Infirmary, I had charge of the Casualty Department of that Institution, and had exceptional opportunities of observing cases of fracture and dislocation of the upper limb. For a period of nearly fifteen months—May 20, 1895, to August 9, 1896—I kept permanent records of all such cases which came under my notice. These records, which form the basis of the present essay, were kept in the following way: When the patient first came for treatment, an account of the nature of the injury, of the cause of the accident, the displacement of the bones, the method of treatment, and of any special features presented by the case, was entered in a book provided for the purpose; when he came for subsequent inspection, a note of his condition was taken on each occasion. I did not in all cases see the patient myself at the time of his first visit; on this occasion he was seen either by myself or by the house-surgeon on duty at the time, but at the subsequent visits he always came under my personal notice, and great care was taken to correct any errors of observation which might have

crept into the original account of the case. In dealing with the cases in the subsequent pages, I have eliminated any doubtful statements, so as to make the conclusions arrived at as reliable as possible.

Whilst recording these cases I have not infrequently met with examples of injuries which are usually regarded as being of rare occurrence, and have formed the opinion that the supposed rarity of some of these accidents is due to the condition being in most cases either overlooked or not recorded.

Part I.

FRACTURES.

Chapter I.

GENERAL CONSIDERATIONS.

THE number of fractures of the bones of the upper extremity, excluding fractures of the carpus, metacarpus, and phalanges, treated at the Manchester Royal Infirmary, during the period already mentioned, was 611—560 out-patients and 51 in-patients. The situation of the fracture was as follows:—

	Out-Patients.	In-Patients.	Totals.
Clavicle	102	13	115
Scapula	4	1	5
Humerus	113	18	131
Radius and Ulna	129	13	142
Radius alone	176	3	179
Ulna alone	36	3	39
	560	51	611

With regard to the cases treated as in-patients I have not, except in a few instances, full notes of their condition, and shall therefore make but limited use of them in the subsequent pages. I add them, however, for the sake of completeness. In all, accounts wil be given of 565 fractures of the bones above the wrist, and in addition a few general remarks will be made about injuries to the carpus, metacarpus, and phalanges.

In one respect out-patients are disappointing, for in many cases, having completely recovered, they fail to present themselves for inspection, and consequently I have not infrequently been unable to record the final result in patients who had almost recovered at the time they were last seen.

In the following pages I shall not attempt to give a systematic account of fractures of the upper extremity. Details of all the cases will be given, and, whenever possible, they will be arranged in tabular

form. The remarks will to a large extent be confined to points which are actually illustrated by the cases mentioned, and to the opinions which have been formed during their treatment.

I am aware that the value of my records is impaired by the fact that skiagrams of the cases were not taken soon after the occurrence of the accident. A large proportion of the patients were treated before the discovery of the remarkable properties of the Röntgen rays, and during the latter part of the period I had no facilities for this method of diagnosis. In order to fill up this defect and to illustrate some of the points to which reference will be made, I have had skiagrams taken of a certain number of the patients at a later period. I have further to express my most sincere thanks to my former teacher, Mr. G. A. Wright, for giving me access to his valuable collection of skiagrams and for his kind permission to make use of a considerable number of them.

It is necessary to mention that patients who had two fractures of different bones, except in the case of the radius and ulna, are counted twice, and the same rule has been followed with regard to patients who came under observation at two different periods with distinct fractures of the same bone.

In analysing the cases I have carefully compared the results with those given in recognised works. The books which have been chiefly consulted are the special works on fractures by Hamilton, Pick, R. W. Smith, Gurlt, and Malgaigne, and the systematic treatises on surgery by Holmes, Erichsen, and Treves. In addition to these a large number of special papers have been referred to.

Before going on to treat the cases systematically, it will be convenient to study them collectively with regard to the sex and age of the patients and the side of the body affected. Information upon these points is given in Tables A and B.

Sex.—As will be seen from Table A, more than two-thirds of the patients were males. The exact numbers were 432 males and 179 females. Up to the age of 50, each decennium showed an excess of male patients; after the age of 50, considerably more than half the patients were females, but this was due entirely to the greater frequency with which Colles' fracture was met with in old women. The great majority of the children who came for treatment with fractures of the arm were boys.

Age.—The ages of the patients are also given in Table A. It will be seen that by far the largest number of cases occurred in the first two decennia, rather more in the second than the first. After the age of 20 the numbers remained fairly constant, although they diminished somewhat after the age of 50.

TABLE A.—FRACTURES OF UPPER EXTREMITY.

In and Out-Patients. Age and Sex of Patients.

	Age 0-10.		Age 10-20.		Age 20-30.		Age 30-40.		Age 40-50.		Age 50-60.		Age Above 60.		Totals.		
	Sex.		Sex.		Sex.		Sex.		Sex.		Sex.		Sex.		Sex.		Sex. M. and F.
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
Clavicle	19	25	15	4	15	3	9	3	8	2	2	4	3	3	71	44	115
Scapula	..	..	..	..	..	..	1	..	2	..	2	..	..	..	5	..	5
Humerus—upper end	3	1	8	1	2	..	1	..	1	1	3	4	4	4	22	11	33
shaft	4	2	8	..	4	..	6	..	4	..	3	..	3	1	32	3	35
,, lower end	26	9	20	..	1	..	3	.	3	..	..	..	1	..	54	9	63
Radius and ulna—upper ends	2	..	1	..	5	1	2	..	1	..	4	..	1	..	16	1	17
,, ,, shafts	48	21	72	4	14	2	9	5	12	3	5	3	4	2	159	40	199
,, ,, lower ends	11	3	37	4	2	2	7	7	14	16	1	21	1	18	73	71	144
Totals	108	61	161	13	43	8	38	15	45	22	20	32	17	28	432	179	611

The *Side of the Body* on which the fractures were situated, is shown in Table B:—

TABLE B.—SIDE OF BODY AFFECTED.

Out-Patients Only.

	Right.	Left.	Not Recorded.	Totals.
Clavicle	39	55	8	102
Scapula	1	3	—	4
Humerus—upper end	9	19	5	33
,, shaft	11	6	3	20
,, lower end	24	31	5	60
Radius and ulna—upper ends	6	7	2	15
,, ,, shafts	68	102	12	182
,, ,, lower ends	57	80	7	144
Totals	215	303	42	560

It will be noticed that of 518 cases in which information upon this point was recorded, the right arm was broken in 215 and the left in 303. Throughout the cases there was a preponderance of fractures of the left arm, a fact which does not admit of satisfactory explanation.

Chapter II.

FRACTURES OF THE CLAVICLE.

During the period already mentioned 102 fractures of the clavicle came under my notice. They may be classified as follows:—

Incomplete or Greenstick fractures	25
Complete fractures—middle third of bone	31
„ „ junction of middle and outer thirds	38
„ „ between conoid and trapezoid ligaments	7
„ „ outside the ligaments	1
Total	102

In addition to the above, 13 cases of fracture of this bone were treated as in-patients, viz.:—

Fractures of middle third or at junction of middle and outer thirds, along with other injuries necessitating admission. (These cases are not included in the subsequent tables.)	11
Double fracture of right clavicle with subluxation of sternal end of left clavicle	1
Fracture of right clavicle with fracture and dislocation of outer end of left clavicle	1
Total	13

From an analysis of the cases which were treated as out-patients we gather the following facts:—

Sex.—Of the 102 patients, 62 were males and 40 females. Of adults over 20 years of age, 29 were men and only 12 women. These figures agree with the observations of other writers that, in adults, fracture of the clavicle is much more frequent in the male sex.

Age.—The ages of the patients were—

Under 5 years	22
5 to 10 „	23
11 „ 20 „	16
21 „ 30 „	16
31 „ 40 „	11
41 „ 50 „	7
51 „ 60 „	4
61 „ 70 „	3
Total	102

This table illustrates the fact that fractured clavicles occur much more frequently in children than in adults; nearly 50 per cent of the cases were in patients under 10 years of age.

Side Affected.—In 8 cases the notes fail to give information upon this point; but of the remaining 94 cases the right clavicle was broken in 39 and the left in 55. The preponderance of fractures of the left clavicle was especially marked in those cases where the bone was completely broken in the middle third or at the junction of the middle and outer thirds. Of 64 cases of this description the right clavicle was broken in 21 and the left in 43.

INCOMPLETE OR GREENSTICK FRACTURES.

Incomplete fracture of the clavicle is one of the commonest accidents of childhood, and one which is not infrequently overlooked. Children are often brought to the casualty departments of hospitals with an indefinite history of a fall out of bed or a fall down stairs, and it is sometimes difficult to localise the injury which they have sustained. I have several times seen examples of this fracture which have in the first instance been treated as contusion of the shoulder, or even as an injury to the elbow or wrist. Not infrequently the amount of deformity is at first very slight, and this increases the difficulty of the diagnosis. After a few days, however, a callus-tumour appears at the seat of fracture. The nature of the lesion in these cases is shown in the accompanying diagram (Fig. 1). The fracture usually starts at the anterior border of the bone in the middle third. After it has extended

FIG. 1.
DIAGRAM OF GREENSTICK FRACTURE OF CLAVICLE.

for a short distance, it tends to take a longitudinal direction and to split the bone to a greater or less extent. If the force be further continued, the posterior part of the bone may give way, and the fracture then becomes complete.

From the incomplete nature of the greenstick fracture, it follows that there can be but little displacement of the broken ends. Usually they project slightly forwards, and an irregularity can be detected when the finger is passed along the bone. Sometimes one fragment, generally the inner, projects a little more than the other.

The accompanying table (Table I.) gives an account of 25 cases of this injury. The points illustrated by these cases are as follows :—

Age.—The youngest patient was aged 1 year and 10 months, the oldest was 13 years. The great majority of the patients were between

TABLE I.—GREENSTICK FRACTURES OF THE CLAVICLE.

No.	Age	Sex.	Date of Injury.	Position of Fracture.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Result.
1	6	M	1895 May 23	Junction of outer and middle thirds	R	Fall on front of shoulder	Inner fragment more prominent than outer	No treatment for two days after injury	Sayre's method	16 days	Last seen 16 days after accident; then slight prominence at seat of fracture
2	2½	F	June 8	Junction of outer and middle thirds	R	Fall on shoulder	Slight irregularity at seat of fracture	.....	Arm fixed to side by strapping and bandage	17 days	Patient not seen after removal of bandages
3	10	M	June 12	Middle of bone	L	Fall on shoulder	Slight prominence at seat of fracture	.....	Arm fixed to side by strapping and bandage	16 days	Last seen 25 days after accident; bone thickened by callus
4	3	M	July 18	Junction of middle and outer thirds	L	Fall	Slight prominence at seat of fracture	.....	Sayre's method	12 days	Last seen 12 days after accident; bone thickened by callus
5	5	M	July 24	Rather internal to middle of bone	R	Fall down steps	Slight prominence at seat of fracture	Not seen until day after injury	Arm fixed to side by strapping and bandage	16 days	Last seen 16 days after accident; bone slightly thickened by callus
6	2½	M	July 24	Junction of outer and middle thirds	R	Fall on shoulder	Very slight prominence of inner fragment	Not seen until day after injury	Arm fixed to side by strapping and bandage	13 days	Recovery delayed by another fall on shoulder; quite well on Sept. 17.
7	4	F	July 29	Middle of bone	L	Fall on shoulder	Slight prominence at seat of fracture	Not seen for 8 days after injury	Arm fixed to side by strapping and bandage	..	Patient only seen once afterwards
8	2½	F	Sept 2	Junction of outer and middle thirds	L	Fall	Slight prominence at seat of fracture	.....	Arm fixed to side by strapping and bandage	15 days	Oct. 1, quite well, except slight thickening by callus
9	4	M	Aug 27	Middle of bone	L	Fall on shoulder?	Slight prominence at seat of fracture	Fracture not recognised until Sept 6	Arm fixed to side by strapping and bandage	11 days	Last seen Sept. 17; bone thickened by callus
10	1½	F	Sept 13	Not stated	?	Fall	Slight prominence at seat of fracture	.....	Arm fixed to side by strapping and bandage; small axillary pad	..	Patient not seen again
11	7	M	Sept 15	Junction of outer and middle thirds	R	Fall on shoulder	Slight prominence at seat of fracture	.....	Arm fixed to side by bandage	22 days	Last seen Oct. 8; bone slightly thickened by callus

12	6	F	Sept 27	Middle of bone	R	Fall down stairs	Slight prominence at seat of fracture	.....	Arm fixed to side by bandage	..	Patient not seen again
13	13	M	Oct 10	Junction of outer and middle thirds	R	Fall on point of shoulder	Slight prominence at seat of fracture	.....	Sayre's method	..	Last seen 12 days after accident
14	5	M	Oct 22	Middle of bone	L	Fall on shoulder	Slight prominence at seat of fracture	.....	Sayre's method	21 days	At first thickening from callus; this had quite disappeared 3 months after accident
15	4	F	Dec 14	Not recorded	L	Fall	Slight prominence at seat of fracture	.....	Sayre's method	..	Last seen 10 days after accident
16	2½	M	Dec 24	Middle of bone	?	Fall down steps	Slight prominence at seat of fracture	.....	Arm bandaged to side	14 days	Last seen 14 days after accident
17	7	M	1896 Jan 31	Middle of bone	R	Fall from platform	Slight prominence at seat of fracture	.....	Sayre's method	..	Last seen 2 days after accident
18	4	F	April 20	Middle of bone	L	Fall down steps	Slight prominence at seat of fracture	.....	Arm fixed to side by strapping and bandage	15 days	Last seen 15 days after accident
19	6	F	April 19	Middle of bone	R	Fall	Slight prominence at seat of fracture	Patient first seen two days after accident	Arm fixed to side by strapping and bandage	23 days	Last seen May 12; bone slightly thickened by callus
20	2	M	May 10	Middle of bone	R	Fall down stairs	Slight prominence at seat of fracture	.....	Sayre's method	19 days	Callus quite absorbed 7 weeks after accident
21	3	M	May 30	Middle of bone	R	Fall on shoulder	Slight prominence at seat of fracture	.....	Arm bandaged to side	10 days	Result uncertain: only seen once after removal of bandages
22	3	F	June 7	Middle of bone	L	Fall down stairs	Slight prominence at seat of fracture	.....	Arm fixed to side by strapping and bandage	16 days	Last seen 23 days after injury; then quite well
23	10	M	June 7	Middle of bone	R	Fall	Slight prominence at seat of fracture	No treatment for two days	Arm fixed to side by strapping and bandage	9 days	Last seen 5 weeks after accident; very slight thickening from callus
24	6	F	June 16	Junction of outer and middle thirds	R	Fall on shoulder	Slight prominence at seat of fracture	.....	Arm fixed to side by strapping and bandage	14 days	Last seen 2½ weeks after accident; inner fragment rather prominent
25	7	F	June 18	Junction of outer and middle thirds	R	Fall on shoulder	Slight prominence at seat of fracture	.....	Sayre's method	19 days	Last seen 19 days after accident

the ages of 2 and 8 years; after 8 this form of fracture is less frequent. As puberty approaches, the bone becomes more firmly ossified and, hence, complete fracture is the rule rather than the exception.

From time to time cases of fracture at an earlier age than the age of my youngest patient have been recorded, and there is no reason why fracture of the clavicle should not occur at any age after birth or even during intra-uterine life. Thus Gibson[1] has reported a case in which fracture of this bone occurred from traction on the arm during birth, and Gurlt[2] has collected seven cases of intra-uterine fracture from external violence. Mr. A. E. Barker[3] has also recorded a case in which fracture of the clavicle was noticed soon after birth, but in this instance a definite opinion could not be given as to whether the fracture was intra-uterine or extra-uterine.

Position of the Fracture.—The fracture is almost invariably situated at a point between the inner border of the conoid ligament and a point midway from the sternal and clavicular ends of the bone. In the majority of cases it is at, or slightly external to, the middle of the bone. Of my 25 cases, the fracture was situated near the middle of the bone in 14 and at the junction of the middle and outer thirds in 9. In two cases its exact position was not recorded. Once only was it internal to the mid-point of the bone (Case 5).

The *Cause* in many cases could not be exactly defined. Frequently we could learn nothing more than that the child had fallen out of bed or down stairs. In all cases where the exact nature of the injury was known, the fracture appeared to be due to indirect violence, the force having been received on the shoulder.

Displacement.—In all cases there was more or less prominence of the bone at the seat of fracture. The prominence was sometimes very slight; in other cases it was well marked. Occasionally the inner fragment projected rather more than the outer.

It is noteworthy that in several cases the child was not brought for treatment until one, two, or more days had elapsed after the receipt of the injury.

Treatment in these cases is usually very simple. If the fragments be prominent, an attempt may be made to push them into position by pressure. This was done in several cases and was, I think, attended with benefit. In carrying out this procedure care should be taken to avoid making the fracture complete; for, as has been pointed out by J. B. Roberts,[4] "over-zealous attempts at straightening may cause a greater degree of deformity by separating the fragments." An axillary pad can be dispensed with; but in all cases it is advisable to place a thin layer of cotton-wool in the axilla to prevent the skin-surfaces from coming in contact. The treatment adopted in all cases

was the fixing of the arm to the side by means of bandages or strapping. Usually the arm was kept at rest for about fourteen days.

Results.—More or less thickening of the bone from callus is almost invariably present for some time after the injury. Most of my patients were lost sight of soon after the removal of the supports, and hence in only two cases was I able to keep the child under observation until the absorption of the callus was complete. In one of these the prominence of the bone had disappeared seven weeks after the accident; in the other, absorption was complete at the end of three months.

COMPLETE FRACTURES OF THE CLAVICLE IN THE MIDDLE THIRD OF THE BONE AND AT THE JUNCTION OF THE OUTER AND MIDDLE THIRDS.

The great majority of fractures of the clavicle are met with in one of these situations. Of my 102 cases, 31 were complete fractures in the middle third of the bone, and 38 at the junction of the outer and middle thirds. Usually the line of fracture is oblique, travelling from before backwards, downwards, and inwards. The inner end of the acromial fragment is displaced in the direction of the line of fracture. In oblique fractures the maintenance of the fractured ends in good apposition is so difficult that there is almost invariably some permanent deformity. On the other hand, the amount of displacement in cases of transverse fracture is usually not great, and as there is seldom much difficulty in keeping the fragments in position, the fracture usually unites without displacement.

An account of the cases is given in the accompanying Tables II. and III.

From an analysis of these cases we gather the following facts:—

Age.—The ages of the patients were—

	Fractures of Middle Third.	Fractures at Junction of Outer and Middle Thirds.
Under 10 years	8	12
10 to 20 „	5	11
21 „ 30 „	8	5
31 „ 40 „	5	3
41 „ 50 „	4	1
51 „ 60 „	1	3
Over 60 years	0	3
Totals	31	38

From the above it will be seen that even complete fractures of the clavicle occur mostly in young people—one half of my patients were under the age of 20 years. Several were quite young children, and

TABLE II.—Complete Fractures of Clavicle—Middle Third.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Permanent Deformity.	Remarks on Result of Case.
26	37	M	1895. June 10	R	Fall on shoulder (? kick of horse)	Usual (Inner fragment slightly upwards; outer fragment backwards, inwards, and downwards	Elbow ankylosed from old fracture; difficult to fix arm	Sayre's method	..	.....	Last seen 11 days after injury
27	30	F	June 16	R	Fall on shoulder	Usual	Did not come for treatment until next day	Sayre's method, with axillary pad	..	.....	Last seen June 22; tendency to return of displacement
28	21	M	Aug 4	L	Direct violence	Usual	.....	Sayre's method, with axillary pad	..	.....	Patient not seen again
29	27	F	Aug 6	L	Fall on shoulder	Usual	.....	Sayre's method	21 days	Very slight projection of inner fragment	.....
30	2½	M	Aug 7	R	Fall on shoulder	.....	.....	Sayre's method	20 days	Slight projection of inner fragment	.....
31	19	M	Aug 12	R	Fall on back of shoulder	Usual	.....	Sayre's method, with axillary pad	20 days	Slight projection of inner fragment	.....
32	24	M	Sept 7	?	Lifting 28lb. weight	Usual	Fracture in same place 10 weeks before	Sayre's method	..	.....	Patient not seen again
33	32	M	Sept 22	R	Crush by horse	Usual	.....	Sayre's method	23 days	Some projection of inner fragment	.....
34	21	M	Sept 21	R	Fall on point of shoulder	Usual; splinter with inner fragment	Fracture comminuted	Sayre's method	..	.....	Patient only seen twice; sent to private doctor
35	40	M	Sept 24	R	Patient buried in sand	Usual	.....	Sayre's method; small pad over projecting fragment	28 days	Great projection of inner fragment	.....
36	43	F	Oct 13	?	Direct violence – blow from bar of iron	Usual	Much contusion and swelling in supra-clavicular region	Sayre's method	..	.....	Last seen 12 days after accident
37	19	F	Nov 11	R	Fall down steps	Usual	.....	Sayre's method, with axillary pad	30 days	Considerable projection of inner fragment	.....
38	6	F	Nov 25	R	Fall on shoulder	Usual	Not seen until day after injury	Sayre's method, with axillary pad	..	.....	Last seen 11 days after accident
39	49	M	Nov 28	L	Fall of chimney-pot on shoulder	Usual	.....	Sayre's method	24 days	Slight projection of inner fragment	.....

40	3	F	Dec 22 1896.	R	Fall from chair	Usual	Not seen until day after injury	Sayre's method	18 days	Slight projection of inner fragment	.....
41	21	M	Jan 20	L	Fall on shoulder	Usual	.....	Sayre's method	22 days	Some projection of inner fragment	.....
42	17	M	Feb 1	R	"Charging" at football (force on top of shoulder)	Inner end of outer fragment directed inwards, backwards, and slightly upwards	.....	Sayre's method	20 days	.....	Last seen Feb. 25, then only slight thickening of bone at seat of fracture
43	26	M	Feb 24	L	Fall on shoulder	Usual	.....	Sayre's method	..	.....	Last seen 17 days after accident
44	43	M	March 11	L	Shoulder driven against a wall	Outer fragment slightly backwards and upwards	.....	Sayre's method	20 days	None	.....
45	19	M	March 28	L	"Charging" at football	Usual	.....	Sayre's method	20 days	Very slight projection of inner fragment	.....
46	31	M	March 30	L	Fall on elbow	.....	.....	Sayre's method	22 days	Very slight projection of inner fragment	.....
47	18	M	March 30	L	Fall whilst playing football	Usual	Fracture comminuted	Sayre's method	22 days	Loose fragment markedly prominent	.....
48	6	M	April 2	L	Fall; probably on shoulder	Inner fragment slightly forwards	Fracture transverse	Arm fixed to side by strapping	15 days	.....	Last seen 7 weeks after accident; bone thickened by callus, but otherwise quite right
49	6	F	April 3	L	Fall out of bed	Usual	? incomplete fracture	Sayre's method	18 days	Slight prominence at seat of fracture	.....
50	55	F	April 6	L	Fall down stairs on shoulder	Usual	Fracture comminuted; not seen until following day	Sayre's method, with axillary pad	29 days	Loose fragment, very prominent	.....
51	4	F	April 27	L	Direct violence	Very slight	.....	Sayre's method	18 days	.....	Last seen 2 months after accident; bone still much thickened by callus
52	$1\frac{5}{12}$	F	June 2	L	Fall	Slight prominence at seat of fracture	Fracture transverse; distinct crepitus	Arm fixed to side by bandage and strapping	10 days	None	Callus almost all absorbed 7 weeks after accident
53	44	M	June 26	L	Fall on shoulder	Usual	.....	Sayre's method, with pad over fracture	..	.....	Patient sent to Union 2 days later
54	38	M	July 10	R	Direct violence; fall of weight	Usual, but not marked	.....	Sayre's method, with axillary pad	21 days	None	.....
55	29	M	July 31	L	Fall from bicycle on shoulder	Usual; loose fragment backwards	Fracture comminuted; great bruising	Sayre's method, with axillary pad	..	.....	Last seen 11 days after accident
56	$3\frac{1}{2}$	F	July 31	L	Fall on shoulder from sofa	Usual	.....	Sayre's method	21 days	Some projection of inner fragment	.....

TABLE III.—Complete Fractures of Clavicle at Junction of Outer and Middle Thirds.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Permanent Deformity.	Remarks on Result of Case.
57	18	M	1895 July 10	L	Fall on back of shoulder	Usual	.....	Sayre's method, but strapping had to be removed on next day; after that bandages only	20 days	None	Quite right one month after accident
58	7½	F	July 14	R	Fall	Usual	Fracture oblique	Arm fixed to side by strapping	16 days	Some projection of inner fragment	Last seen 16 days after accident
59	18	M	July 18	L	Fall on shoulder	Usual	.....	Sayre's method, with axillary pad	18 days	.....	Much callus when last seen, 23 days after accident
60	21	M	July 21	L	Fall on shoulder	Usual	Skin contused; fracture almost compound	Sayre's method, with axillary pad	17 days	None	Eight weeks after accident quite well; no deformity, pain, or stiffness
61	8	M	July 27	L	Fall on shoulder	Usual	Fracture oblique	Strapping and bandage	20 days	None	Quite well one month after accident
62	63	F	Aug 9	R	Fall on shoulder	Usual	.....	Sayre's method	..	.....	Last seen 4 days after accident
63	57	M	Aug 26	L	Blow on shoulder	Usual	.....	Sayre's method, with axillary pad	23 days	None	Quite right 6½ weeks after injury
64	56	M	Sept 3	L	Fall from tramcar	Usual, but not marked	Also fracture of olecranon on same side; see No. 228	Arm fixed to side, with elbow flexed	14 days	Some projection of inner fragment	.....
65	27	M	Sept 7	L	Blow on shoulder	Usual	.....	Sayre's method	..	.....	Sent to Union 10 days after accident
66	7	F	Sept 18	L	Fall on shoulder	None	Fracture transverse	Sayre's method	13 days	.....	Last seen 13 days after accident; bone thickened by callus
67	18	M	Sept 25	R	Fall on shoulder from bicycle	Usual	.....	Sayre's method	..	.....	Sent to own medical man on day after accident
68	2½	F	Oct 1	L	Fall out of bed	Usual, but slight	? Incomplete fracture	Sayre's method; small axillary pad	..	.....	Only seen twice
69	27	F	Oct 8	?	Fall on shoulder	Usual	.....	Sayre's method	..	Marked projection of inner fragment	.....

70	37	M	Oct 19	L	Fall on shoulder	Usual	.....	Sayre's method	27 days	Some projection of inner fragment	.....
71	65	F	Nov 18	L	Fall on shoulder	Usual	Fracture of same clavicle 10 years before	Sayre's method	..	.....	Last seen 2 days after accident
72	50	F	Dec 14	L	Fall on shoulder	Usual	.....	Sayre's method	About 3 weeks	None	.....
73	14	F	Dec 20	?	Fall down stairs	Usual	.....	Sayre s method	18 days	.....	Callus-thickening when last seen, 3½ weeks after accident, but no apparent displacement of bone
			1896								
74	39	M	Jan 6	L	Fall on shoulder from dray	None	.....	Arm bound to side with strapping	22 days	None	.....
75	4	F	Feb 8	L	Fall on shoulder	Usual	.....	Sayre's method	13 days	Slight projection of inner fragment	.....
76	25	F	Feb 15	L	Fall on shoulder	Usual	.....	Sayre's method	17 days	Some projection of inner fragment	.....
77	8	F	March 18	L	Run over by a bicycle	Usual	.....	Sayre's method	20 days	Some projection of inner fragment	.....
78	14	F	March 23	L	Fall on kerbstone; direct violence	Both fragments backwards and outer fragment also upwards; loose fragment driven back between the ends of the bone	Fracture comminuted	Sayre's method	15 days	..	Last seen 3 weeks after accident; some thickening (callus), but no displacement of bones
79	16	M	April 7	L	Fall on shoulder	Only slight	.....	Sayre's method	14 days	None	.....
80	57	F	April 11	L	Direct violence; blow with cupboard door	Usual	Great extravasation and bruising of skin over fracture	Sayre's method, with small axillary pad	20 days	Some projection of inner fragment	.....
81	8	M	May 4	R	Fall on shoulder	Usual	.....	Sayre's method	22 days	Some projection of inner fragment	.....
82	4½	M	May 11	L	Fall from lurry on side	Usual	.....	Sayre's method	18 days	Some projection of inner fragment	.....

TABLE III.—Complete Fractures of Clavicle at Junction of Outer and Middle Thirds—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Permanent Deformity.	Remarks on Result of Case.
			1896.								
83	20	M	May 13	R	Fall on shoulder whilst wrestling	Usual	.....	Sayre's method	23 days	Slight projection of inner fragment	.....
84	28	M	May 16	L	Fall on elbow	Usual	Same clavicle fractured 8 months before	Sayre's method	..	.....	Sent to Union Hospital
85	10	M	May 25	R	Fall on shoulder	Usual	.....	Sayre's method	18 days	Slight projection of inner fragment	.....
86	14	F	June 28	?	Fall on shoulder	Slight—outer fragment, downwards and forwards	Did not apply for treatment until following day	Sayre's method	15 days	.....	Last seen 16 days after injury; callus, but no displacement of bones
87	7	M	July 4	L	Fall on shoulder	Usual	.....	Sayre's method, with axillary pad	15 days	Some projection of inner fragment	.....
88	32	M	July 8	L	Fall from bicycle amongst some chairs	None	.....	Sayre's method	..	.....	Patient not seen again
89	7	F	July 12	L	Fall on shoulder out of bed	Usual	.....	Sayre's method	19 days	.....	Some thickening (? altogether callus) when last seen, 4 weeks after injury
90	63	M	July 21	R	Blow on shoulder	Usual	.....	Sayre's method	..	.....	Patient not seen again
91	5	M	July 27	L	Fall on side	Usual	.....	Sayre's method	18 days	.....	Last seen 18 days after accident; bone thickened by callus
92	19	M	July 27	L	Fall on side	Usual	.....	Sayre's method	22 days	None	.....
93	17	M	July 31	R	Fall on side from scaffold	Usual	.....	Sayre's method	22 days	Marked projection of inner fragment	.....
94	3	F	Aug 2	R	Fall out of bed on shoulder	Nil	.....	Arm strapped to side	16 days	.....	Slight thickening (callus) when last seen 16 days after accident

one was a child aged only one year and eight months; in this case the bone was broken transversely near its middle point; there was distinct crepitus, but not much displacement of the broken ends.

Previous Fracture of the same Clavicle was noted in three instances; the time which had elapsed since the previous accident was 10 years, 8 months, and 10 weeks, respectively.

Comminution of the bone was present in five cases. One patient, in addition to fracture of the clavicle, had fractured olecranon on the same side.

The *Cause* of the accident was as follows:—

Falls on the shoulder	34
Blows „ „	6
Direct violence at seat of fracture	6
Falls on the elbow	2
Lifting a heavy weight—28lbs.	1
Cause unascertainable	20
Total	69

The great majority of these fractures thus arise from indirect violence applied to the shoulder. A few are due to violence applied to the elbow, although in most falls on the elbow the olecranon or the humerus gives way rather than the clavicle. Falls upon the hand are also mentioned as a cause of fractured clavicle, but I met with no example of this among my 102 cases. Six were due to direct violence from blows upon the bone; the force in some of these cases was considerable, and there was great bruising of the overlying skin. One man (Case 32), who had had a fracture of the clavicle ten weeks before, refractured the bone in the same place from lifting a weight of 28 pounds. Probably this is an example of fracture from muscular action, the previous breakage of the bone acting as a predisposing cause. A somewhat similar case of fracture of the clavicle from lifting a heavy weight has been recorded by McKee.[5]

Fracture of the clavicle from muscular action is of decidedly rare occurrence. Gurlt[6] collected 20 cases from the literature of various countries. To these we may add seven others: Three cases mentioned by Polaillon,[7] one of which had come under his own observation; a case reported by W. E. Whitehead,[8] in which a man, aged 28, broke his clavicle at the junction of the outer and middle thirds whilst attempting to raise himself to a platform eight feet high; a case of a healthy man, aged 34, who came under the notice of T. H. Manley[9]—this patient was suddenly awakened in the middle of the night by a severe pain in the right shoulder, and was afterwards found to be

suffering from a fractured clavicle; McKee's and my own cases, already referred to, in which the bone was broken whilst lifting a heavy weight.

From an examination of the above cases it would appear that in several there is considerable doubt as to muscular action having been the sole cause of the fracture. One cannot but be struck by the fact that in a large proportion of the cases the bone was previously weakened by syphilitic or tuberculous disease, scurvy, old age, or previous injury. In some cases, however, fracture from muscular action alone has undoubtedly occurred in healthy subjects with no indication of any organic disease. The particular movements which have given rise to the fracture have been most frequently: (1) Lifting a heavy weight to a level above the body or raising the body by means of the arms; (2) making a powerful muscular effort in such a direction that the arm comes to lie behind the body. Polaillon,[7] from a careful analysis of reported cases, came to the conclusion that the muscles which are most concerned in this injury are the deltoid and the clavicular part of the pectoralis major.

Four of my cases of fracture of the clavicle were due to bicycle accidents and three to football-playing; two of the latter were caused by "charging" an opponent, the force being applied to the point of the shoulder.

Displacement.—There are few fractures where the manner of displacement of the broken ends is so constant as in fractures of the clavicle at the situations under consideration. Almost invariably the outer end of the sternal fragment is slightly raised, whilst the inner end of the acromial fragment is displaced backwards, downwards, and inwards, and is overlapped by the sternal fragment. The overlapping in most cases is about half-an-inch; it may be less, or it may be as much as one inch. The accompanying skiagram (Fig. 2) illustrates very well the downward and inward displacement of the outer fragment. Omitting two cases in which the displacement was not recorded, I find that in 59 out of my 67 cases it was in the usual direction; in some cases it was only slight, whilst in others it was well marked. In four cases, all of which were fractures at the junction of the outer and middle thirds, there was no displacement; two of these were transverse fractures of the bone in children, one was a fracture immediately internal to the conoid ligament, and the fourth case had been fixed by a medical man before the patient's arrival at hospital.

Unusual Displacements.—In two cases the inner end of the *outer fragment* was displaced inwards, backwards, and *upwards.* In both the fracture was situated near the middle of the bone; in one it was due to "charging" at football, and in the other to the shoulder being driven violently against a wall. I am inclined to attribute the unusual

displacement to the force having been applied to a certain extent on the top of the shoulder, so that the outer end of the bone was driven downwards and the inner end of the outer fragment levered upwards.

In one case of comminuted fracture at the junction of the outer and middle thirds caused by direct violence, *both fragments* were driven *backwards* and the outer fragment was also displaced somewhat upwards.

Another case presented displacement of the *outer fragment slightly downwards and forwards.* The fracture was at the junction of the middle and outer thirds and was due to indirect violence applied to the shoulder.

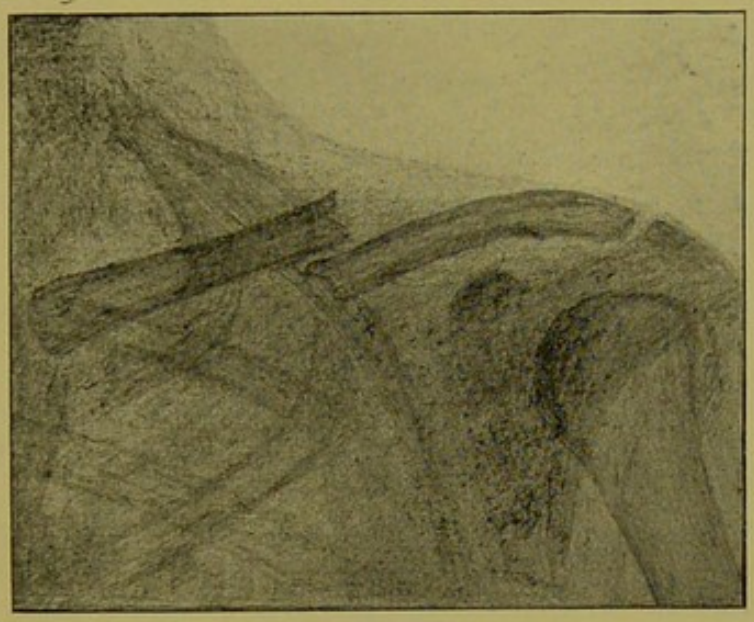

FIG. 2.

FRACTURE OF THE CLAVICLE. (From a Skiagram lent by Mr. G. A. Wright.)

According to Hamilton,[10] examples of overlapping of the sternal by the acromial fragment have been recorded by Desault, Syme, Guéretin, Malgaigne, and Stephen Smith. In Stephen Smith's case the fracture was transverse and was situated in the outer third, the sternal fragment being overlapped for one inch.

Treatment.—It may be taken as a general rule that the number of different appliances which have been recommended for the treatment of any fracture, forms a fairly accurate index of the difficulties which have to be overcome in the treatment of that fracture. The appliances which have been recommended for the treatment of fractured clavicle are very numerous; each in its turn has been highly praised, but probably not one of them has proved to be all that could be desired. With every method of treatment, it has been found very difficult, if

not impossible, to prevent some permanent deformity of the bone. The treatment I have almost invariably adopted is Sayre's method with adhesive strapping. It is unnecessary to enter into a description of this treatment; reference to a few points of practical interest will suffice.

An axillary pad is not essential in all cases. The objections to a large pad are that it may cause dangerous compression of the blood-vessels of the arm, and that it may lead to paralysis from pressure upon the main nerve-trunks. I have therefore been in the habit of dispensing with the use of an axillary pad when there was no marked tendency to inward displacement of the outer fragment, and in other cases have reduced the size of the pad as much as possible. In all cases, however, a thin layer of cotton-wool should be placed between the apposed skin-surfaces. Care should also be taken to protect the elbow, and especially the extensor surface of the forearm, from the pressure of the strapping, by means of cotton-wool; I have frequently seen cases where intolerable itching has been caused by neglect of this simple precaution. The comfort of the patient will also be greatly promoted by dusting freely with boracic powder.

However carefully the strapping be applied when the patient is first seen, and however well the displacement of the fragments be remedied, these cases are apt to be disappointing, for it will often be found, on the patient's next visit, that the displacement has returned. In many cases it is impossible to prevent a certain amount of permanent irregularity of the bone.

The average time that the arm was kept fixed was about 21 days in adults and 14 days in children.

Results:—

Cases lost sight of soon after accident	18
Union without deformity	10
„ with more or less projection of inner fragment	28
Bone more or less thickened by callus when patient was last seen, but no evident displacement of fragments	11
Loose fragments in cases of comminuted fractures much displaced forwards	2
Total	69

The cases which united without deformity include 7 fractures at the junction of the middle and outer thirds. Six of these were oblique fractures presenting the usual displacement (in one only slightly marked), and the seventh was a transverse fracture without displacement. In the other three cases the bone was broken in the middle third; one was a transverse fracture with very little displacement, another was an oblique fracture with the usual deformity only slightly

marked, and the third was a case in which the outer fragment was in the first instance displaced inwards and somewhat upwards.

The deformity in those cases which united with projection forwards of the inner fragment, varied considerably. In the great majority it was only slight; in a few it was hardly recognisable; in four it was very marked.

The cases in which the bone was thickened by callus when the patient was last seen, were lost sight of at periods varying from 16 days to two months after the accident. In many cases the thickening was only slight, and I was of opinion that ultimately it would be completely absorbed.

Before leaving this part of my subject, reference may be made to two methods of treatment of fractures of the clavicle which have been advocated during recent years. These are: (1) Treatment by massage without immobilisation, and (2) primary wiring of the bone.

Treatment by Massage without Immobilisation has been advocated, especially by Lucas-Championnière. Details of this method of treatment, together with the results of 20 cases treated by Lucas-Championnière, have been recorded by Dagron.[11] Massage was commenced at once, and was afterwards employed daily for a period of from fifteen to thirty minutes. Not only the seat of fracture, but also the adjacent joints and muscles, especially the deltoid, were manipulated. Careful movements, both active and passive, of the shoulder-joint were also carried out. During the intervals the limb was supported in a sling. Consolidation of the bone was usually effected in from 18 to 25 days, and at the end of that time the patient was able to use the arm freely.

Immediate Wiring of a Fractured Clavicle is an operation which has been performed by several surgeons in Germany, France, Italy, and America, but, so far as I am aware, the only case in which it has been carried out in this country was one of compound fracture of the bone. The chief reason which has been advanced in favour of operation is the almost constant occurrence of more or less permanent deformity after treatment by the ordinary methods. The operation appears to have been first performed by Langenbuch,[12] in 1882. In the following year Whitson[13] recorded a case of compound fracture of the clavicle in which he successfully brought together the ends of the bone with silver wire. More recently a case has been recorded by Foote,[14] in which the broken ends were united by a kangaroo-tendon suture. Février,[15] in 1896, collected 44 cases of primary and secondary wiring of the clavicle, 13 of which were associated with nerve-lesions. He states that the only disadvantage which has resulted from the operation has been some anæsthesia of the upper part of the chest-wall from division of the descending branches of the cervical

FRACTURE OF THE CLAVICLE BETWEEN THE CONOID AND TRAPEZOID LIGAMENTS.

Table IV. gives an account of 7 cases in which this injury was diagnosed.

It will be seen from the table that in two cases there was some doubt as to the presence of a fracture. Usually there is no displacement of the broken ends, and the diagnosis must be made from the presence of pain and slight crepitus on pressure over the seat of fracture. Occasionally there is a little mobility of the fragments.

Five of the patients were males, and two females. Their ages varied from 21 to 50 years. The right clavicle was broken in four cases, the left in 3. The cause of the fracture was recorded as direct violence in one case, and as a fall on the shoulder in six. Probably in some of the latter the force was applied directly to the seat of fracture.

In 5 cases there was no displacement of the fragments, owing to their being held in position by the coraco-clavicular ligaments. In one case there was slight dropping of the outer fragment. In the remaining case the fracture was oblique from before backwards and outwards, and the inner fragment was displaced somewhat backwards.

With regard to treatment, all that is necessary in most cases is to fix the arm to the side. The fracture unites readily without deformity, and recovery rapidly takes place. Almost all my patients with this injury were lost sight of soon after the accident.

FRACTURE OF THE CLAVICLE OUTSIDE THE CORACO-CLAVICULAR LIGAMENTS.

Only one example of this accident (Case 102) is included amongst my cases. The patient was a man, aged 24, who had fallen upon the point of his shoulder. The outer fragment of the bone was displaced downwards, but there was an absence of the forward rotation of the fragment, which has been described by R. W. Smith[16] as occurring in these cases. The broken arm was fixed by Sayre's method, but as the patient's circumstances raised him above the class of hospital patients, he was sent to his own medical man, and was not afterwards seen.

FRACTURE OF THE CLAVICLE IN THE INNER THIRD.

The following case of this injury was treated as an in-patient:—

Case 103.—Double Fracture of Right Clavicle (Inner Third and Outer Third), with Dislocation of Sternal End of Left Clavicle.—E. C., male, aged 22, by occupation a "capstan-man" in a shunting yard, was crushed between the buffers of two waggons, on August 27th, 1895. The right clavicle was broken one inch from the sternum, and the inner end of the outer fragment was displaced downwards, forwards, and inwards, lying somewhat below and in front of the inner fragment.

TABLE IV.—Fractures of the Clavicle Between the Conoid and Trapezoid Ligaments.

No.	Age.	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Permanent Deformity.	Result.
95	36	M	1895 June 24	R	Fall on shoulder from bicycle	None	Some doubt as to the presence of a fracture	Arm fixed to side by strapping	18 days	None	Quite well 3 weeks after accident
96	21	M	Aug 14	L	Fall on shoulder	None	Slight crepitus and pain on pressure over seat of fracture	Arm fixed to side by strapping	..	..	Last seen 6 days after accident
97	35	M	Sept 27	R	Fall on shoulder	Inner fragment slightly pushed backwards	Fracture oblique from before, backwards and outwards	Sayre's method	..	..	Last seen 4 days after accident
98	50	F	Dec 18	L	Fall on shoulder	Slight dropping of outer fragment	Patient not seen until day after injury	Arm fixed to side by strapping	..	..	Last seen 2 days after accident
99	23	M	1896 April 1	R	Direct violence	None	Great doubt as to the presence of a fracture; doubtful crepitus	Sayre's method	8 days	None	Quite well 3 weeks after accident
100	39	F	July 4	L	Fall on shoulder	None	Pain and slight mobility on pressure over fracture; no crepitus; patient not seen until following day	Arm fixed to side by strapping	15 days	None	.....
101	42	M	July 11	R	Fall whilst wrestling	None	.....	Arm fixed to side by strapping	..	..	Patient was not seen again

The same bone was also broken at the seat of the conoid and trapezoid ligaments; in this situation there was no displacement of the broken ends, but pain and crepitus were elicited on pressure. The sternal end of the left clavicle was partially displaced backwards, and the margin of the articular surface of the sternum could be distinctly felt. The displacement of the right clavicle and the dislocation of the left clavicle were both easily reduced by drawing backwards the shoulders. A pad was placed between the scapulæ, and the shoulders were drawn backwards by figure-of-eight bandages. The bandages were removed on September 10th, and on the following day the man was made an out-patient. Four weeks after the accident there was a considerable amount of callus at the situation of the inner fracture of the right clavicle, but with this exception his recovery was complete. At my request the man presented himself for examination three years later; there was then a very slight irregularity of the inner third of the right clavicle from projection forwards of the outer fragment; otherwise he had made a perfect recovery.

The fracture in this case was external to the rhomboid ligament, and the displacement was such as is stated by R. W. Smith[17] to be usual with fractures in this situation. When the bone is broken within the limits of the rhomboid ligament, displacement is usually slight or absent; when internal to the ligament, the outer fragment is drawn simply forwards (R. W. Smith).

COMMINUTED FRACTURE OF THE CLAVICLE.

In five of the cases previously mentioned the fracture was comminuted. A brief account of the cases is as follows:—

Case 34.—Male, aged 21, fracture of middle of right clavicle, caused by a fall on the point of the shoulder. The splinter was roughly triangular in shape, and involved chiefly the upper border of the bone. The outer end of the inner fragment was displaced slightly upwards in the usual manner, and the loose splinter was carried with it. Of the two the splinter was rather the more prominent. The outer fragment was displaced backwards, though not markedly so. The patient was only seen twice, and consequently the ultimate result is unknown.

Case 47.—Male, aged 18, fracture of middle third of left clavicle. The exact direction of the force which caused the fracture could not be ascertained; the youth had been knocked down whilst playing football, and another player had fallen over him. The broken ends were displaced in the usual direction; the loose fragment was in contact with the inner part of the bone, and was displaced markedly forwards. During the after-treatment it gave a great deal of trouble; it could not be kept in place, and union took place with the fragment projecting forwards.

Case 50.—Female, aged 55, fracture immediately external to middle of left clavicle, caused by a fall down stairs, the shoulder having come in contact with the ground. The displacement of the broken ends was in the usual direction. The loose fragment involved the lower part of the bone: it was displaced forwards, and gave great trouble during the subsequent treatment of the case. Union took place with the fragment somewhat displaced forwards.

Case 55.—Male, aged 29, fracture of middle of left clavicle, caused by a fall on the shoulder from a bicycle. The displacement was in the usual direction. The loose fragment was carried backwards with the outer fragment. There was great bruising of the shoulder and surrounding parts. The ultimate result of this case is unknown.

Case 78.—Girl, aged 14, fracture at junction of outer and middle thirds of left clavicle, due to direct violence. The girl fell in the street, and the clavicle came in contact with the edge of the kerbstone. Both ends of the clavicle were driven backwards, the outer fragment also somewhat upwards. Between the ends was a small loose piece of bone, which was also driven backwards. Union took place with very little deformity.

The violence causing the injury in these cases was excessive; in one the fracture was due to direct violence, and in four to indirect force applied to the shoulder. In two cases the exact limits of the fragment were made out; in both it was roughly triangular in shape. It involved mainly the upper part of the bone in one case, and the lower part of the bone in the other. The direction of displacement of the loose fragment varied. In three cases it was carried forwards with the sternal part of the bone and gave great trouble during the after-treatment. In two instances it was displaced backwards.

COMPOUND FRACTURE OF THE CLAVICLE.

This accident appears to be of very rare occurrence, except in cases of gun-shot injury. No example has come under my notice, but I have many times seen cases where the sharp, prominent end of the inner fragments pressed upon the skin and threatened to make the fracture compound. Hamilton[18] mentions four cases which he collected from various sources. A fifth case, reported by Whitson,[13] in 1883, was due to the patient being knocked down and run over by a reaping machine.

FRACTURE OF THE CLAVICLE IN TWO PLACES.

This is also of rare occurrence; the only example which has come under my notice is Case 103, already described. Franklin[19] has recently recorded an example of this accident, which was due to direct violence, and Johnston[20] one due to indirect violence.

FRACTURE OF BOTH CLAVICLES.

This is also very uncommon; the following case is therefore worthy of mention:—

Case 104.—J. C., aged 36, by occupation a porter, was engaged in "shunting" in a goods-yard when he was crushed between one of the waggons and a wall. The force was probably applied laterally, so that it tended to push the shoulders towards the middle line. The right clavicle was broken at the junction of the outer and middle thirds of the bone. The outer end of the left clavicle was dislocated upwards on the acromion, and a small fragment—about half-an-inch—of the tip was broken off. The fragment was displaced somewhat higher than the rest of the bone, but it was quite free, and could be moved in almost any direction. The accident occurred on June 19th, 1896, and the man was detained as an in-patient until June 27th. When last seen the outer end of the left clavicle was greatly thickened by callus.

UNUNITED FRACTURE OF THE CLAVICLE.

Considering the frequency with which the clavicle is broken, non-union of the fragments is of exceedingly rare occurrence. In a considerable number of the cases which have been reported there has been trouble from pressure upon the cords of the brachial plexus. Resection of the ends of the bone and wiring have been followed by excellent results. Examples of this operation have been recorded by Messrs. A. E. Barker,[3] G. A. Wright,[21] Bilton Pollard,[22] Hassler,[23] G. G. Davis,[24] C. B. Nichols,[25] and others.

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In the cases marked with an asterisk I have been unable to consult the original paper, but have given the source of information in parentheses.

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Chapter III.

FRACTURES OF THE SCAPULA.

Four cases of fracture of the acromion process were treated as out-patients and one case of fracture of the surgical neck of the scapula as an in-patient, during the time whilst I was recording my cases. The four examples of fracture of the acromion are arranged in the accompanying table (Table V.).

The acromion process is ossified from two centres, which make their appearance from the 14th to the 16th year. These centres coalesce and join the rest of the bone from the 22nd to the 25th year.[1] It would appear, however, that union of the epiphysis may be delayed until a much later period of life; thus Hamilton[2] refers to four specimens of delayed union observed by Jackson, in one of which the patient could not have been less than 40 years of age. He therefore says that most cases of supposed fracture of the acromion are really cases of separated epiphysis; other observers have made the same statement. Lane,[3] however, from an examination of the bones from 325 bodies, came to the conclusion that fracture of the acromion is an exceedingly common accident, and that this lesion is present in many cases of so-called contusions of the shoulder.

The question of fracture or epiphysial separation has recently been carefully considered by Sir John Struthers,[4] who has arrived at the following conclusions: (1) Fracture of the acromion is in all probability much more frequent than is usually supposed. (2) Fracture may occur at any part of the process—in front of the facet for the clavicle, through the facet, or behind it. Most frequently it is situated just behind the facet. (3) The latter point, which corresponds with the epiphysial junction, is the weakest part of the process. (4) In favour of these cases being usually epiphysial separations, the following reasons may be given: (*a*) The usual place of fracture corresponds with the epiphysial junction; (*b*) union of the epiphysis may in some cases be delayed beyond the usual age of 25 years; (*c*) under the age of 25 the epiphysis may undoubtedly be separated and non-union with the formation of a false joint may result. (5) Against this view, the following facts are adduced: (*a*) The position of the fracture is by no means constant; (*b*) many of the specimens of supposed epiphysial separation have been taken from persons under 25 years of age, and the epiphysis has been detached during the process of maceration. He considers that in the majority of cases the lesion is a true fracture.

TABLE V.—Fractures of the Acromion Process.

No.	Age.	Sex. ♂	Date of Injury.	Side.	Position of Fracture.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Result.
105	42	M	1895 Aug 13	L	Acromion process; ¾in. from tip	Fall on shoulder	Slight dropping of fragment and shoulder	Distinct crepitus	Arm fixed to side by strapping and bandage	22 days	Good union; no deformity; some stiffness of shoulder, but this had almost disappeared when last seen, seven weeks after injury
106	32	M	1896 March 24	L	½in. from tip of process	Fall on shoulder from scaffolding	Fragment displaced downwards	Movements of arm not much impaired, but could not lift hand above head	Strapping — (1) under elbow and over opposite shoulder, (2) round body	21 days	Good union; no deformity; very little stiffness, and this had almost gone when patient last seen, one month after accident
107	48	M	May 11	R	Close to tip of process	Fall on shoulder	Slight falling of arm	.....	Strapping—(1) to raise elbow, (2) round body	21 days	Good union; no deformity; some stiffness of shoulder when strapping removed; patient not seen afterwards
108	55	M	June 27	L	Fracture at base of acromion process	Fall backwards on shoulder	.....	Did not apply for treatment until June 30	Strapping as Sayre's method for fractured clavicle	..	Patient only attended for a week

My four patients with this accident were all adult males. The fracture was close to the tip of the process in one case, half-an-inch from the tip in a second, three-quarters of an inch from the tip in a third, and across the base of the process at its junction with the spine in the fourth. Probably in all cases the cause of the fracture was direct violence at the seat of fracture. The loose fragment was usually displaced downwards and there was some falling of the arm. The treatment adopted was much the same as Sayre's method for fractured clavicle. Three cases, which I was able to follow throughout, made good recoveries; there was firm union without deformity of the bone.

REFERENCES (Fractures of the Scapula).

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3. Lane (W. A.).—*Brit. Med. Journ.*, 1888, Vol. I., pp. 1047-1049.
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Chapter IV.

FRACTURES OF THE HUMERUS.

My notes include 113 cases of fracture of this bone, 20 involving the shaft, 33 the upper end, and 60 the lower end. Amongst the fractures of the upper end are included those occurring at or above the surgical neck; amongst fractures of the lower end are classified transverse fractures immediately above the condylar processes. All cases affecting the portion of bone between these points are included amongst fractures of the shaft. It is worthy of notice that amongst my cases of fracture there are a larger number involving the humerus than the clavicle: this would appear to be a somewhat uncommon occurrence, since the clavicle is usually stated to be broken more frequently than any other bone in the body except the radius.

In addition to the above cases the following were treated as in-patients during the same period:—

Simple Fractures—Shaft	2
„ „ —Lower End	1
Compound Fractures—Shaft	5
„ Comminuted Fractures—Shaft	2
„ „ „ „ requiring Amputation	6
„ Fractures into Elbow-Joint	2
Total	18

TABLE VI.—Fractures at or near the Anatomical Neck of the Humerus.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture and Displacement.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Result.
109	28	M	1895. May 30	R	Fall on shoulder	Anatomical neck; no displacement	.....	Shoulder-cap; arm bound to side	4 weeks	Several times after removal of supports	Patient seen on day of accident, and not again for 6 weeks; union with slight displacement forwards of lower fragment; last seen 10 weeks after accident; stiffness not quite gone
110	48	M	Sept 22	L	Fall on front of shoulder	Just below anatomical neck; shaft displaced somewhat forwards	Not seen until Sept. 25	Arm fixed to side by strapping and bandage; Oct. 15, chloroform given to correct re-displacement: union broken down	6 weeks	None	Last seen 2 months after accident; thickening around seat of fracture, and some stiffness of shoulder
111	71	F	Nov 23	L	Blow on front of shoulder by cart-shaft	Exact position of fracture uncertain; no displacement	.....	Internal angular splint and shoulder-cap	..	.....	Patient not seen again
112	71	M	1896. Feb 28	R	Direct violence	Exact position of fracture doubtful; no displacement?	.....	Arm fixed to side by strapping and bandage	28 days	None	Union without deformity; considerable stiffness of shoulder when supports removed, but greatly improved when last seen, 2 months after accident

113	54	F	April 13	L	Fall from tramcar during epileptic fit; probably on shoulder	Exact position of fracture uncertain; probably fracture of neck high up; no displacement discovered	Great swelling of shoulder	Arm fixed to side by strapping and bandage; axillary pad	..	.....	Patient admitted to wards on April 26; discharged May 11; ultimate result of case unknown
114	57	F	May 8	?	Fall on shoulder	Fracture near anatomical neck; no displacement	Great bruising of shoulder	Arm fixed to side by strapping and bandage	3 weeks	None	Very good; no deformity; only slight stiffness when strapping removed, and this had almost disappeared when patient last seen, 6 weeks after accident
115	10	M	July 28	L	Fall on arm	Fracture of anatomical neck	.....	Arm fixed to side	..	.....	Patient not seen again
116	23	M	July 31	R	Fall on shoulder—direct violence	Fracture near anatomical neck, with general comminution of head; lesser tuberosity probably chipped off, and ? fracture of glenoid cavity	Great bruising of shoulder	Arm fixed to side; Sept. 11, attempt to remedy stiffness and deformity under chloroform: union broken down	3 weeks	None	The shoulder gradually became ankylosed, and excision was performed in Nov., 1896; the articular cartilage of the humerus was almost gone, and the head of the bone had evidently been extensively comminuted
117	50	M	Aug 9	L	Fall down stairs on shoulder	Fracture near anatomical neck, with splitting off of lesser tuberosity; lower fragment displaced backwards; tuberosity inwards and downwards	.....	Arm fixed to side	26 days	None	Last seen Sept. 25; then almost well; there was no stiffness of the shoulder, but the patient had pain in it occasionally

FRACTURES OF THE UPPER END OF THE HUMERUS.

The 33 fractures of the upper end of the humerus may be classified as follows:—

Fractures at or near the Anatomical Neck	9
Fractures of the Surgical Neck	14
Separations of the Epiphysis	10
Total	33

FRACTURES AT OR NEAR THE ANATOMICAL NECK.

Details of 9 cases are given in the accompanying table (Table VI.):

In this table I have classified together fractures at the anatomical neck and fractures occurring through the tuberosities of the bone. So far as could be ascertained, the line of fracture, in two of the cases, corresponded fairly closely with the anatomical neck, whilst in the remaining seven cases the articular surface, together with a greater or smaller portion of the tuberosities, was separated. In some of the cases there was no doubt as to the presence of a fracture, but its exact position was difficult to localise.

The majority of the patients were above middle age. Six were males, and three were females. In all cases the cause of the fracture was probably direct violence, and in some, judging from the great bruising of the parts, the force must have been very great. Usually there was little or no displacement of the broken ends; one case, however, presented some projection forwards of the lower fragment, and another case, in which fracture near the anatomical neck was associated with fracture of the lesser tuberosity, showed displacement backwards of the shaft with inward and downward displacement of the tuberosity. In none of the cases was the fracture impacted. R. W. Smith,[1] Nélaton,[2] and Hamilton[3] have each recorded a case in which the upper fragment was rotated upon itself, so that its cartilaginous surface rested upon the broken surface of the lower fragment. Occasionally this injury is accompanied by dislocation of the head of the bone into the axilla, as in cases recently reported by Monks[4] and Gerster.[5]

The best treatment in these cases is the fixing of the arm to the side by means of adhesive strapping and the application of a shoulder-cap of gutta-percha or poroplastic felt. A small pad of wool should be placed in the axilla. The supports should be discarded at the end of three weeks, or, at the latest, four weeks: if retained for a longer period there is apt to be prolonged stiffness of the shoulder. Passive movement, during the earlier stages of the treatment, is, in my opinion, unnecessary, but I shall have occasion to refer more particu-

larly to this subject in dealing with fractures into the elbow-joint and of the lower end of the radius. I have come to the conclusion that the best results and most speedy recoveries will be obtained by keeping the arm at rest for about three weeks, and then encouraging the patient to persevere in active movements of the joint. Immediately after the removal of the supports there will probably be considerable stiffness of the shoulder, but this will rapidly improve, and in most cases will disappear entirely in the course of the next month or six weeks. Lucas-Championnière,[6] on the other hand, recommends that these cases be treated by early massage without immobilisation. He regards fracture of the anatomical neck of the humerus as a bad sprain rather than a fracture, and advises that massage and gentle passive movement be commenced at the end of twenty-four hours. Such treatment is, in my opinion, likely to lead to the pouring-out of an excessive amount of inflammatory exudation into the neighbouring parts, and to interfere with the union of the fragments, since the reparative material is usually small in amount, being formed almost entirely from the lower fragment. Cases of non-union and fibrous union are not uncommon after this fracture.

Results.—The results in my cases were as follows:—Three patients were lost sight of before union had taken place; five were almost well when they were last seen, at periods varying from six to ten weeks after the accident. In one man, who had a very badly comminuted fracture of the head of the humerus and probably also fracture of the glenoid cavity of the scapula, the shoulder gradually became ankylosed: he was admitted as an in-patient, and excision of the joint was performed three and a half months after the accident: when he was last heard of, the prospects of a useful false-joint were good.

FRACTURES OF THE SURGICAL NECK.

This accident is of more frequent occurrence than fracture in the neighbourhood of the anatomical neck. My notes include 14 cases, which are classified in the following list (Table VII.).

Very various statements have been made from time to time as to the age at which this fracture is most frequently met with. Undoubtedly Hamilton is correct when he says that it occurs most often in adult life; in my own experience it is most common in advanced life. Malgaigne[7] states that the age of the youngest patient he has been called upon to treat was 53 years. Fracture of the bone in this situation may, however, be met with at any period of life. Two of my patients were aged 13 and 16 respectively, but, on the other hand, 6 of the 14 cases were over 60 years of age, and 10 of the total number over 50. Sutherland[3] has recently reported a case of green-

TABLE VII.—Fractures of the Surgical Neck of the Humerus.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Result.
118	47	F	1895 June 16	L	Fall on shoulder	Lower fragment upwards and inwards	Not seen for 24 hours after injury	Arm bound to side with Gooch splint around humerus	25 days	After removal of supports	Considerable stiffness of shoulder when supports removed; patient last seen 4 weeks after accident
119	36	M	Sept 5	L	Direct injury	Upper fragment outwards, lower fragment upwards and inwards; one inch shortening	Old fracture lower end of humerus (18 years ago), with subsequent median and ulnar paralysis	Axillary pad; arm bound to side	22 days	Once before and several times after removal of supports	Complete recovery in about 2 months; never much stiffness of shoulder
120	50	F	Nov 10	?	Fall on side with arm under body	Lower fragment upwards and inwards	.....	Arm fixed to side; shoulder-cap	..	None	Last seen 3½ weeks after injury
121	54	M	Nov 13	L	Fall on shoulder	Lower fragment upwards and inwards	.....	Axillary pad; arm bound to side	27 days	Once after removal of supports	Last seen 3 months after accident; then almost completely recovered
122	64	F	Dec 25	L	Fall on shoulder	?	Not seen until day after accident	Axillary pad; arm bound to side	..	.....	Patient not seen again
123	60	F	1896 March 17	L	Direct violence—blow from shaft of cart	None apparent	Patient very obese	Axillary pad; arm bound to side	28 days	None	Some stiffness of shoulder when supports removed, but this had almost gone when patient last seen 2½ months after accident
124	67	M	April 19	R	Fall on shoulder	?	.....	Axillary pad; arm bound to side	..	.....	Patient not seen again

125	52	F	April 23	R	Fall on shoulder	None	Patient very obese, soft parts much bruised	Arm bound to side	22 days	None	Last seen 1 month after accident; then some stiffness of shoulder, but improving
126	60	M	May 18	L	Fall; ? on shoulder	Lower fragment slightly backwards	.....	Arm fixed to side; shoulder cap	29 days	None	Last seen 6 weeks after accident; stiffness not gone, but improving
127	16	M	May 28	L	Direct violence—run over by cab	Lower fragment backwards, upwards, and inwards	.....	Axillary pad: arm fixed to side; shoulder-cap	22 days	None	Last seen 7 weeks after accident; union with lower fragment drawn somewhat upwards and backwards; not much stiffness of shoulder. After removal of supports there was partial paralysis, probably from pressure on nerves, but this had almost recovered when patient was last seen
128	13	F	June 3	R	Fall: ? on shoulder	None	Patient had morbus coxæ on right side and wore a Thomas's splint; her crutches caught on the ground and threw her down	Shoulder-cap; arm bound to side	23 days	None	Quite well 2 months after accident; there was no stiffness of shoulder after removal of supports; she was allowed to use her crutches 5 weeks after the injury, and three weeks later could walk well
129	62	F	July 12	R	Fall on shoulder	None	.....	Axillary pad; arm bound to side	..	.....	Patient not seen again
130	52	M	July 14	?	Fall on shoulder	Lower fragment upwards and inwards	.....	Internal angular splint and arm bound to side	..	.....	Patient only seen once afterwards
131	68	M	July 18	L	Fall on shoulder	Lower fragment upwards and inwards	.....	Arm fixed to side	31 days	None	At first considerable stiffness of shoulder; this was better, but had not disappeared, when patient last seen, 6 weeks after the accident

stick fracture of the surgical neck of the humerus, accompanied by some longitudinal splitting of the bone, which was discovered in the body of a girl, aged 10½ years, who died from general tuberculosis. There was no tuberculous disease of the bone itself.

Seven of the patients were males, and 7 females. The left humerus was affected much more frequently than the right.

Cause.—The cause of the fracture was probably in all cases direct violence applied to the shoulder. There are, however, a few cases on record in which this part of the bone has been broken by falls upon the elbow or upon the hand, and Malgaigne[7] refers to a case, published by Goyrand, in which the fracture appeared to be due to muscular action, whilst the patient was in the act of throwing a ball.

None of the fractures which came under my notice were impacted.

Displacement.—The manner of displacement of the broken ends is open to considerable variation. In many cases they are not displaced at all, being retained in position by the long heads of the biceps and triceps. When they are displaced, the upper end of the lower fragment is usually drawn upwards and inwards, lying on the inner side of the upper fragment, and frequently rather in front of it. Certain examples of unusual displacement have been recorded. Desault[9] was a case in which the lower fragment was drawn backwards; Hamilton[10] has examined a specimen in which the two ends were tilted towards the axilla, and several examples of displacement of one or both fragments outwards have been reported.

Amongst my own cases there was no displacement in 4 out of 14 (Hamilton's cases, 5 out of 17). In 6 cases the lower fragment was drawn upwards and inwards, and in one case upwards, inwards, and backwards. In two the manner of displacement was uncertain.

Treatment.—The best treatment in my experience is the following: (1) An axillary pad, to counteract the tendency to inward displacement of the lower fragment, after this has been reduced by traction on the arm; (2) the fixing of the arm to the side by means of strapping; and (3) a cap of poroplastic felt, leather, or gutta-percha, moulded to the shoulder. Union will usually be firm enough for the removal of the supports at the end of three and a half or four weeks. Passive movement of the shoulder during the earlier stages of the treatment is, in my opinion, unnecessary.

Results.—The results in my cases were as follows:—Five patients were lost sight of before the fracture had united. Of the remainder the bone united without permanent deformity in all except one: this was the case in which the lower fragment was displaced inwards, upwards, and backwards, and in which the deformity was not altogether reduced. When the supports were removed there was, in most of the

cases, though by no means in all, a fair amount of stiffness of the shoulder-joint, but, as a rule, this rapidly improved. Two cases were perfectly well and free from stiffness two months after the accident; 3 cases had almost completely recovered when they were last seen at periods of six weeks, two and a half months, and three months respectively after the injury; 4 cases still had stiffness, but all were improving when they were last seen, four weeks, four weeks, six weeks, and seven weeks respectively after the occurrence of the fracture.

FRACTURE OF THE GREAT TUBEROSITY.

This fracture is of very rare occurrence. R. W. Smith[11] has described and figured a specimen which he discovered accidentally whilst making a post-mortem examination. He also refers to a second case which he examined in the living subject, and similar cases have been described by Hamilton[12] and by Charles[13]. Almost invariably the fracture is accompanied by luxation of the head of the bone. Of 35 cases collected by Gurlt,[14] 9 were complicated by partial and 22 by complete luxation, whilst in 4 only was the head of the bone in its normal situation.

SEPARATIONS OF THE UPPER EPIPHYSIS OF THE HUMERUS.

This is an accident which has given rise to very great difficulties, both as regards diagnosis and treatment. J. Hutchinson, junr.,[15] says that in 50 per cent of recorded cases separation of the upper epiphysis of the humerus has been diagnosed as dislocation of the shoulder. The mistake, however, may be avoided by remembering that dislocation of the shoulder very rarely occurs before the age of 20 years (under one per cent of the total number of cases).

The epiphysis is ossified from three centres—one for the head, which makes its appearance during the first year of life; a second for the great tuberosity, during the third year; and a third for the small tuberosity, during the fifth year. The three centres join together in the sixth year, and the epiphysis unites with the shaft at the age of 20.[16] Occasionally the union of the epiphysis with the diaphysis is delayed beyond the usual age: cases of non-union at 24 and 30 years of age have been recorded by von Bruns and Uffelmann.

The peculiar shape of the epiphysial line accounts, to a certain extent, for the great difficulty which is sometimes met with in the reduction of the displacement in separation of this epiphysis. The upper end of the diaphysis is markedly convex, and is traversed by a prominent ridge, situated rather nearer the inner than the outer border of the bone. The ridge commences at the anterior and inner part of the diaphysis, some distance internal to the bicipital groove; it runs

backwards and outwards, gradually increasing in height, to a prominent tubercle situated near the posterior part of the bone. The ridge divides the upper surface of the diaphysis into a smaller postero-internal convex portion and a larger antero-external portion. The latter is convex in the greater part of its extent, but presents externally a slight concavity, corresponding to the under surface of the greater tuberosity. The under surface of the epiphysis is deeply hollowed to receive the convex end of the diaphysis. Some of the above-mentioned anatomical points are illustrated by the accompanying figure (Fig. 3). When the epiphysis is separated, the diaphysis is often displaced inwards and forwards, so that the prominent ridge hitches upon the margin of the epiphysis, and thus offers a serious obstacle to reduction.

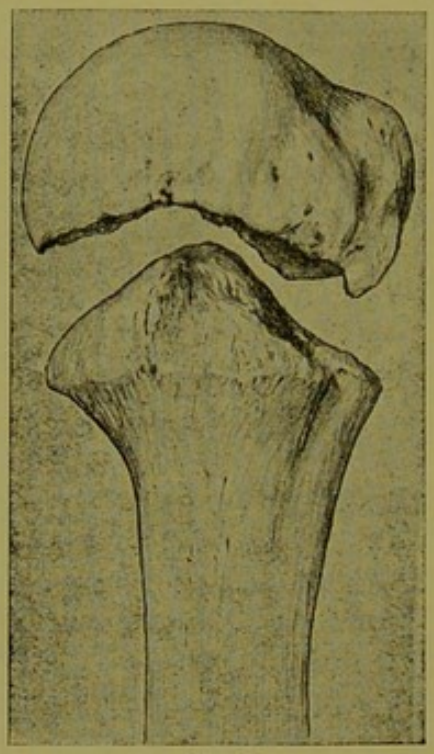

Fig. 3.

The Upper End of the Humerus of a Girl aged 12 years.

The Epiphysis has become separated during the process of maceration. (From a Specimen in the Anatomical Museum of Owens College. Drawn by Mr. T. E. Bingham.)

In this injury the separation probably always occurs exactly at the epiphysial line. This, according to Hutchinson,[15] was found in 11 cases, which have been examined post mortem or by operation.

Table VIII. gives details of 10 cases of this injury.

From the table it will be seen that 9 of the patients were boys and one a girl. Their ages varied from 13 months to 17 years; the greater

number, however, were over the age of 12 years, a fact which agrees with Hutchinson's statement that the average age of the patients is about 13 years.

Cause.—The cause of the separation of the epiphysis was direct violence from falls upon the shoulder in 6, or possibly 7, cases. In 1 it was due to a young child being lifted up by the hand. In the 2 remaining cases the exact point of application of the force could not be ascertained.

Several examples of this accident from traction upon the arm during birth have been recorded.

Displacement was absent in four cases, one of which was probably an incomplete separation of the epiphysis. The diaphysis was displaced inwards in 2 cases, and forwards in 4. Probably in some of the latter there was a little inward, in addition to the forward, movement of the diaphysis. It would appear that in these cases the diaphysis may be displaced in almost any direction—inwards, outwards, forwards, or backwards: in the majority of the cases, however, it is displaced inwards or forwards. As a rule the diaphysis is not completely dislocated from the epiphysis.

In four instances (Cases 132, 138, 140, and 141) the diagnosis presented great difficulties, and was not made until a considerable time had elapsed after the receipt of the injury. In these cases there was a very great deal of swelling, and although I examined them carefully several times I was unable to satisfy myself of the existence of a fracture until the swelling had subsided and the outlines of the bones could be more distinctly felt. These cases were examples of separation of the epiphysis with locking of the fragments.

Complications and Sequelæ.—Certain important complications and sequelæ have been described as having occurred in these cases. The following may be mentioned:—

(1) Locking of the fragments.

(2) Compound separation of the epiphysis.

(3) Compression or tearing of the main blood-vessels of the arm. In 2 cases this has resulted in gangrene.

(4) Injury to the main nerve-trunks of the arm.

(5) Dislocation of the epiphysis from the glenoid cavity, as in a case recorded by Bull.[17]

(6) Irreducibility of the diaphysis, the end of which lies immediately under the skin. In these cases it is necessary to adopt open incision with antiseptic precautions. McBurney[18] has reported a case in which the diaphysis was displaced upwards and forwards, and was entangled in the substance of the deltoid muscle, and in which reduction could not be effected without operation.

TABLE VIII.—Separations of the Upper Epiphysis of the Humerus.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Result.	Late Result.
132	12 9/12	M	1895 June 8	L	Direct violence; fall on shoulder	Diaphysis somewhat forwards, with locking of fragments	Great swelling; diagnosis not made until June 16	Arm fixed to side with strapping	31 days	Several times after removal of strapping	Union with some projection forwards of diaphysis; at first some stiffness of shoulder, but this had gone and patient was quite well, except for the deformity, two months after the accident; twelve months later the projection was rather less marked, but could still be felt	August, 1898. Patient stated that his arm was quite right; there was, however, some thickening about the head of the humerus, and the bone was ½in. shorter than its fellow
133	1 5/12	M	Aug 5	R	Lifting child by hand	Nil	.....	Arm fixed to side with strapping	..	..	Patient last seen four days after accident	August, 1898; arm was quite normal; no shortening
134	16	M	Aug 19	?	Fall on shoulder	Nil	.....	Arm fixed to side with strapping	25 days	Several times after removal of strapping	Union in good position; at first considerable stiffness of elbow and shoulder, but this was much improved when patient was last seen five weeks after accident	Not known
135	5	F	Aug 24	L	Fall down stairs	Nil, but fragments could be moved about	.....	Arm fixed to side with strapping	24 days	None	Quite well one month after accident; no deformity; no stiffness of shoulder when supports removed	August, 1898; arm perfectly normal; no shortening

136	17	M	Nov 4	L	Fall on shoulder	Diaphysis inwards	Much bruising about shoulder	Arm fixed to side with strapping; axillary pad	..	..	Patient only seen once afterwards	Not known
137	6	M	Nov 11	L	Knocked down by tram-car	Diaphysis inwards	.....	Arm fixed to side	29 days	None	Quite well five weeks after accident; no deformity; very little stiffness on removal of supports	August, 1898; arm quite normal; no shortening
138	14	M	1896 Jan 9	?	Fall down steps; probably on shoulder	Diaphysis somewhat forwards, with locking	Not diagnosed until Jan 31; at first treated as contusion	After the fracture was recognised there was firm union, and no special support was necessary	..	None	Not much stiffness of shoulder; patient almost well, except for deformity, when last seen two months after the accident	Not known
139	$1_1^1{}_2$	M	Feb 14	L	Fall on shoulder	Nil	Separation probably incomplete	Arm fixed to side	11 days	None	Patient not seen after removal of supports	Not known
140	12	M	Feb 24	L	Fall on shoulder	Diaphysis forwards with locking	Not seen until Feb 27, and not diagnosed until March 6	Arm fixed for a fortnight after injury recognised	..	None	Union with projection forwards of diaphysis; very little stiffness of shoulder; quite right, except for deformity, two months after accident	August, 1898. Head of humerus somewhat thickened; no shortening; movements perfect
141	16	M	April 6	R	Fall on shoulder	Diaphysis forwards with locking	.....	Arm fixed to side; chloroform given on April 16, and attempt made to remedy displacement—only partially successful	22 days	None	Patient last seen five weeks after accident; still some stiffness of shoulder; diaphysis projecting somewhat forwards	August, 1898; arm quite strong; no deformity of head of humerus could be felt; $\frac{3}{4}$in. shortening

(7) *Suppuration.*—Many suppurative bone-affections in children have their origin in the immediate neighbourhood of the epiphysial line, the micro-organisms which lead to the formation of pus being brought to the part by the blood-stream. In these cases the onset of the disease often appears to be determined by an injury, more or less severe. Suppuration after separation of an epiphysis must, however, be regarded as of very rare occurrence. I have seen about 150 cases of separation of various epiphyses, but have never yet met with an example of this complication. Poland[19] quotes two instances of the occurrence of suppuration after separation of this epiphysis.

(8) Comminution of the epiphysis.

(9) Fracture of the diaphysis.

(10) Extensive separation of the periosteum from the diaphysis. This is most important, and may prove a serious obstacle to the reduction of the displacement.

(11) Subsequent ankylosis of the shoulder-joint. Hutchinson[15] mentions 4 cases.

(12) Non-union of the fragments.

(13) Arrest of growth of the bone. Poland[20] gives a list of 8 cases in which this has occurred. Two examples (Cases 132 and 141) have come under my own observation.

Locking of the Fragments is a complication which is apt to give rise to considerable difficulty both as regards diagnosis and treatment. I have had trouble from this cause in 4 cases, a brief account of which is as follows:—

Case 132 (Table VIII.) was a boy, aged 12, who was first seen by me on June 8th 1895. He stated that he had fallen down a distance of five feet, and that his shoulder had come in contact with some flag-stones. There was a very great deal of swelling of the soft parts around the shoulder-joint, except at one point on the anterior surface, and a little below the level of the articulation, where the skin was depressed and adherent to the underlying parts. Evidently this point had received the greater part of the force which caused the injury. At the time I suspected a fracture, but failed to detect crepitus or unusual mobility at any part of the bone. The head of the humerus rotated freely with the shaft. The swelling gradually subsided, and on June 16th, eight days after the receipt of the injury, I was able to feel a projecting piece of bone a little above the depression in the skin already referred to. This was recognised as the upper end of the diaphysis by its want of sharpness. An attempt was made to reduce the deformity, but the epiphysis and diaphysis were firmly joined, and reduction could not be effected. The head of the humerus rotated with the shaft, and there was not the slightest suspicion of movement between the epiphysis and diaphysis. A skiagram of this case would have been interesting, but at that time Röntgen's discovery had not been made known. Two-and-a-half months after the accident, the boy had regained perfect movement of the shoulder joint; and, except for the forward projection of the diaphysis, was perfectly well. I had an opportunity of examining him 14 months after the injury. The anterior edge of the diaphysis could still be felt, but it appeared to have become somewhat rounded off. In

August, 1898—three years and two months after the accident—I saw him again. The head of the humerus was somewhat thickened, and the growth of the bone had been interfered with. Careful measurements showed that it was half an inch shorter than its fellow.

Case 138 presented very similar features. I first saw the boy, who was 14 years of age, on January 9th, 1896—the day of the injury. The cause was direct violence to the shoulder from a fall down some steps. The parts around the joint were very much swollen, and I was unable to detect any fracture of the humerus; the head of the bone rotated with the shaft, and there was an entire absence of crepitus. The patient was seen from time to time, and on January 31st, the swelling having subsided, the upper end of the diaphysis was felt projecting forwards, as in the last case. Firm union had taken place, and consequently at that time it was not deemed advisable to attempt reduction. The lad made a good recovery, and when I last saw him, two months after the accident, he was almost well, except for the deformity of the bone.

Case 140 had somewhat similar characteristics. The accident occurred on February 24th, 1896, and was due to direct violence; but the patient did not come for treatment until three days after the receipt of the injury, and I did not see him myself until a later date. The true nature of the injury was not recognised until March 6th. Union took place with the diaphysis displaced somewhat forwards; but, except for this, the patient was quite well, two months after the accident. I examined him again in August, 1898—two-and-a-half years after the injury. The head of the humerus showed some slight thickening, but there had been no arrest in the growth of the bone.

Case 141 was a youth, aged 16, who sustained a similar injury from a fall upon the shoulder on April 6th, 1896. The true nature of the accident was not recognised until April 16th, when an examination was made under an anæsthetic. The diaphysis was found to be displaced forwards, and attempts to rectify its position were only partially successful. In August, 1898—two years and four months after the accident—I could detect no deformity of the head of the humerus by an external examination. The growth of the bone had, however, been interfered with; measurement showed that it was nearly three-quarters of an inch shorter than its fellow.

The question of the cause of the difficulty in overcoming the displacement in these cases has received a considerable amount of attention. Professor E. M. Moore,[21] of Rochester, U.S.A., says that the displacement is usually incomplete, and that the difficulty is due to locking of the fragments. "The upper end of the lower fragment is carried inward to the distance of about one-fourth of its diameter, when it is arrested by a convexity of the lower fragment becoming lodged in a natural concavity in the upper fragment. The upper fragment now becomes tilted by the action of the muscles, its internal margin ascending in the glenoid cavity and its outer margin descending until it is arrested by the capsule." He describes a special method of reduction.

Mr. J. Hutchinson, junr.,[15] on the other hand, says that Moore's contention is a fallacy, and that the main difficulty, if one exists, is due to the interposition of soft parts, and especially to the tense periosteal

sheath, through which the expanding end of the diaphysis has been driven.

In a case recorded by McBurney[18], already referred to, reduction could not be effected owing to the diaphysis being entangled in the substance of the deltoid muscle.

The true explanation of these cases appears to me to be as follows: When the diaphysis is completely dislocated from the epiphysis, difficulty may arise from at least three causes, viz.:—(1) From the end of the diaphysis being encircled by the torn periosteum, as described by Hutchinson; (2) from the diaphysis being entangled in the deltoid muscle, as in McBurney's case; and (3) from the hitching of the expanding upper end of the diaphysis against the sharp margin of the epiphysis.

In incomplete separation I believe, with Professor Moore, that the difficulty is due to locking of the bone, but cannot accept his views *in toto*. In all the four cases above described the diaphysis was partially displaced forwards, and a consideration of the anatomy of the part will show that the ridge which is present upon the upper surface of the diaphysis, leading backwards to a prominent tubercle, must have been in contact with the sharp anterior border of the epiphysis. I therefore think that the difficulty in these cases was mainly due to locking of these two portions of bone. Probably in these cases there was a little inward, in addition to the forward, displacement of the diaphysis. Moreover, in Case 132, which I examined immediately after the occurrence of the accident, and in which the injury had been caused by very severe direct violence, the epiphysis and diaphysis were so firmly joined together that I am of opinion that the diaphysis had become embedded in the sharp anterior border of the epiphysis, and that there was a certain degree of impaction. The epiphysis and diaphysis moved together in all positions of the arm, and there was an entire absence of even that soft variety of crepitus which is met with when two cartilaginous surfaces rub against each other. The fact that in this case the growth of the bone was subsequently interfered with may add weight to the opinion I have just expressed.

Impaction of the fragments has been described as having occurred in cases of fracture of the surgical neck, and also of the anatomical neck, of the humerus, but so far as I am aware the possibility of this complication has not hitherto been mentioned in cases of separated epiphysis. On anatomical grounds I see no reason why it should not occur—in fact, the irregular, sinuous character of the epiphysial line and the cancellous texture of the epiphysis would appear rather to favour the possibility of its occurrence.

Treatment.—As already stated, the reduction of the displacement sometimes gives rise to considerable trouble. Hutchinson[15] advises steady traction on the arm and slight abduction, aided by rotation of the humerus or by direct pressure. Moore[21] recommends that the arm be carried forwards and upwards to the perpendicular plane. In this position, he says, the epiphysis will remain comparatively fixed, whilst the diaphysis will return to its proper position. In a few cases it will be necessary to resort to operative measures.

After reduction, supports, similar to those recommended for fracture of the surgical neck of the bone, may be applied. The arm should be kept at rest for three or four weeks. In one case (a child aged 13 months) I dispensed with the supports at the end of 11 days.

Results.—Of my 10 patients two ceased to attend shortly after the occurrence of the accident; one I last saw on the day of the removal of the supports, when union had taken place in good position; one, when last seen, five weeks after the accident, still had stiffness of the shoulder, although he was improving. Two patients were perfectly well at periods of four weeks and five weeks respectively after the injury. In the remaining four cases union took place with some projection forwards of the diaphysis.

With one exception there was not much stiffness of the shoulder-joint when the dressings were removed, and in all cases improvement of the joint-movements rapidly took place.

Six of the 10 cases I had an opportunity of examining at periods varying from two years and four months to three years and two months after the accident. Three of them were perfectly well: no deformity could be discovered, and there had been no arrest of the growth of the bone. The other three were patients in whom union had taken place with more or less displacement forwards of the diaphysis. In two of these cases the end of the diaphysis appeared to have become rounded off, but could still be felt, whilst in the third the examination failed to reveal any abnormality of the bone. In one patient the growth of the humerus had not suffered, but in the two others the bone was distinctly shorter than its fellow. The shortening was three-quarters of an inch in one case and half-an-inch in the other. All the patients had perfect movement in the shoulder-joint.

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FRACTURES OF THE SHAFT OF THE HUMERUS.

For purposes of description the shaft of the humerus may be divided into thirds—upper, middle, and lower. Fractures in the upper third in many respects resemble fractures of the surgical neck. In the lower third they have some features in common with transverse supra-condylar fractures. Five of my cases involved the upper third of the bone, 11 the middle third, and 4 the lower third. Details are given in Tables IX., X., and XI.

Taking the cases collectively we find that of the 20 patients there were 17 males and 3 females. Of 17 cases in which the side of the body affected was recorded, the right humerus was broken in 11 and the left in 6. The majority of the patients were young people, 12 being under 20 years of age.

Cause.—Nine patients were unable to give a sufficiently clear account of the accident to enable the exact mode of production of the fracture to be ascertained. Of the remaining cases, the injury was apparently due to direct violence in 6, to falls upon the elbow in 2, to a fall upon the hand in 1, and to "fisting" a football in 2. In one of the last cases the arm was stretched out in front of the body when the football came in contact with the closed fist.

Three examples of fractures of the humerus during birth—one of which had come under his own observation—are mentioned by Hamilton[1]. Gurlt[2] refers to two cases of intra-uterine fracture of the shaft of this bone, and two further cases have recently been placed on record by T. C. Smith.[3]

TABLE IX.—Fractures of Shaft of Humerus.—Upper Third.

No.	Age.	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Result.
142	34	M	1895 Oct 6	L	Fall from tram-car: ? direct injury	Upper fragment inwards; lower fragment upwards and outwards	Fracture just above insertion of deltoid	At first internal angular and short splints around upper arm; arm fixed to side 5 days later	30 days	Good union; there was some stiffness of the shoulder and elbow when the splints were removed, but this was improved when the patient was last seen 6 weeks after the accident
143	32	M	Oct 24	R	Fall from a ladder	Upper fragment inwards and slightly forwards; lower fragment backwards and outwards	Fracture just above insertion of deltoid	Internal angular and 3 short splints; two days later arm was fixed to side and shoulder – cap applied	29 days	Good union, but with slight displacement forwards of upper fragment; only slight stiffness of shoulder, but patient had pain for some time afterwards; he had recovered completely, and returned to work 3 months after the accident
144	72	F	Oct 26	?	?	Lower fragment slightly forwards	Fracture one inch below surgical neck	Internal angular and 2 short splints	21 days	Patient not seen from day of accident until November 22nd; the union was then firm, with some displacement forwards of lower fragment; there was very little stiffness of the joints
145	63	M	1896 Jan 16	R	Fall on elbow	Upper fragment inwards; lower outwards	Fracture just above insertion of deltoid	Internal angular and 3 short splints	..	Patient sent to Union Hospital 4 days after accident
146	15	M	April 6	R	"Fisting" a football; ball struck closed fist when arm was stretched out in front of body	Nil	Fracture just above insertion of deltoid	Shoulder-cap and arm fixed to side	5 weeks	Good union without deformity; no subsequent stiffness of joints

TABLE X.—Fractures of Shaft of Humerus—Middle Third.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Result.
147	10	M	1895 Aug. 5	L	Fall for distance of about 8 feet on arm, probably direct violence	Lower fragment drawn a little upwards and outside the upper fragment	Fracture oblique	Internal angular and short splints; arm fixed to side	29 days	Patient not seen after day of removal of splints; there was good union, and he appeared to be all right with exception of some stiffness of elbow
148	18	M	Sept 30	L	Direct violence; arm caught between a strap and a wheel	Fracture comminuted	Fracture just above junction of middle and lower thirds of bone; also fracture of radius and ulna on same side. (See No. 331.)	Internal angular splint and Gooch splinting around humerus	6 weeks	Good union; never much stiffness of the joints. Paralysis of small muscles of hand supplied by *ulnar* nerve was noticed some time after removal of splints, but this completely recovered in a short time; 3½ months after accident patient was quite well, except for considerable thickening of bones at seat of fractures
149	46	M	Dec. 23	R	Fall on side from hay-loft, with arm under body	Upper fragment inwards: lower fragment upwards and outwards	Fracture just below insertion of deltoid	Internal angular and 3 short splints; arm afterwards fastened to side	5½ weeks	Good union; when last seen, 3 weeks after removal of splints, was quite well, except for slight thickening at seat of fracture; not much stiffness
150	17	M	1896 Jan. 4	R	"Fisting" a football	Lower fragment upwards and outwards	Fracture at middle of bone	Internal angular and 3 short splints	4½ weeks	Firm union: last seen 7 weeks after accident; quite well, except for thick'ning of bone; not much stiffness

151	35	M	March 4	L	Knocked down by cab, and run over	Lower fragment inwards, backwards, and slightly upwards	Fracture at middle of bone	Internal angular at first; six days later arm bound to side, and shoulder-cap applied	5 weeks	Firm union, with slight displacement inwards of lower fragment. Three months after accident was quite right except for displacement
152	15	M	March 11	R	Direct violence; arm caught by revolving strap	Upper fragment backwards and outwards; lower forwards	Fracture just below middle of bone	Internal angular and 3 short splints	6 weeks	Firm union, with considerable thickening; (? some displacement forwards of upper fragment) at seat of fracture; quite well 2½ months after accident
153	5	M	May 12	R	Fall out of bed	Fragments could be moved in any direction	Fracture transverse, just below middle of bone	Internal angular and 3 short splints	5 weeks	Firm union; no displacement; 3½ months after accident the thickening at the seat of fracture had disappeared
154	55	M	June 3	?	Fall from a ladder	Lower fragment upwards and outwards	Fracture at middle of bone	Internal angular and short external splint	..	Patient not seen again
155	63	M	July 11	R	Fall. ? how	None	Fracture at middle of bone	Internal angular splint; shoulder-cap; arm fixed to side	5½ weeks	Union in good position; last seen a week after removal of splints; then quite right, except for some rigidity of shoulder and elbow
156	15	M	July 18	L	Run over by cart-wheel	Fragments could be moved in any direction	Fracture just below insertion of deltoid	Internal angular splint; shoulder-cap; arm fixed to side	5½ weeks	Firm union; last seen 6½ weeks after accident; then quite well except for some thickening of bone at seat of fracture and some rigidity of elbow
157	3	F	July 19	R	Fall. ? how	Fragments could be moved in any direction	Fracture at middle of bone	Internal angular splint and arm bound to side	26 days	Patient not seen after day of removal of splints; the union was then firm, and the movements of the joints were free

TABLE XI.—Fractures of Shaft of Humerus.—Lower Third.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Result.
158	6	M	1895. June 23	?	Fall on elbow	No displacement but some thickening, and great pain and tenderness at seat of supposed fracture; no crepitus	Greenstick fracture diagnosed, but there was considerable doubt as to the presence of a fracture	Evaporating lotion and internal angular splint	3 weeks	Quite well three weeks after accident
159	18	M	June 25	L	Fall on arm	Both fragments tilted outwards	Fracture about junction of lower and middle thirds of bone	Internal angular with Gooch splinting on outer side of arm	37 days.	Firm union in good position; recovery was complete 6 weeks after injury
160	7	F	1896. June 10	R	Fall on arm	Lower fragment backwards	Fracture 1½ inches from lower end of bone	Internal angular splint	34 days.	Firm union with slight bowing outwards at seat of fracture. Ten weeks after the accident the patient had quite recovered except for the deformity of the bone
161	7	M	June 16	R	Fall on hand	Lower fragment backwards	Fracture in lower part of lower third	Internal angular splint	14 days.	Union with some displacement backwards of the lower fragment. Recovery was delayed, owing to the movement of full flexion of the elbow-joint being limited, but this was greatly improved when the patient was last seen, 10 weeks after the accident

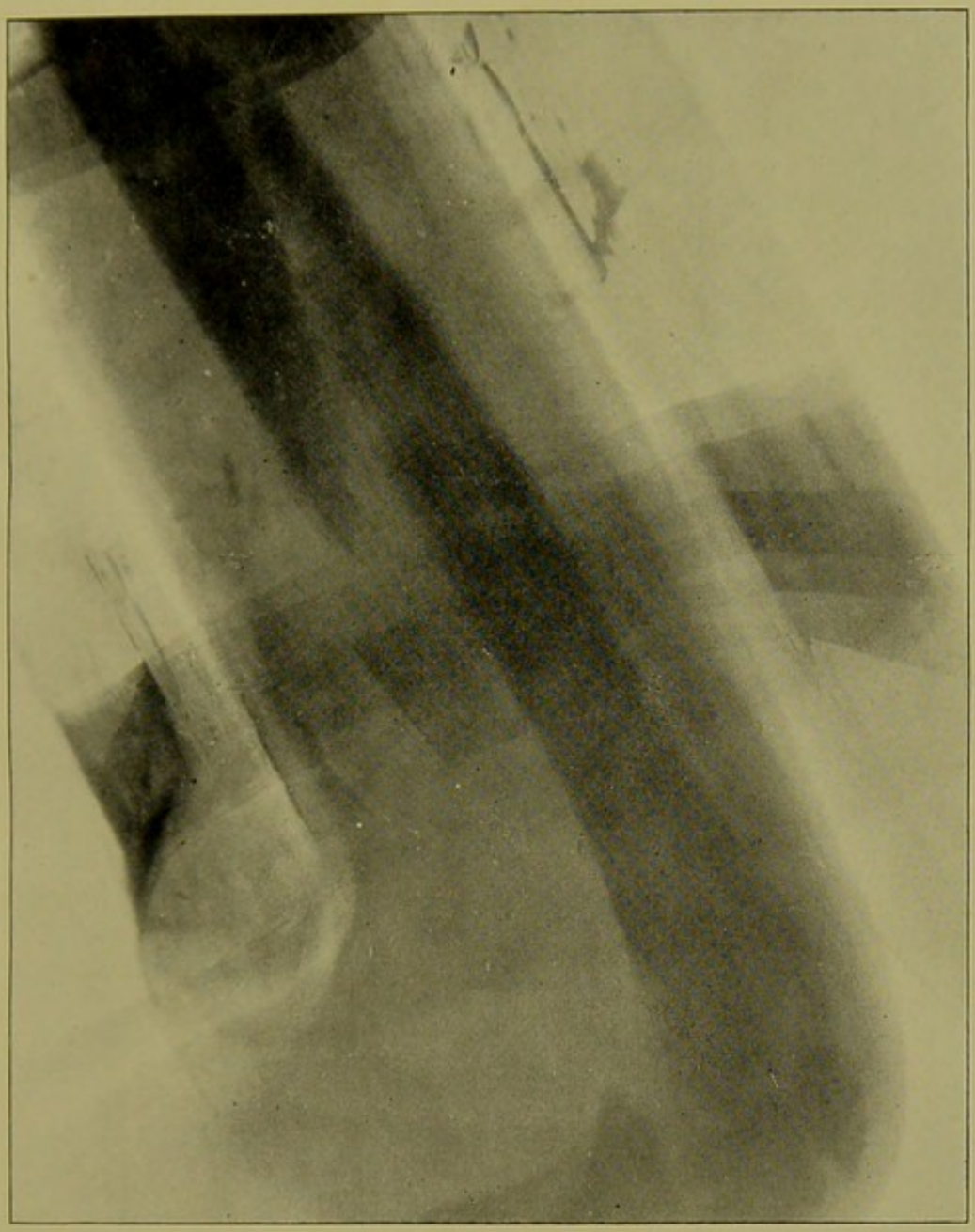

FIG. 4.

FRACTURE OF THE SHAFT OF THE HUMERUS.

The patient was a lad, aged 15 years, whose right Humerus was broken by direct violence. Six weeks later, after removal of the splints, he re-fractured the bone by muscular action, whilst throwing a piece of bread at a cat. The fracture was very oblique, and was situated immediately below the deltoid insertion. The illustration shows faint outlines of the splints in which the arm was enclosed, and also transverse marks due to strapping. (From a skiagram lent by Mr. G. A. Wright.)

The humerus would appear to be broken as a result of muscular action more frequently than any of the other long bones. Gurlt[4] collected no less than 72 cases. He considers that the upper part of the bone is fixed by the deltoid muscle, and, the lower part being forcibly moved along with the forearm, the bone gives way below the deltoid insertion. Hamilton[1] refers to a patient who broke his humerus from muscular action alone on three separate occasions, each fracture being at a different part of the bone. The patient from whom the skiagram (Fig. 4) was taken broke his humerus whilst throwing a piece of bread: six weeks previously the bone had been broken in the same place by direct violence. Many cases, however, are on record where a previously healthy bone has been broken during the act of throwing a ball or other object.

Most important are the recorded cases of fracture of the humerus during so-called "trials of strength." In this form of recreation, which is called by the French *tour de poignet* (the game of "turning wrists"), two persons grasp hands with the fingers interlocked, and then, resting the elbows upon a table, try to force backwards each other's wrists. The strain thus placed upon the bones is very great, and the humerus is very apt to give way below the insertion of the deltoid. I have found references to no less than 14 examples of fracture of the bone from this cause. Malgaigne[5] saw one case, and refers to four others. Gurlt[6] collected six additional cases. Hamilton[1] recorded one, and Monks[7] has recently described two which came under his own observation. One of Monks' patients died subsequently from pneumonia, and post-mortem examination showed that the fracture was spiral in direction. He attributes the fracture to torsion of the bone, and says that a very similar accident sometimes occurs during the reduction of a dislocated shoulder by Kocher's method.

The *Displacement* of the fractured ends of the bone in these cases is open to very considerable variation.

Of the five fractures of the upper third of the bone recorded in the preceding table, there was no displacement in one. The lower fragment was displaced upwards and outwards in one, simply outwards in one, backwards and outwards in one, and forwards in one. Three of the cases thus presented outward displacement with or without movement in some other direction.

Of the 11 fractures in the middle third the lower fragment was displaced upwards and outwards in four, inwards, backwards, and slightly upwards in one, and forwards in one. There was no displacement in one case, in three cases the fragments could be moved in almost any direction, and in one case the fracture was comminuted.

Of the four fractures in the lower third, one was incomplete, both fragments were displaced outwards in one, and the lower fragment was displaced backwards in two.

It would appear that there are many causes which operate in producing these numerous forms of displacement. The most important is probably the direction of the fracture: transverse fractures are usually unaccompanied by displacement, but in oblique fractures the broken ends generally move in the direction of the line of fracture.

Another important factor is the force causing the injury which displaces the bones at the time the fracture occurs. Muscular action is probably not so important as is usually supposed, but the deltoid undoubtedly has an influence in producing the outward displacement of the lower fragment, so frequently met with in fractures above the middle of the bone.

Treatment.—Whenever the fracture is situated above the middle of the shaft of the humerus, I am of opinion that the arm should be bound to the side of the body. If it be treated simply with an internal angular splint and with short splints along the humerus, the shoulder-joint is free to move, and in all probability more or less movement will take place between the broken ends. If, however, the arm with the splints be fixed to the side, this movement cannot take place. I believe that this want of fixation of the shoulder, with its resulting want of fixation of the fracture, is the cause of many cases of ununited fracture of this bone. The treatment I would advise is the following: An internal angular splint, with three short splints along the upper arm, should be applied, care being taken that the splints are not too broad, and that the outer splint is long enough to reach from the acromion to the external condyle; the arm with the splints should then be fixed to the body by means of adhesive strapping, cotton-wool being applied where necessary to prevent pressure; the hand should be supported by a sling. When the fracture involves the lower part of the bone the same splints may be used, but it is unnecessary to fix the arm to the side. It is usually advisable to retain the splints for four and a half, five, or six weeks in the treatment of these cases; before that time the uniting material is not sufficiently firm to permit of their safe removal.

Results.—The results in my cases were as follows:—

Patients lost sight of	2
Union, without deformity	8
Bone thickened by callus when patient last seen, but no evident displacement	4
Union, with some displacement of the fragments	6
Total	20

In the last cases the lower fragment was displaced somewhat forwards in two, backwards in two, inwards in one, and outwards in one. In each case, however, there was firm union.

COMPOUND AND COMMINUTED FRACTURES OF THE SHAFT OF THE HUMERUS.

Compound fractures must be treated upon ordinary antiseptic principles. If the wound be carefully washed out with antiseptic lotion, and if all precautions be taken, union by first intention will usually be secured, provided that the soft parts are not very badly lacerated. My own practice in these cases has been, after cleansing the surrounding skin, to thoroughly flush out the wounds with perchloride of mercury lotion (1 in 2,000), and afterwards with perchloride lotion (1 in 4,000). Very dirty wounds have been first flushed with 1 in 1,000 lotion. Antiseptic dressings and suitable splints have then been applied. With this treatment primary union has taken place in the majority of the cases. In one case of compound fracture, with extensive separation of the skin and laceration of the muscles, I drilled the ends of the bone and fastened them together with silver wire: a great deal of sloughing followed and afterwards necrosis, but the patient ultimately recovered with a useful hand.

In cases of compound comminuted fracture amputation should not be performed unless the parts are hopelessly disorganised. Much can usually be done by conservative surgery, and even after removal of a considerable portion of the humerus the patient may have almost perfect use of the forearm and hand. The majority of the cases mentioned in my list as requiring amputation were cases in which the arm was almost or quite torn off.

Simple comminuted fracture of the humerus is not a very common accident: one case (No. 148) is included in Table X.

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FRACTURES OF THE LOWER END OF THE HUMERUS.

These injuries, although they are of common occurrence in the out-patient practice of large hospitals, yet very frequently present considerable difficulties both as regards diagnosis and treatment. I

believe, however, that the difficulties can usually be overcome and that, in the great majority of cases, a perfect joint should result from the treatment. My cases of fracture include 60 involving the lower end of the humerus. I have classified them as follows:—

Separations of the lower epiphysis	13
Transverse fractures near the elbow-joint	7
T-shaped fractures	3
Oblique fractures of the external condyle, extending into the joint	20
" " " internal " " " "	7
Separations of the internal epicondyle	9
Fractures of the capitellum and trochlea	1
Total	60

Taken collectively, 51 of the patients were males and only 9 females. The right arm was broken in 24 cases, the left in 31, whilst in five the side affected was not recorded. The great majority of these fractures occur in the early years of life; thus no less than 35 of the patients were under 10 years of age and 55 of the total number under 20.

In dealing with these cases I shall first make some remarks about each variety of fracture, and afterwards speak of diagnosis and treatment as a whole.

SEPARATIONS OF THE LOWER EPIPHYSIS.

In order to correctly understand the pathology of these accidents, it is essential to have a knowledge of the mode of development of the bone. At birth the lower epiphysis of the humerus is entirely cartilaginous: the first ossific centre to make its appearance is that for the capitellum, which is usually stated to be present in the third year of life. This is followed by a centre for the internal epicondyle in the fifth year, a centre for the trochlea in the 11th or 12th year, and lastly a centre for the external epicondyle in the thirteenth or fourteenth year. The internal epicondyle forms a separate epiphysis, and joins the shaft at the age of 18. The other three centres fuse together and unite with the shaft at 16 or 17. Henle[1] states that the centre for the capitellum usually appears at the end of the second year, and Hutchinson[2] says that he has found it present at the age of 18 months.

At birth the epiphysial disc forms a fairly straight line running across the bone just above the level of the two epicondyles. As growth goes on the epiphysis increases greatly in width but comparatively little in depth, and at the same time the lower end of the diaphysis gradually assumes a convex appearance. The convexity is especially well marked in the transverse diameter of the bone, less so in the antero-posterior direction. The epiphysis thus becomes like a cap fitted upon the end

of the diaphysis, and the epicondylar processes are removed by a greater distance from the capitellum and trochlea. As puberty approaches the down-growth of the diaphysis becomes especially marked at the inner part of the bone, and ultimately the internal epicondyle is altogether separated from the trochlea and unites with the shaft as a distinct epiphysis. Moreover, the down-growth on the inner side causes the epiphysial line to run in a very oblique direction downwards and inwards for several years before puberty.

It is worthy of note that the capitellar portion of the epiphysis is vertically very much thicker than the trochlear portion. The latter

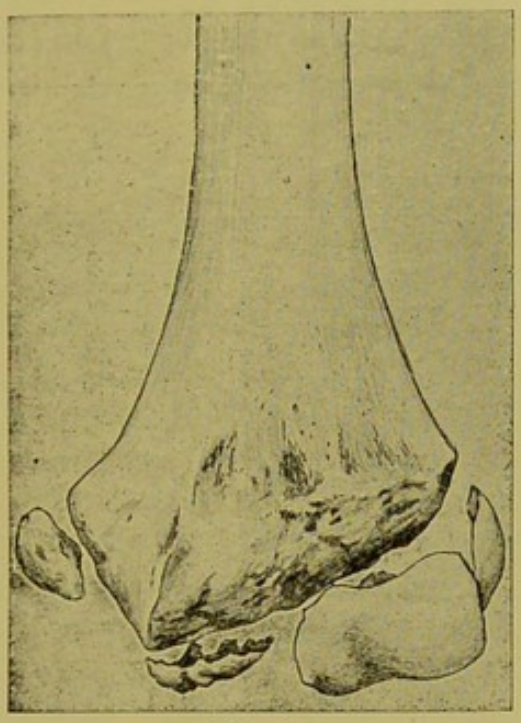

FIG. 5.

THE LOWER END OF THE HUMERUS OF A GIRL AGED 12 YEARS.

The Epiphyses have been detached during the process of maceration. (From a preparation in the Anatomical Museum of Owens College. Drawn by Mr. T. E. Bingham.)

does not begin to ossify until the eleventh or twelfth year of life, and is from 5 to 7 mm. in thickness, whilst the former is from 10 to 12 mm. in vertical measurement.

Many of the above-mentioned anatomical points are illustrated by the accompanying figure (Fig. 5).

From the manner in which the growth of the epiphysis takes place, the increase in size being almost entirely in a transverse direction, and from the way in which it becomes spread out upon the convex end of the diaphysis, it follows that separation of the epiphysis *en masse*

TABLE XII.—Separations of Lower Epiphysis of Humerus.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Treatment.	Passive Movement.	How long fixed.	Period of Recovery.	Deformity after Union of Fracture	Remarks on Result.	Late Result.
162	2¾	F	1895 July 14	L	Fall from sofa	None	Internal angular splint; evaporating lotion	Twice; on July 23rd and 30th	23 days	4 weeks	None	.....	Aug. 1898: some cubitus varus; movements of elbow perfect
163	3	F	July 29	L	Fall on elbow	Backwards	Anterior angular splint; evaporating lotion; chloroform administered on Aug. 20 to remedy redisplacement; external angular splint applied	First on Aug 13th; several times at subsequent periods	39 days	4 months	Some inward displacement of epiphysis and cubitus varus	During the after-treatment there was very great trouble from redisplacement of the epiphysis, and some deformity could not be prevented; musculo-spiral paralysis was noticed on Sept. 10, but recovered completely in 6 weeks: no permanent stiffness	Oct. 1898: varus hardly perceptible; movement perfect
164	9	M	July 30	L	Fall on outer side of elbow	Inwards	Anterior angular splint; cotton-wool pressure	Several times after removal of splint	21 days	—	None	Almost well when last seen 5½ weeks after accident	.....
165	3	M	Aug 9	L	Fall down stairs	None	Anterior angular splint	....	..	..	..	Last seen 4 days after the injury; heard afterwards that the child died from convulsions 3 weeks after the accident	.....
166	9	M	Aug 26	R	?	Backwards	Anterior angular splint; evaporating lotion; great difficulty from swelling; internal angular splint applied on Sept. 6	After removal of splints	25 days	3 months	Cubitus varus	.....	Aug. 1898: cubitus varus; no stiffness; no shortening
167	5	F	Sept 7	R	Fall with arm under body	Outwards and forwards	Internal angular splint; cotton-wool pressure	None	15 days	3 weeks	None	.....	.....

168	5	M	Sept 9	R	Fall on hand	Backwards	Anterior angular splint and evaporating lotion	None	22 days	3½ months	Cubitus varus	Diagnosis and treatment interfered with by great amount of swelling: attempt to remedy deformity under chloroform on Oct. 21; when discharged there was no stiffness of the elbow	Aug. 1898: marked cubitus varus; no stiffness; arm quite strong and perfectly useful; skiagram (Fig. 11) showed that there had been partial separation of epiphysis and fracture into diaphysis
169	5	F	Oct 21	L	Fall on elbow	Backwards and upwards	Internal angular splint; redisplacement remedied, Nov. 12	None	36 days	2 months	Cubitus varus	Stiffness of elbow almost gone when last seen 9 weeks after accident	Aug. 1898: slight cubitus varus; movements perfect; skiagram—partial separation of epiphysis and fracture into diaphysis (Fig. 12)
170	6	M	Nov 1	L	Fall on elbow	Backwards	Anterior and internal angular splints; redisplacement reduced under chloroform, Nov. 12	None	28 days	2 months	None	.....	Aug. 1898: arm quite straight when extended; neither valgus nor varus; movements perfect
171	2	F	1896 Jan 1	L	Fall down stairs	Inwards	Internal angular splint; return of displacement; anterior and external angular splints applied on Jan. 14	None	23 days	..	None	Last seen 5 weeks after accident; the stiffness had not disappeared at that time	.....
172	6	M	Jan 21	?	Fall. ? on hand	Backwards	Anterior and internal angular splints; cotton-wool pressure	None	21 days	6 weeks	None	.....	Aug. 1898: perfect result
173	5	M	June 29	L	Fall. ? on elbow	Forwards	Internal angular splint at first; anterior angular and internal angular splints applied on July 3	None	20 days	..	None	Last seen 25 days after accident; stiffness had not disappeared, but was improving	Aug. 1898: some cubitus varus; otherwise quite right; skiagram (Fig. 13)
174	2¾	M	July 10	L	Fall	None	Internal angular splint; cotton-wool pressure	None	20 days	5 weeks	None	.....	Aug. 1898: perfect result

becomes increasingly less likely to occur as the age of the child advances. Hutchinson says that in all probability a clean separation at the epiphysial line is uncommon after the age of five or six, although it may occur some years later. As puberty approaches the external epicondyle is much more likely to be detached with the capitellum and trochlea than is the internal epicondyle.

Table XII. gives details of the 13 cases of separation of this epiphysis, which came under my notice.

From the table it will be seen that the ages of the patients varied from two to nine years. With two exceptions they were all under seven years of age.

Cause.—The cause of the separation may be either direct or indirect violence. In only a few of my cases could the exact mode of production of the injury be ascertained: it was due to a fall upon the hand in one case and to falls upon the elbow in four.

Displacement.—The displacement of the detached epiphysis is open to some variation. In the great majority of cases it is displaced backwards, partly from the original force of the injury, and partly from the action of the triceps muscle: in a few cases it is displaced outwards or inwards, or, more rarely, forwards. These unusual displacements are due to the violence which caused the separation. In such cases it will probably be found that the injury has been produced by direct violence to the elbow.

In three of my cases there appeared to be little or no displacement of the epiphysis. In six cases the displacement was backwards, in two inwards, in one outwards and forwards, and in one forwards.

Pathological Anatomy.—From the limited number of published cases which have been examined anatomically, it would appear that occasionally the separation follows closely the epiphysial line. In a larger proportion of cases, however, the separation takes the course of the epiphysial line for a certain distance and then diverges into the diaphysis. From the examination of a number of skiagrams, I have formed the opinion that the disjunction often starts at the outer side of the bone, and after following the epiphysial line for a certain distance, diverges sharply upwards into the diaphysis, and splits the bone longitudinally to a greater or less extent. This condition is illustrated by the accompanying skiagrams (Figs. 6 and 7).

Complications.—Certain complications may occur with this injury, but they are of rarer occurrence than the complications met with in cases of separation of the upper epiphysis of the same bone. The following have been described:—

(1) Injury to the brachial artery.

(2) Extensive laceration of the ligaments of the elbow-joint.

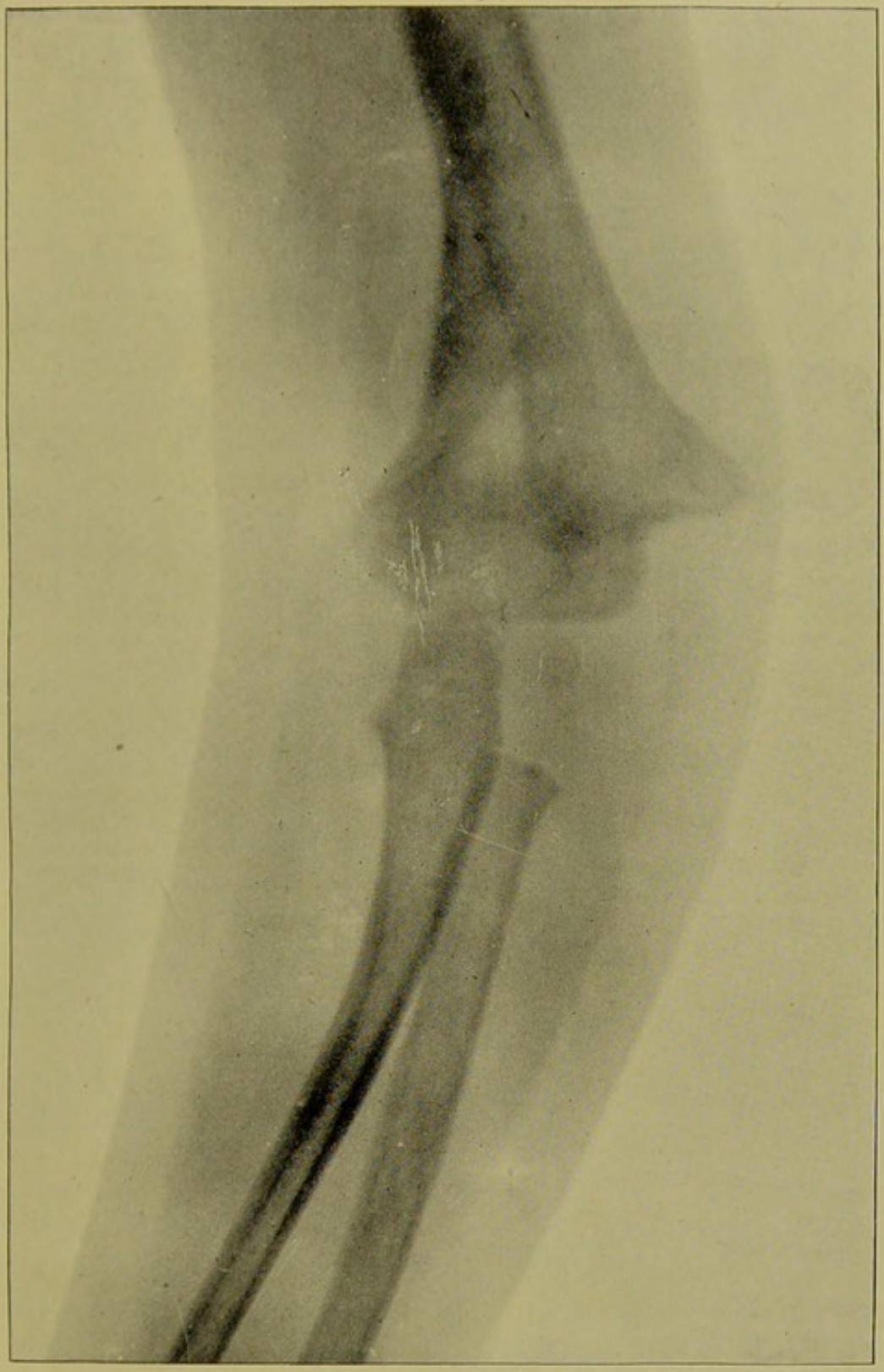

FIG. 6.

PARTIAL SEPARATION OF LOWER EPIPHYSIS OF HUMERUS WITH LONGITUDINAL FRACTURE OF DIAPHYSIS AND LOSS OF "CARRYING ANGLE."

Patient aged 2½ years; injury due to a fall down two or three steps; skiagram taken two months after injury. (From a skiagram lent by Mr. G. A. Wright.)

TABLE XIII.—TRANSVERSE FRACTURES OF LOWER END OF HUMERUS.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Treatment.	Passive Movement.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks.
175	9	M	1895. June 19	L	Fall on elbow	Backwards and inwards	Anterior angular splint; some displacement outwards, and internal angular splint applied on July 2	Several times after removal of splints; once under chloroform, on July 26	18 days	..	Slight displacement outwards of lower fragment	Line of fracture somewhat oblique from within, outwards and downwards; great amount of swelling during earlier stages of treatment; stiffness of elbow was considerable when splints were removed, but was improving when patient was last seen, 7 weeks after the accident
176	42	M	July 10	?	Fall with elbow against a wall	None	Anterior angular splint	Several times after removal of splint	40 days	..	None	Fracture just above epicondyles; union was long in taking place; 3 weeks after the injury there was still mobility between the fragments; stiffness of elbow almost disappeared when last seen, 12 weeks after the injury
177	7	M	1896. May 4	R	Fall on side	Backwards	Internal angular splint at first; May 12, redisplacement, anterior and internal angular splints applied; May 27, redisplacement, anterior and external angular splints	None	36 days	..	None	Patient was last seen on Aug. 11; the elbow was quite right except that extension was somewhat limited; slight wasting of muscles of hand noticed in July; probably pressure on ulnar nerve; this had not recovered when the boy was last seen.

178	5	F	June 6	L	Fall on arm	Backwards	Internal angular splint; June 12, re-displacement; anterior and internal angular splints; June 23, fragment displaced inwards; anterior and external angular splints	None	34 days	3½ months	None	Fracture transverse just above epiphysial line
179	10	M	July 5	L	Fall on arm	Forwards (considerable displacement difficult to overcome)	Anterior angular splint and short splint along back of upper arm; afterwards great difficulty from displacement backwards and inwards of lower fragment, which could not be altogether prevented	None	26 days	..	Displacement backwards and inwards of lower fragment	Patient discharged 2½ months after accident; then almost complete recovery of movements of elbow. Fig. 8 is a skiagram of this case taken 7 months after the accident
180	17	M	July 6	L	Fall; probably first on hand, and then on elbow	None	Anterior and external angular splints; cotton-wool pressure	None	22 days	..	None	Last seen 2½ months after accident; the stiffness of the elbow had not then quite disappeared
181	39	M	July 15	R	Fall on point of elbow		Internal angular splint at first; afterwards anterior angular splint; cotton-wool pressure	.....	..	..	.....	Fracture transverse through the points of the external and internal epicondyles; the patient went to the Union Hospital a few days after the accident, and was not afterwards seen by me.

Displacement.—The displacement of the lower fragment was backwards in two cases, backwards and inwards in one, and forwards in one. In the last case the reduction of the deformity presented great difficulties; the lower fragment afterwards became displaced backwards, and union took place in this position (Fig. 8). There was no displacement in two cases; in one the notes fail to give information upon this point.

Results.—Four of the cases gave great trouble during the after-treatment from redisplacement of the lower part of the bone, and consequently the period of recovery was greatly prolonged. The stiffness of the elbow-joint had disappeared in two cases at periods of $2\frac{1}{2}$ and $3\frac{1}{2}$ months respectively after the accident. It was improving, but had not disappeared, in four other cases, when they were last seen at periods varying from 7 to 14 weeks after the injury.

In transverse fractures of the lower ends of the humerus I have found very much more difficulty in maintaining the broken ends in good position than in cases of oblique fracture running into the elbow-joint. The same remark applies, though with rather less force, to separations of the lower epiphysis of the bone.

T-SHAPED FRACTURES.

The three examples of this injury are arranged in Table XIV.

From the table it will be seen that two of the patients were children, whilst one was a man, aged 62. In all cases the fracture was due to direct force applied to the elbow. The nature of the injury in two cases was probably transverse fracture of the lower end of the humerus, with vertical fracture between the condyles. In one of these there was no doubt as to the presence of both the transverse and vertical fractures, since the condyles were pushed apart, but could be moved upon each other with crepitus. In the other case there was some doubt as to the exact nature of the fracture, although there was no doubt that it extended into the joint. The third case was one of transverse supracondylar fracture with comminution of the part of the bone in the neighbourhood of the external condyle and capitellum. In all cases the loose fragments were displaced backwards.

Results.—All the three patients made complete recoveries, the movements of the elbow-joint being ultimately fully restored. In two the subsequent stiffness of the joint rapidly disappeared, and recovery was complete at the end of two and two-and-a-half months respectively. In the remaining case (the one in which there was some doubt as to the exact nature of the fracture) full extension of the elbow was prevented for a long time, owing to the olecranon fossa being filled with

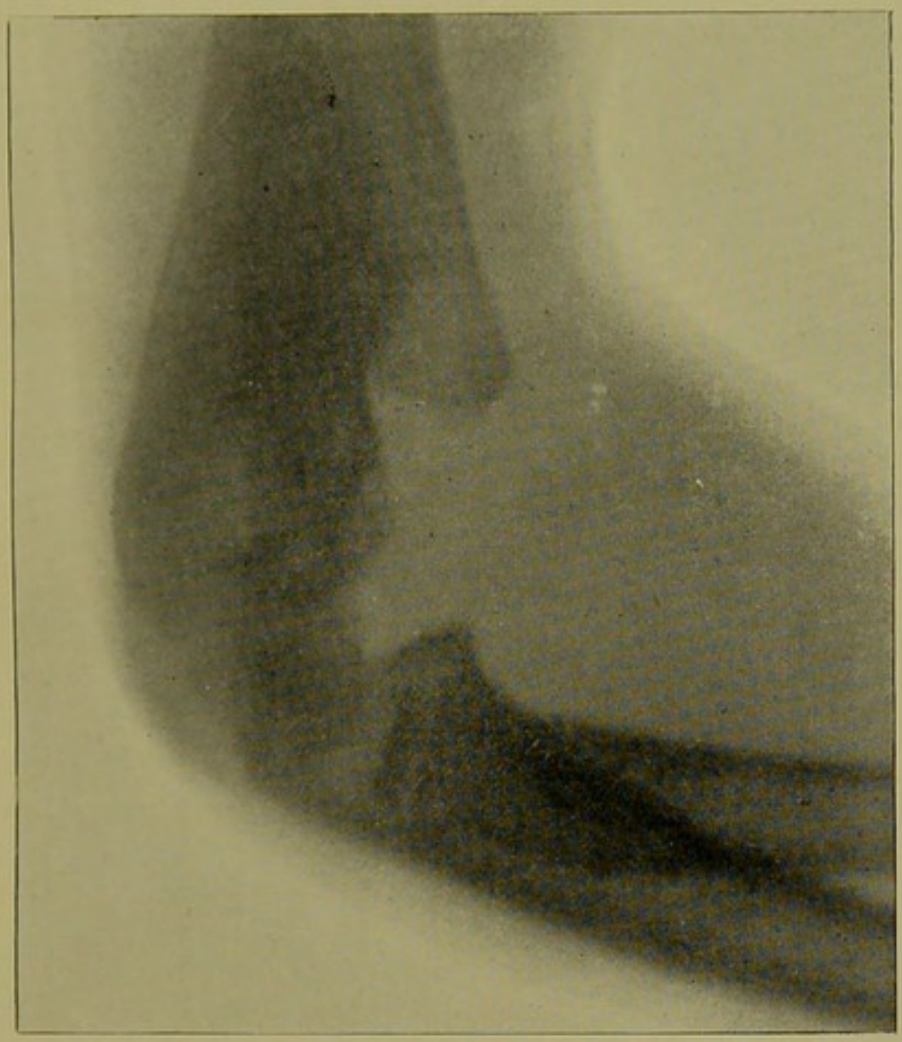

FIG. 8.

TRANSVERSE FRACTURE OF LOWER END OF HUMERUS.

Case 179.—The fracture has united with marked displacement backwards of the lower fragment. (The skiagram, which was taken seven months after the accident was kindly lent to me by Mr. G. A. Wright.)

callus: the callus, however, was ultimately absorbed, and ten months after the accident the movements of the joint were fully restored.

From the results in these cases I am inclined to look not unfavourably upon the prognosis in T-shaped fractures, and I cannot agree with Hamilton,[3] when he says that permanent deformity and bony ankylosis of the joint must be regarded as the rule after this injury. If the fragments be restored to their proper positions—under an anæsthetic, if necessary—and if subsequent swelling be checked, I see no reason why many of these cases should not recover with perfect, or almost perfect, joints.

OBLIQUE FRACTURES OF THE CONDYLES.

Amongst these injuries are included fractures separating the epicondylar processes and extending obliquely downwards into the elbow-joint, thus splitting off a greater or smaller portion of the capitellum or trochlea. Oblique fractures of the condyles are the most frequent fractures of the lower ends of the humerus—27 out of 60 cases—and it would appear, moreover, that the external condyle is more often involved than the internal—20 cases against 7.

The great majority of the patients were children: of the patients with fractures of the external condyle, all except two were under 14 years of age, whilst the ages of those with fractures of the internal condyle varied from 4 to 19 years. These facts agree very closely with the observations of Hamilton; of 49 patients under his care with these injuries, only four were over 18 years of age.

Twenty-five of the patients were males and only four females.

FRACTURES OF THE EXTERNAL CONDYLE.

Details of the 20 cases are given in Table XV.

Cause.—The cause of the injury, so far as could be ascertained, was as follows:—

Falls upon the elbow	14
„ „ probably	4
Doubtful	2

In no case did the injury appear to have been caused by a fall upon the hand. R. Adams,[4] however, in speaking of this fracture, says that it is frequently met with in children from falls upon the hand, whilst Hamilton[5] says that in the great majority of his cases there was conclusive evidence of direct injury to the elbow.

Pathological Anatomy.—From the specimens of this fracture which have been examined anatomically, it would appear that the line of disjunction may take one of three directions:—(1) The epiphyses of the external epicondyle and the capitellum, including the outer part

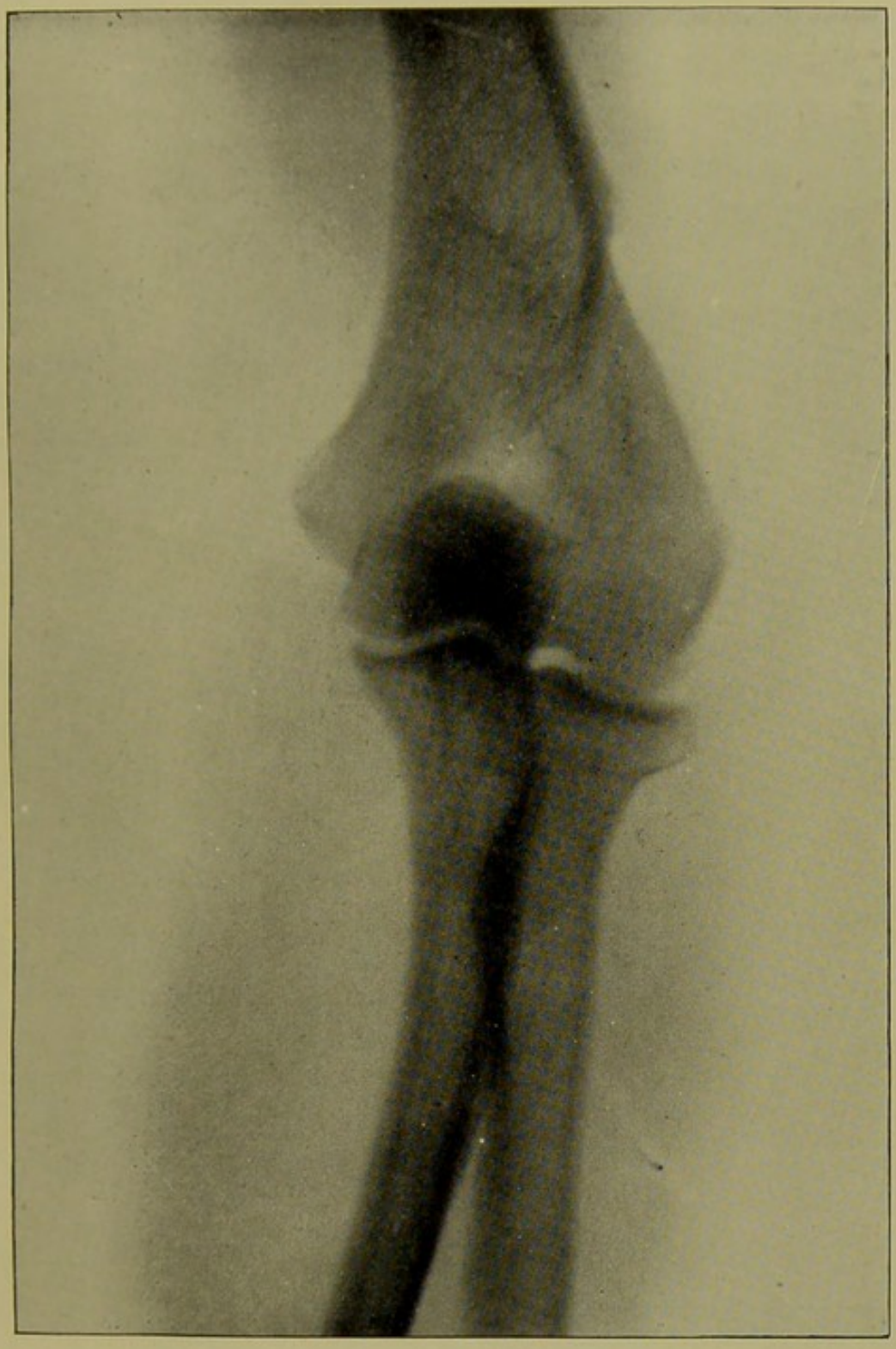

FIG. 9.

OLD FRACTURE OF EXTERNAL CONDYLE OF HUMERUS (Union with displacement downwards and forwards and with cubitus varus).

Patient a man aged 25; injury many years before. Union of olecranon epiphysis apparently imperfect, and head of radius distorted. (From a skiagram lent by Mr. G. A. Wright.)

TABLE XV.—Fractures of External Condyle of Humerus.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	Passive Movement.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
185	9	M	1895. June 16	L	Fall on elbow	Condyle downwards	Distinct gap felt above condyle	Internal angular splint; evaporating lotion	Nine days after accident, afterwards once a week	25 days	2 months	None	Six weeks after injury was quite well, except for slight limitation of extension of elbow
186	42	M	July 1	L	Fall on elbow from a lurry	None	Considerable bruising	Internal angular splint	On July 12, 19, 23, and 26	18 days	..	None	Last seen on July 26; the stiffness had not then disappeared; much trouble during after-treatment from bruising and blistering of skin
187	7	M	July 2	R	Fall on elbow	Condyle upwards and outwards	Also fracture of olecranon and of head of radius (Nos. 225 and 239); great swelling	Internal angular splint and evaporating lotion	One month after accident; afterwards once a week	28 days	..	Some displacement upwards of condyle and increase of normal cubitus valgus	Stiffness very slow in disappearing, especially from upper radio-ulnar joint. Elbow recovered completely, but upper radial joint very stiff, 14 months afrer the injury. *Ulnar paralysis* noticed two months after accident; disappeared in another two months. Aug., 1898: elbow-joint quite movable; upper radio-ulnar joint very stiff, and some grating on movement; head of radius enlarged; cubitus valgus not so marked as when last seen. Skiagram, Fig. 15
188	7	M	July 10	R	Fall on elbow	Very little, if any	Great amount of swelling; crepitus easily felt	Anterior angular splint; cotton-wool pressure	13 days after accident, and several times after removal of splint	20 days	2 months	None	.....
189	6	F	July 10	L	Fall on elbow	Condyle backwards, with radius and ulna	Fracture from above external condyle to trochlea	Internal angular splint and cotton wool	Twice—on July 30 and Aug 2	20 days	..	None	Last seen August 2. Stiffness of elbow not altogether disappeared

190	12	M	Aug 12	?	Fall on elbow	None	Great swelling	Anterior angular splint and cotton wool; splint removed four days later owing to great swelling	11 days after accident, afterwards twice a week	4 days	2½ months	None	.....
191	7	M	Aug 18	?	Fall ? on elbow		Also partial dislocation inwards of radius and ulna	Dislocation reduced. Anterior angular splint. Splint removed two days later because of great swelling	Commenced 15 days after accident	2 days	2½ months	None	.....
192	6	M	Sept 13	L	Fall on elbow	Condyle backwards, upwards, and outwards	.....	Anterior angular splint	....	..	....	....	Last seen a week after accident
193	7	F	Sept 14	R	Fall on elbow	None	Great swelling; crepitus easily obtained	Internal angular splint	None	24 days	7 weeks	None	.....
194	10	M	Sept 19	L	Fall on elbow	Upwards and forwards	.....	Internal angular splint and evaporating lotion	After removal of splint	22 days	....	None	Almost well when last seen, 6 weeks after accident
195	4	M	Nov 1	R	Fall on elbow	Upwards and outwards	Great swelling	Internal angular splint; cotton-wool pressure. Nov. 12, anterior angular splint	None	28 days	....	None	Patient last seen 4 weeks after accident; stiffness of elbow not disappeared; great trouble during the treatment from contusion and swelling of the parts
196	6	M	1896. Feb 10	L	Fall on elbow	None	.....	Internal angular splint and evaporating lotion	None	22 days	4½ months	External condyle rather more prominent than normal	One month after accident recovery was complete, except that extension of the elbow was limited. Recovery was ultimately perfect
197	8	M	Feb 11	R	Fall	None	.....	Internal angular splint	None	21 days	6 weeks	None	.....

TABLE XV.—Fractures of External Condyle of Humerus—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	Passive Movement.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
			1896.										
198	9	M	May 4	R	Fall on elbow	Upwards and slightly forwards	.....	Internal angular splint at first. May 12, Redisplacement — anterior and internal splints	None	29 days	8 weeks	None	.....
199	30	M	May 6	L	Fall on arm	Little or none	.....	Internal angular and short splint along upper arm	None	26 days	....	None	Last seen 4½ weeks after accident; elbow improving, but stiffness not disappeared
200	5	M	May 9	L	Fall on arm	None	.....	Internal angular splint	None	20 days	4 months	None	Six weeks after accident patient was quite well, except that extension of elbow was limited. Recovery was ultimately perfect
201	4	M	June 1	R	Fall	Outwards	Great swelling	Internal angular splint	None	18 days	....	None	Patient not seen after day of removal of splints; there was then very little stiffness
202	13	M	June 17	R	Fall on elbow	Outwards, slight	Said to have had dislocation of elbow; reduced before he came to hospital	Anterior and internal angular splints and cotton-wool	None	20 days	....	Some projection outwards of external condyle	Not seen until day after injury. When last seen, 3 months later, he was quite well, except for the displacement and slight limitation of extension of elbow.
203	4	M	July 30	R	Fall on elbow?	Slightly backwards	.....	Anterior angular splint	None	26 days	....	None	Last seen 8 weeks after accident; stiffness had not then disappeared
204	9	M	Aug 4	L	Fall on elbow	.....	Also dislocation of elbow inwards	Internal angular splint and evaporating lotion	None	30 days	....	None	Last seen 7 weeks after accident; there was then a considerable amount of stiffness remaining

TABLE XVI.—Fractures of Internal Condyle of Humerus.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	Passive Movement.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
205	12	M	1895 July 29	R	Fall on elbow	None	Great swelling	Anterior angular splint	After removal of splint	22 days	3½ months	None	.....
206	11	M	Aug 31	L	Fall on inner side of elbow	None	Great swelling	Anterior angular splint; evaporating lotion at first, afterwards cotton-wool pressure	After removal of splint	20 days	2½ months	None	.....
207	4	F	Oct. 22	?	Fall on elbow	None	Much swelling	Anterior angular splint and cotton wool; internal splint applied on Oct. 25	None	21 days	.....	None	Last seen 3 weeks after accident; stiffness of elbow almost disappeared
208	15	M	1896 Feb. 11	L	Fall on elbow	None	.....	Anterior angular splint and evaporating lotion; cotton-wool applied Feb. 14	None	21 days	8 weeks	None	.....
209	19	M	Mar 22	R	Fall on elbow from bicycle	?	Much swelling	Internal angular splint	None	23 days	.....	None	Last seen 5 weeks after accident; stiffness almost gone
210	6	M	May 8	R	Fall on elbow (?)	Very slightly forwards	Much swelling	Anterior and internal angular splints	None	23 days	.....	Very slight displacement forwards of condyle	Last seen 2½ months after accident; extension of elbow was still limited, but was improving
211	9	M	May 29	R	Fall on elbow	Epicondyle very prominent; condyle comminuted	Great danger of becoming compound	Internal angular splint and evaporating lotion at first; anterior and internal splints applied on May 31	None	18 days	6 weeks	None	.....

Pathological Anatomy.—Poland[7] says that there is no authentic specimen of separation of the epiphyses of the internal epicondyle and trochlea in one piece. The lesion would appear to be a true fracture, running obliquely downwards and outwards to the articular surface, and detaching the internal epicondyle and a greater or smaller portion of the trochlea.

Displacement.—As in fractures of the external condyle, the position of the loose fragment can usually be made to vary very considerably with the position of the forearm. In some cases the detached condyle is not displaced, whilst in others it is pushed backwards, upwards, inwards, forwards, or even downwards to a slight degree. Gurlt[8] figures a specimen from the Anatomical Museum at Breslau, in which union has taken place with marked displacement upwards of the fractured portion.

Results.—The results in my cases were as follows:—

Union without deformity	6
„ with slight displacement forwards of the condyle	1
Total	7

The average time necessary for complete restoration of the movements of the elbow-joint in 4 of the cases was about ten weeks.

FRACTURES AND EPIPHYSIAL SEPARATIONS OF THE INTERNAL EPICONDYLE.

The internal epicondyle is ossified from a centre, which makes its appearance during the fifth year of life in the innermost part of the cartilaginous lower end of the humerus. During the 13th year the epicondyle becomes separated from the trochlear epiphysis, owing to the downward and inward growth of the diaphysis, and thus forms a separate piece of bone, which unites with the shaft from the 18th to the 20th year. Occasionally union is delayed until adult life.

Separation of the epicondylar epiphysis is most likely to take place between the ages of 10 and 16 years. Before the age of 13 separation can only occur by fracture of the strip of cartilage intervening between the epicondyle and the trochlea. In adults a true fracture of the process may occur in rare cases.

Three anatomical points are of great importance in connection with these injuries: (1) The flexor muscles of the forearm arise almost entirely from the internal epicondyle. Hence, in certain cases the epicondyle is separated by muscular action alone, and in almost all cases the process, when detached, is displaced in a downward direction. (2) The internal lateral ligament of the elbow-joint is also attached to the epicondyle. When, therefore, the epicondyle is separated, this ligament loses its point of support, and dislocation of the elbow-joint

is liable to occur at the same time. (3) The ulnar nerve lies immediately behind the process, and may be injured by the loose fragment of bone.

Nine cases of separation of this epiphysis are included in Table XVII.

Age.—The ages of the patients were all from 10 to 16 years, a fact which agrees very closely with the experience of other observers. Hutchinson[9] says that in 38 cases of this injury which he collected the age ranged from 8 to 18 years. Of 46 cases collected by Poland,[10] in which the exact age of the patient was known, 34 were between 10 and 16 years old. As already stated, true fracture of the epicondyle occasionally occurs in adults, although it is possible that in some of these cases the injury may be separation of an epiphysis, the union of which with the diaphysis has been delayed. Hamilton[11] met with a case in a man, aged 34, and César[12] stated that of 14 cases collected by himself four were in adults.

Sex.—From the statements of various writers it would appear that this injury is of very much more common occurrence in the male than in the female sex. All my nine patients were males.

Cause.—In most of my cases the injury was caused by direct violence applied to the elbow. In two cases, however, it appeared to be due to falls upon the hand, and was probably produced by the action of the flexor muscles. Granger,[13] who first described this injury, was of opinion that it was always due to muscular action.

Probably in many cases the internal lateral ligament of the elbow-joint plays an important part in causing the separation. If the forearm be violently twisted outwards, the internal epicondyle will be very liable to be pulled off by the traction of this ligament. In such cases especially is the injury liable to be complicated by dislocation of the elbow-joint.

Displacement.—The epicondyle is usually displaced downwards or downwards and forwards by the action of the flexor muscles. Occasionally displacement is absent, or the epicondyle is pushed upwards or backwards by the force of the injury.

In most of the above cases there was considerable localised extravasation of blood, in which it was not always easy to find the detached epicondyle.

Complications.—In only one of my cases was the injury associated with dislocation of the elbow. Fallier,[14] however, found dislocation in 19 out of 48 cases which he collected. Usually the dislocation is in a backward and outward direction.

Other complications which have been described are comminution of the epicondyle (Poland), fracture of the olecranon (Sir A. Cooper),

TABLE XVII.—Separations of Internal Epicondyle of Humerus.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	Passive Movement.	How long fixed.	Period of Recovery.	Remarks on Result.
212	15	M	1895. June 27	L	Fall on hand in extended position; ? muscular action	Displacement downwards	Considerable swelling over inner side of elbow	External angular splint; evaporating lotion	Only once; on removal of splint	19 days	6 weeks	Aug. 1898: firm bony union; epicondyle somewhat enlarged; arm quite strong
213	10½	M	Sept 4	L	Fall on elbow	Downwards	.....	External angular splint	None	20 days	?	Aug. 1898: firm bony union; perfect recovery
214	12	M	Nov 1	L	Fall backwards with arm under body	None	Considerable swelling	External angular splint and cotton-wool	.....	..	..	Patient only seen once
215	11	M	Dec 1	R	Fall on palm of hand; doubtful whether elbow struck the ground	Downwards for ½ inch	Considerable swelling	External angular splint and cotton-wool; internal angular splint applied after subsidence of swelling	Once only; on Jan. 14, to correct some limitation of extension of elbow	23 days	8 weeks	Aug. 1898: firm bony union; perfect recovery
216	14	M	1896 Jan 25	L	Fall on elbow	Downwards	.....	External angular splint and cotton-wool pressure; evaporating lotion for first few days	None	17 days	..	Last seen 3 weeks after accident; there was then some stiffness of the elbow remaining
217	16	M	Feb 24	R	Fall on elbow	?	.....	External angular splint and evaporating lotion	None	22 days	4 weeks	Aug. 1898: fibrous union ¾in. long; epicondyle enlarged and displaced downwards; elbow quite strong and moveable
218	13	M	March 3	R	Fall on elbow	Downwards for ½ inch	Considerable extravasation of blood over inner side of elbow	External angular splint and cotton-wool	Once only; on March 31, to correct some limitation of extension of elbow	21 days	5 weeks	Aug. 1898: fibrous union; epicondyle enlarged and slightly moveable; very little displacement; elbow quite strong and moveable
219	12	M	April 22	L	Fall on elbow	Displacement very slight	Accompanied by dislocation of elbow — backwards and slightly outwards	Internal angular splint and cotton-wool	.....	..	..	Patient only seen once
220	13	M	April 23	R	Fall on elbow which was afterwards trodden upon	Fragment quite loose and easily moved about	.....	Internal angular splint	....	22 days	6 weeks	Aug. 1898: fibrous union; epicondyle somewhat enlarged; very little displacement; elbow quite strong and moveable

fracture of the coronoid process, and injury to the ulnar nerve. Hutchinson[9] has published two cases of the last-mentioned complication, in which he removed the epicondyle with most satisfactory results.

Results.—Two of the patients only attended once: a third was progressing favourably when he was last seen three weeks after the accident. The remaining 6 cases made uninterrupted good progress, the average period necessary for complete recovery being about six weeks from the time of the accident.

Six of the patients I had an opportunity of examining in August, 1898—at periods varying from two years and four months to three years and two months after the accident. In three union had taken place by bone, in the others by fibrous tissue. The three latter cases, as well as one of those in which bony union had taken place, showed distinct enlargement of the epicondyle. All the patients had full range of movement in the elbow-joint, and there was not the slightest impairment of the strength of the arm.

FRACTURES AND EPIPHYSIAL SEPARATIONS OF THE EXTERNAL EPICONDYLE.

These are very rare accidents, but are said to occur occasionally from direct or indirect violence. In the majority of reported cases the epicondyle, together with a greater or smaller portion of the capitellum, has been separated. It would appear, however, from a few published cases, and from experimental observations, that in rare cases true fracture in the adult or epiphysial separation in children may occur.

FRACTURES AND EPIPHYSIAL SEPARATIONS OF THE CAPITELLUM AND TROCHLEA.

These injuries are of decidedly rare occurrence. F. E. Clarke,[15] in 1870, recorded a case, proved by anatomical examination of the parts, in which the epiphyses of the capitellum and trochlea were separated in one piece, the subject being a boy, aged 12 years. No other precisely similar specimen has been described, but there are several cases on record in which the external epicondyle has been separated along with the capitellum and trochlea.

Poland[16] quotes 4 cases in which fracture of the capitellum alone has been proved anatomically, and refers to a fifth case of probable separation of the capitellar epiphysis. Cates,[17] in 1896, recorded a case (examined after death) in which fracture of the capitellum was associated with fractures of the head of the radius and of the coronoid process of the ulna. Poland[18] has only been able to find one case in which separation of the trochlear epiphysis alone has been proved beyond doubt.

In the following case which came under my notice there was undoubtedly fracture of these parts of the bone, the epicondyles being intact, but it was impossible to define the exact limits of the fracture.

Case 221. Dislocation of head of radius backwards and of upper end of ulna inwards, with fracture of capitellum or trochlea.—H. H., a youth, aged 13, was, on May 2nd, 1896, practising in a gymnasium, when he fell backwards, with his arm under his body. I saw him very shortly afterwards, before much swelling had come on, and found the following condition. The ulna was dislocated partially inwards; the head of the radius was dislocated backwards, and could easily be pushed in and out of place; the orbicular ligament was ruptured. The epicondylar processes of the humerus were intact, and were attached to the diaphysis, but there was a detached portion of bone between the two; the exact limits of the latter could not be made out, but it probably involved both the capitellum and the trochlea. There did not appear to be much displacement of the fragment, but distinct crepitus was obtained occasionally during manipulation. As reduction of the dislocation of the ulna could not be effected, chloroform was administered, but, in spite of prolonged attempts, the bone could not be put back into place. It appeared that the separated portion of the humerus locked the bones, and so prevented reduction. After consultation, it was decided that no further operation was advisable, and hence the arm was placed on an anterior angular splint, on which it was kept at rest for three weeks. The after-progress was fairly good. When the splint was removed, there was considerable stiffness of the elbow, but this was improving when the patient was last seen, five-and-a-half weeks after the accident. At that time the prospects of a useful joint were good. I have since regretted very much that open operation was not adopted in this case, the fragment removed if necessary, and the displacement of the ulna rectified.

DIAGNOSIS OF FRACTURES OF THE LOWER END OF THE HUMERUS.

Diagnosis in these cases frequently presents very considerable difficulties. In many cases the difficulties are so great that it is almost impossible to be certain of the exact nature of the fracture, although in this respect much light can often be thrown upon the case by a careful examination under an anæsthetic and by the use of skiagraphy. It is not my intention to deal at great length with this part of my subject: I merely wish to call attention to a few points which will give considerable assistance in arriving at an opinion.

In all cases it is essential to compare the injured limb with its fellow. By carefully mapping out the corresponding points of bone on the two sides, one can, in most cases, detect any deviation from the normal.

The relative positions which the external and internal epicondyles bear to each other and to the olecranon process should be determined. It is seldom that there is so much swelling that these bony points are altogether obscured. If one of the epicondyles be displaced upwards, the lesion will probably be an oblique fracture of the condyle extending into the joint. The relation of the olecranon to the epicondyles is altered in cases of dislocation.

The relation of the epicondyles to the shaft of the humerus should also be noted. By viewing the arm from the side the general direction of the shaft of the bone can be determined, and if it be found that the epicondyles lie behind the transverse plane of the shaft, one may suspect separation of the epiphysis, or transverse supracondylar fracture, with displacement backwards of the lower fragment.

Attention should also be paid to the lateral angle of the elbow. Most patients with injuries about the lower end of the humerus present themselves for treatment with the elbow in a flexed condition. If now the joint be gradually extended, one can say, when the extension has been carried through a very few degrees of a circle, whether the forearm is taking up a position of valgus or varus. If the latter, there is probably a fracture, with displacement upwards, of the internal condyle. If there is a condition of excessive cubitus valgus, the lesion is probably fracture of the external condyle. With either fracture it is easy, by moving the forearm laterally, to alter the lateral angle.

Mr. G. A. Wright[19] has pointed out two useful tests which will be of great assistance in the diagnosis of fractures in this region. It will be found, he says—(1) That a line can be drawn, in all positions of the joint, from the most prominent point of the internal epicondyle, obliquely downwards and outwards through the upper border of the olecranon to the head of the radius, and that such a line is bisected at a point corresponding to the superior and external angle of the olecranon; and (2) that a line drawn across the back of the joint in full extension, from the external to the internal epicondyle, will lie above the upper border of the olecranon.

The importance of the administration of an anæsthetic for the purpose of diagnosis, as well as for the satisfactory reduction of the displacement, in many of these cases, cannot be too strongly insisted upon. Not only does this save the pain of a prolonged examination, but it enables the surgeon to make out the bony points much more satisfactorily.

Skiagraphy undoubtedly gives very great assistance in a large number of cases, and is the means of enabling a correct diagnosis to be made in many cases which would otherwise remain obscure. At the same time it must not be forgotten that, if reliance be placed altogether upon skiagraphy, to the exclusion of other methods of diagnosis, and especially if the arm be skiagraphed from one point of view only, mistakes are very liable to occur. Up to the present time Röntgen photography has failed to give any idea of perspective, and hence displacement of a fractured portion of bone in the direction in which the X-rays pass through the limb, may not be shown at all in the skiagram. Not infrequently is it necessary, if skiagraphy is to be

of any service, to have photographs taken from two or more points of view.

In the interpretation of skiagrams I have several times seen errors arise owing to the normal capitellum being mistaken for a loose fragment of bone. As has already been mentioned, the capitellum begins to ossify at a much earlier age than either the trochlea or the external epicondyle, and hence in many skiagrams it stands out as an apparently detached piece of bone.

TREATMENT OF FRACTURES OF THE LOWER END OF THE HUMERUS.

The treatment of these fractures has always given rise to considerable difficulties, and hence many different methods have been advocated, and the literature of the subject is most extensive. I propose to discuss the main points of treatment under the following headings:—

(1) *The Immediate Reduction of the Displacement of the Fractured Portions of Bone.*—This is of the utmost importance. It may not always be possible, but I am of opinion that it should always be attempted, an anæsthetic being administered if necessary. The reduction of the displacement, if delayed for some days until the swelling has subsided, becomes increasingly difficult, since the inflammatory effusion which is thrown out tends to prevent the return of the fragments to their proper positions. Moreover, the necessary manipulations will probably give rise to fresh hæmorrhage and inflammatory exudation. Amongst my own cases it has almost always been those in which reduction of the deformity has been delayed which have presented the greatest difficulty in the maintenance of the fractured ends in good position. Moreover, it has been these cases, and especially those in which there has been some permanent deformity, which have suffered most from subsequent stiffness of the elbow-joint. The importance of early reduction of the deformity has recently been forcibly stated by Gould[20] and Bunts.[21]

(2) *Position of Arm and Splints.*—In cases of fracture of the internal epicondyle the best splint is an angular one applied to the outer side of the arm. The elbow being flexed to a right angle, and the forearm placed in a position of semi-pronation, the flexor muscles arising from the epicondyle are relaxed and the tendency to displacement downwards is to a certain extent counteracted. Also, the splint being well away from the seat of fracture, cannot press the epicondyle against the ulnar nerve.

In all other fractures of the lower end of the humerus, I have come the conclusion that the case is best treated with the elbow flexed to a right angle and the forearm supinated, an anterior or a posterior angular splint being applied.

From time to time certain surgeons have recommended that these fractures be treated with the elbow extended. Amongst those who have advocated this position may be mentioned Lauenstein,[22] Bardenheuer,[23] Illingworth,[24] Nunn,[25] Berthomier,[26] Allis,[27] L. C. Lane,[28] and J. B. Roberts.[29] These surgeons state that in the flexed position it is impossible to set the fracture so as to maintain the natural angle ("carrying angle") of the elbow, which is held to be a test of perfect reduction of the displacement. The objections to this position are—(1) It is less comfortable to the patient; (2) if there be any permanent stiffness, the arm is much less useful than it would be were the elbow flexed; and (3) in cases of epiphysial separation the tendency to displacement backwards of the epiphysis is not counteracted. I have been accustomed for some time past to use a test which combines the advantages of the extended position with the more evident advantages of the flexed position. Treating the case on an anterior angular splint, I have, when the patient presented himself for subsequent inspection, removed the splint, and then, grasping the elbow with one hand and the forearm with the other hand, have gradually extended the elbow: after the extension has been carried through a few degrees of a circle, one can say, by noticing the relative outlines of the arm and forearm, whether the latter is taking up a position of valgus or varus. In some of my earlier cases I was disappointed to find an alteration in the "carrying angle" after the union of the fracture, but since I have been in the habit of applying this test in the after-treatment of all fractures of the lower end of the humerus, I have been almost uniformly successful in preventing cubitus varus or excessive cubitus valgus. I have already referred to the value of this test in the diagnosis of fractures of the condyles of the humerus. In applying the test, it is only necessary to extend the elbow to a slight degree: nothing amounting to passive motion of the joint has been carried out.

Most writers upon the subject have recommended that fractures of the lower end of the humerus be treated with the elbow flexed to a right angle. Amongst these we may specially mention C. A. Powers,[30] of New York, who has recorded the results of 650 cases, 120 of which had come under his personal observation.

If these fractures be treated with the elbow flexed, either a lateral (usually internal) or an anterior angular splint may be used. With the former the forearm is maintained in a position of semi-pronation; with the latter in a position of full supination.

The *internal angular splint* is recommended by many surgeons, and frequently gives very good results. On the whole, I have found greater difficulty in maintaining the position of the bones with this

form of splint than with an anterior splint, and I have in several cases succeeded in keeping the fragments in position with an anterior splint after an internal splint has failed.

Hutchinson[2] and Stanley Boyd[31] say that an internal angular splint is liable to cause lateral displacement of the fragments.

If the elbow be flexed and the forearm fully supinated, either an *anterior* or a *posterior angular splint* may be applied. I have usually used the former, and have often combined it with an internal or an external splint when there has been much tendency to lateral displacement. The only objection to the anterior splint is that it may cause rather too much pressure in the bend of the elbow. A posterior angular splint, moulded to the arm and forearm, is recommended by Hamilton, and also by Hutchinson, for the treatment of these cases.

For the treatment of injuries about the elbow-joint in children, Poland[32] advocates the use of Croft's plaster-of-Paris lateral splints, These are prepared from patterns previously cut out, and shaped to the sound limb. The elbow is flexed to a right angle and the forearm supinated.

Recently several surgeons (W. Bruce,[33] H. L. Smith,[34] and others) have expressed themselves strongly in favour of treatment without any splints whatever, the elbow being placed in a position of acute flexion, and the arm fixed to the body.

(3) *The Prevention and Reduction of Swelling.*—I have tried very extensively in these cases both the use of evaporating lotions and the exhibition of a slight degree of pressure by means of a layer of cotton-wool, and I have no doubt that the latter gives much better results than the former. It is quicker in its action, and is not open to the objection that the splints and dressings become soaked with lotion. Further, if the patient be seen soon after the injury, and if the elbow be wrapped in a moderately thick layer of cotton-wool, hæmorrhage will be restrained and the considerable degree of effusion into the surrounding tissues, which is otherwise inevitable, will be prevented: the same cannot be urged in favour of evaporating lotions, even if diligently applied from the first.

For the first week after the accident the arm and hand should be carefully watched, so that any undue pressure of the splints and dressings may be instantly corrected. Many cases of gangrene of the limb have occurred from neglect of this simple precaution.

(4) *Removal of the Splints.*—The splints, as a rule, should be discarded at the end of three weeks: in young children they may be removed rather earlier; in adults it may be necessary to retain them for a longer period.

(5) *Passive Movement.*—I have no hesitation in saying that passive movement in the treatment of these fractures is bad, and that it should never be carried out before the fracture has united. If the fragments of bone have been placed in proper position, the stiffness of the joint after the removal of the splint is seldom great, and usually disappears in the course of a few weeks, or, at the most, a few months. In the first week or two after the occurrence of the fracture passive movement can hardly be carried out without more or less disturbance of the fragments; this leads to the throwing-out of more callus, and thus the ultimate recovery of the joint is delayed. At the end of three weeks the splints should be removed, and the patient encouraged to use the arm as much as possible. During the treatment of my earlier cases I used passive movement; during my later cases I never used it, and the results in the latter were, on the whole, better than in the former—the average period of recovery was decidedly shorter. A considerable number of writers now recommend that the arm be kept altogether at rest for three weeks.

Amongst the surgeons who practise passive movement in these cases there is some difference of opinion as to the time at which it should be commenced. Some begin the movement as early as the second or third day, while others defer it for a week or ten days.

(6) *Operation.*—In some cases of irreducible or recurrent displacement the question of operation will arise. Excellent results from such treatment have been recorded by Watson Cheyne[35] and others.

I venture to say, in leaving this subject, that if fractures of the lower end of the humerus be treated by immediate reposition of the fragments, if the arm be placed upon an anterior angular splint with a layer of cotton-wool to check swelling, if passive movement be avoided, and if the splints be removed at the end of three weeks and the patient encouraged to use the arm, recovery will take place in a comparatively short time, and one will seldom have a bad result.

ALTERATIONS IN THE LATERAL ANGLE OF THE ELBOW AFTER FRACTURE OF THE LOWER END OF THE HUMERUS.—CUBITUS VARUS AND EXCESSIVE CUBITUS VALGUS.

Normally the forearm in the extended position of the elbow is directed somewhat outwards, forming an angle of about 170° with the upper arm. In consequence of this the hand projects somewhat from the side of the body, and the lateral angle becomes of service when any object is carried in the hand: it is, therefore, frequently spoken of as the "carrying angle." From the resemblance to the deformity, genu valgum, so frequently met with in the leg, the arm is said to be in a condition of slight cubitus valgus. It must be remembered that the lateral angle is not evident when the elbow-joint is flexed.

After fracture of the lower end of the humerus it is not uncommon to meet with cases which present an alteration in the natural lateral angle. Either the normal condition of slight valgus may be increased, giving rise to excessive cubitus valgus, or the arm may be bent outwards at the elbow, giving rise to a condition of cubitus varus.

These deformities may result from the following fractures of the lower end of the humerus:—

(1) *Oblique Fractures of the Condyles*, extending into the elbow-joint.—Case 187 (Table XV., page 66) is an instance of excessive cubitus valgus following fracture of the external condyle, and Fig. 9 (page 65) exemplifies cubitus varus following the same fracture.

(2) *Separation of the Epiphysis.*—This is the most frequent cause of cubitus varus. Six examples are mentioned in Table XII. (page 56). Less frequently excessive cubitus valgus follows separation of the epiphysis.

(3) *Transverse Supra-Condylar Fracture.*—Nunn[36] has recorded a case of excessive cubitus valgus after this fracture. The specimen was found in the dissecting room of Middlesex Hospital, and the lesion was therefore proved anatomically.

(4) T-*shaped Fracture.*—I am not acquainted with any recorded case after this variety of fracture, but there is no doubt that it might occur if one of the condyles were displaced to a higher level than the other.

Pathology.—After *oblique fractures of the condyles* these deformities are due to permanent displacement upwards or downwards of the detached portion of bone. If the external condyle be pushed upwards the normal cubitus valgus will be increased (Case 187); if it be displaced downwards there will be cubitus varus (Fig. 9). In the case of the internal condyle the conditions will be exactly reversed. Gurlt[8] figures a specimen in which marked cubitus varus followed fracture of the internal condyle with displacement upwards. Poland[37] gives skiagrams of two cases, in one of which cubitus varus resulted from displacement downwards and inwards of a fractured external condyle; in the other case, which was also a fracture of the external condyle, the fragment was ununited, and was displaced upwards, leading to cubitus valgus.

After *transverse supracondylar fractures* the condition is due to tilting of the fragment, so that the trochlea comes to lie at a higher level than the capitellum, or *vice versâ*.

After *separation of the epiphysis* the pathology of these cases is more complicated. They may, in all probability, be due to several causes:—

(*a*) As has already been mentioned the line of disjunction in many cases of detachment of the epiphysis follows the epiphysial line for a

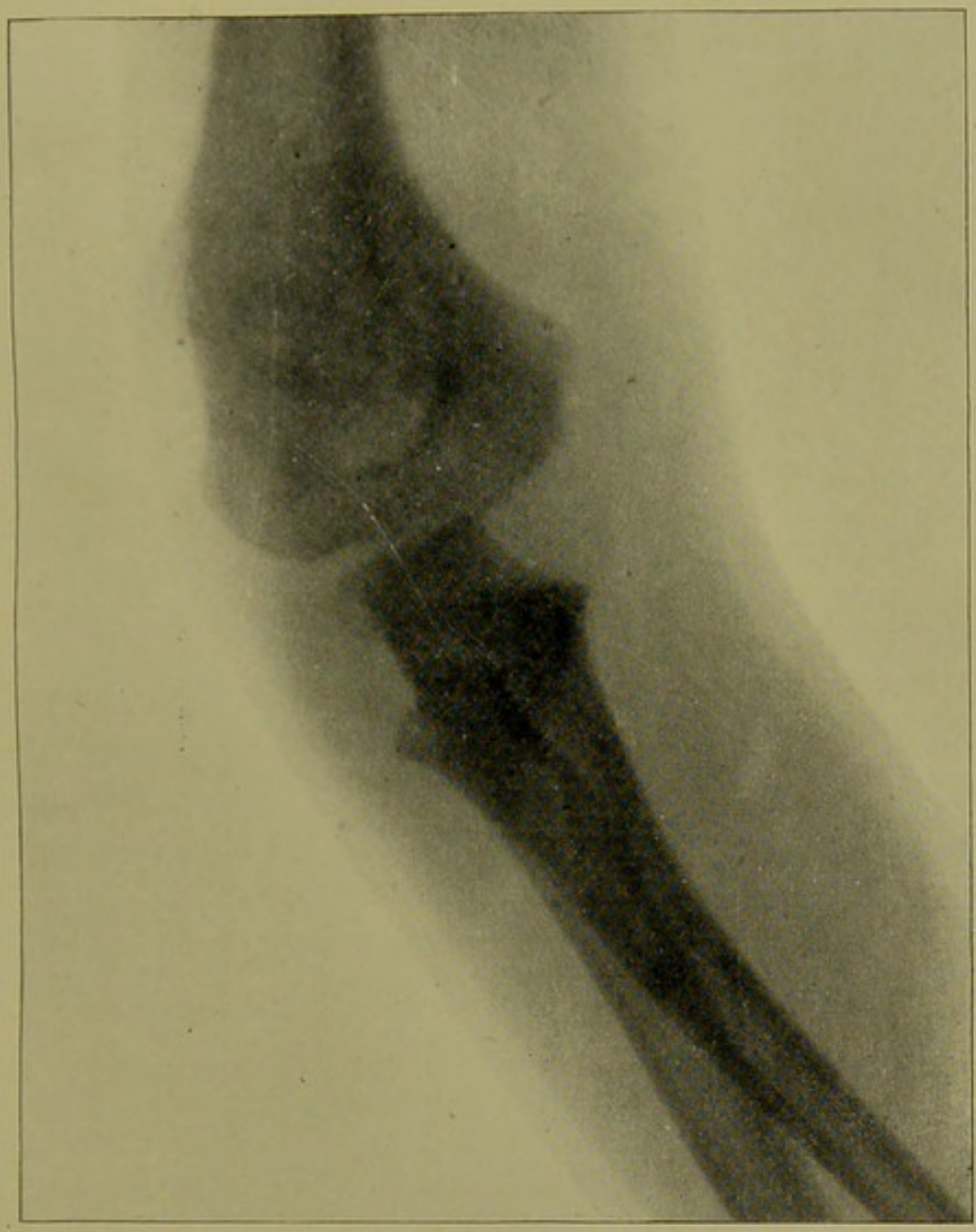

Fig. 10.

Cubitus Varus following Partial Separation of Lower Epiphysis of Humerus with Fracture of Diaphysis.

Patient a boy aged 6. Injury due to a fall on the elbow, on October 28, 1896. Skiagram taken February 9, 1897. (From a skiagram lent by Mr. G. A. Wright.)

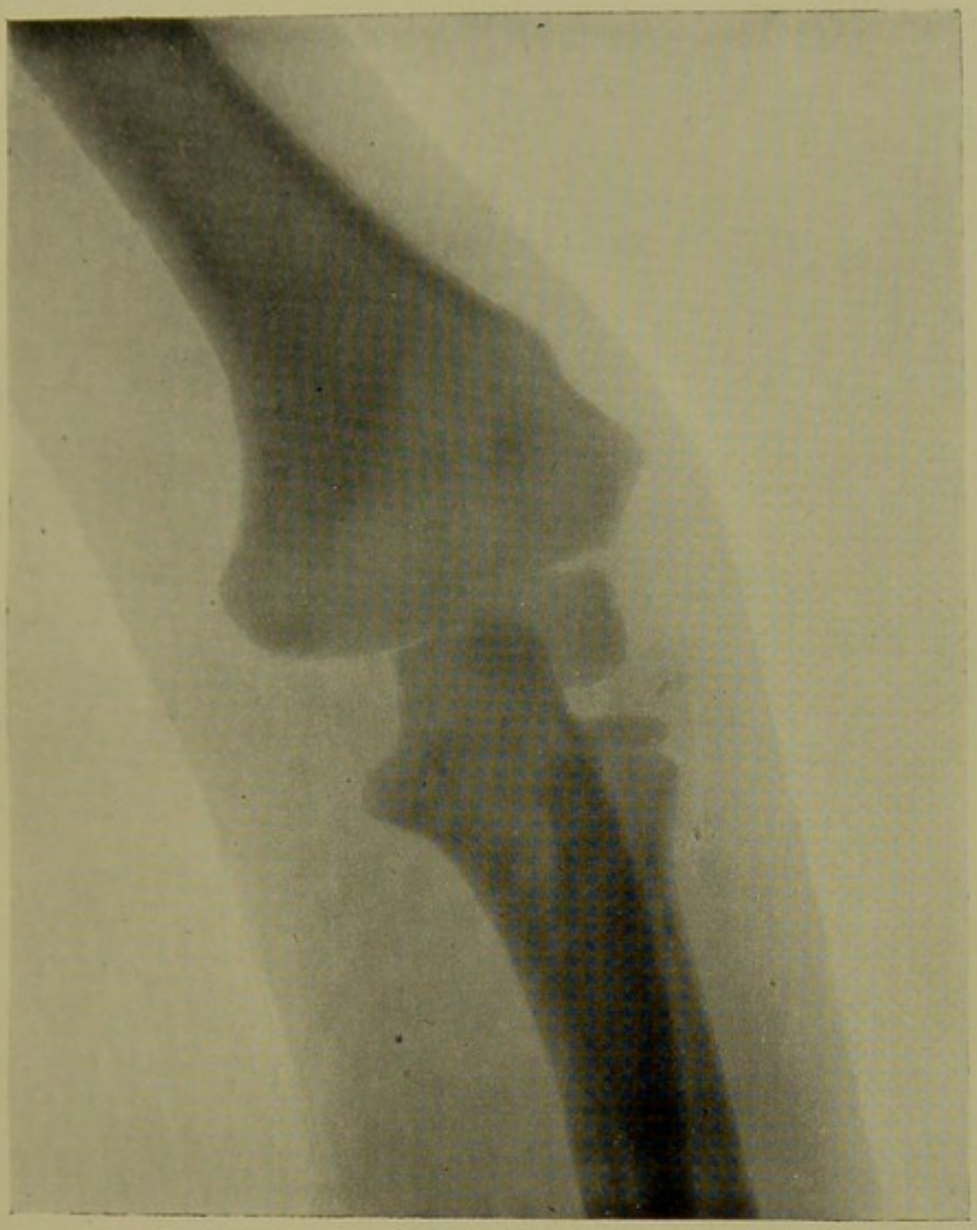

FIG. 11.

CUBITUS VARUS FOLLOWING PARTIAL SEPARATION OF LOWER EPIPHYSIS OF HUMERUS WITH FRACTURE OF DIAPHYSIS.

Case 168.—Skiagram taken three years after injury.

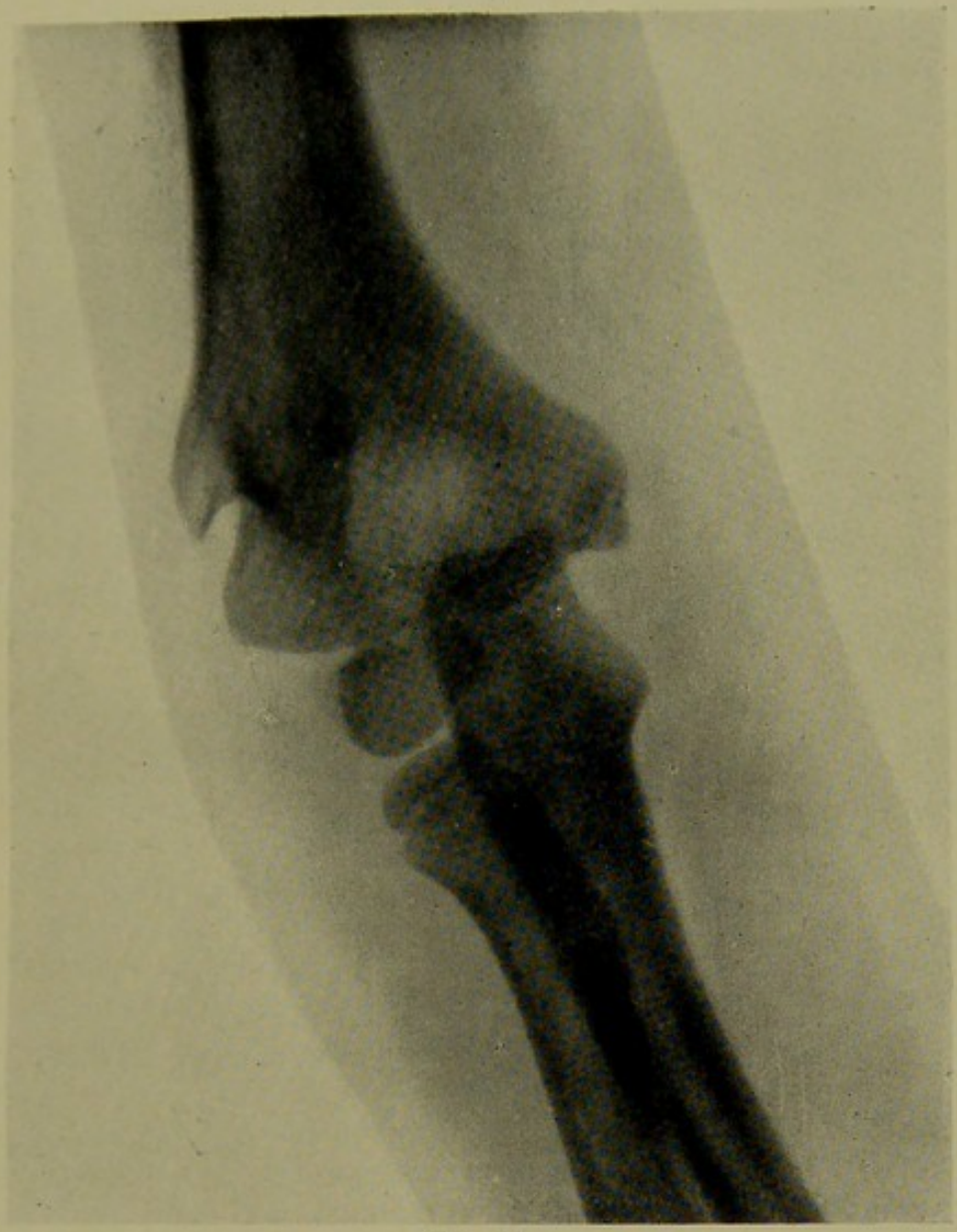

FIG. 12.

CUBITUS VARUS FOLLOWING PARTIAL SEPARATION OF LOWER EPIPHYSIS OF HUMERUS WITH FRACTURE OF DIAPHYSIS.

Case 169,—Skiagram taken three years after injury.

certain distance, and then diverges into the diaphysis. This is illustrated by the skiagram shown in Fig. 6 (page 58). A similar specimen is figured by Hutchinson.[2] In such cases imperfect reduction of the deformity will lead to permanent cubitus varus, and I am of opinion that this is the true explanation of three cases of which skiagrams are here reproduced (Figs. 10, 11, and 12). Two of these were taken from patients included in the preceding table of cases of separation of the epiphysis, and the third was kindly lent to me by Mr. G. A. Wright. These three skiagrams show very clearly what will ensue if a deformity, such as that represented in Fig. 6, be left unreduced. In all three there appears to be an excessive formation of new bone, which causes a considerable projection on the outer side of the humerus between the capitellum and the lower end of the diaphysis. It may be that the new formation of bone in these cases has gone on for some time after the injury, and has thus led to further displacement downwards of the capitellum, and to a gradual increase in the degree of the cubitus varus.

Poland[38] figures a case in which cubitus varus followed epiphysial separation with fracture of the diaphysis. The line of detachment had travelled along the epiphysial line for more than the inner half of the bone, and had then passed obliquely upwards through the diaphysis to above the external supracondylar ridge.

(*b*) In describing the anatomy of the lower humeral epiphysis I have already referred to the oblique direction downwards and inwards which the epiphysial line assumes shortly after birth, and to the fact that this obliquity becomes more marked as the child grows up. The obliquity, which is well shown in Fig. 5 (page 55), tends to favour displacement outwards of the epiphysis in cases of separation, and such displacement might lead to an alteration in the lateral angle of the elbow. The treatment of these cases upon an internal angular splint is objectionable, because this tendency to outward displacement is not corrected by such a splint.

(*c*) It has also been mentioned that as the bone grows the end of the diaphysis becomes convex, and the epiphysis is fitted upon it like a cap. Some cases of cubitus varus and valgus may, I think, be explained by a rotation of the epiphysis having taken place upon the convex end of the diaphysis. In Case 163 (Table XII.) union took place with some displacement (? rotation) inwards of the epiphysis.

(*d*) In some cases an alteration in the "carrying angle" is due to irregular growth at the epiphysial line after the fracture has united. Poland[39] says that this may occur without any displacement of the epiphysis having taken place. He further says: "An injury to the conjugal cartilage in early childhood may cause an early ossification or destruction of the conjugal cartilage and arrest of growth of a part

of the growing end of the bone, and thereby produce considerable deformity of the joint in after years." This irregular growth will be more likely to occur because, as has already been mentioned, the line of separation seldom follows the whole course of the epiphysial line. In three of the cases of separated epiphyses described in Table XII. the lateral angle of the elbow underwent an alteration in the course of the two or three years following the injury. In one case which united with some inward displacement of the epiphysis, the varus gradually improved, and had almost disappeared when I examined the patient three years after the accident. On the other hand, varus gradually supervened in two cases in which union had taken place without deformity. A skiagram of one of these cases is reproduced in Fig. 13.

Prognosis.—With rare exceptions, such as the case just referred to, these deformities are permanent, when once the bones have firmly united. In most cases they interfere little, if at all, with the usefulness of the limb. In several cases which I have examined there was a certain degree of power of hyperextension of the elbow-joint. These deformities may, however, prove disadvantageous in the following ways:—

(1) They may act as a bar to entrance to the public services.

(2) They are unsightly, and parents often attach great importance to them. Actions for malpraxis have been threatened on their account.

(3) Cubitus varus may interfere with the use of the hand for carrying purposes.

(4) The presence of these deformities shows that the displacement of the fractured pieces of bone has not been properly remedied, and hence the subsequent period of stiffness of the elbow-joint will probably be greater than usual, and the ultimate recovery of the patient much delayed.

Prevention.—It has already been mentioned that some surgeons, in order to prevent these deformities, recommend that fractures of the lower end of the humerus be treated with the elbow extended. If the flexed position be used, an anterior angular splint is preferable to an internal angular splint, since the latter more often allows lateral displacement of the fragments. I have already described a test which I have found very useful in the treatment of these fractures, and I am of opinion that if this test be applied, a tendency to cubitus varus or excessive cubitus valgus can be recognised at an early stage of the treatment, and means can then be taken for its prevention. If malposition be found, the patient should be placed under an anæsthetic and an attempt made to rectify it.

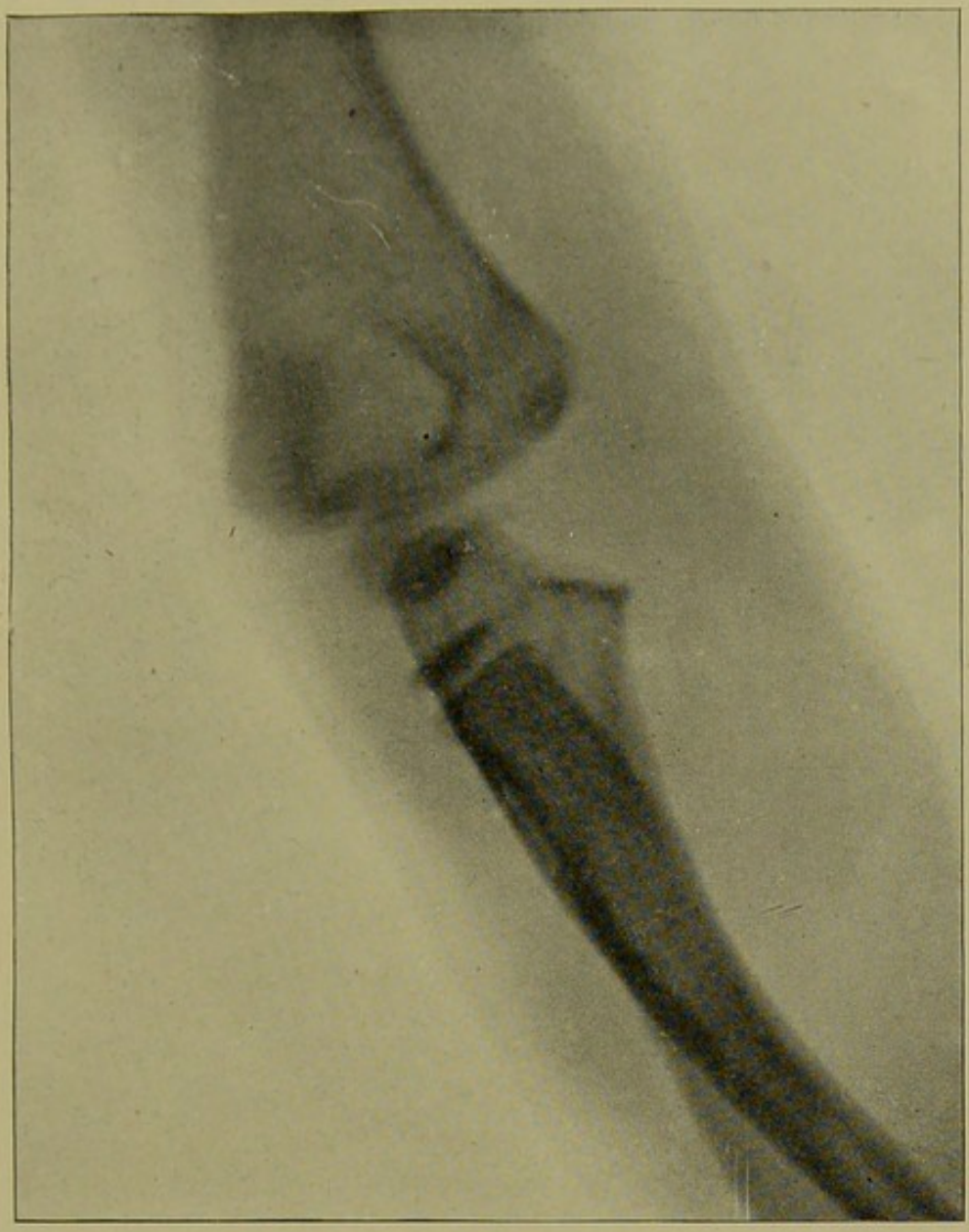

Fig. 13.

Cubitus Varus due to Irregular Growth following Separation of Lower Epiphysis of Humerus.

Case 173.—Skiagram taken two years after injury.

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Chapter V.

FRACTURES OF THE RADIUS AND ULNA.

During the fifteen months whilst I was recording cases of fracture, 342 fractures of these bones came under my notice. They were as follows:—

Upper Ends:—			
Olecranon process		12	
Coronoid process		3	
Head of Radius		1	
		—	16
Shafts:—			
Incomplete Fractures:			
Radius and Ulna	62		
Radius alone	9		
Ulna alone	5		
	—	76	
Complete Fractures:			
Radius and Ulna	50		
„ „ Compound	4		
Radius alone	39		
Ulna alone	13		
	—	106	
		——	182
Lower Ends:—			
Separations of lower Epiphysis of Radius		36	
„ „ Epiphyses of Radius and Ulna		6	
„ „ Epiphysis of Ulna		1	
Colles' fractures		88	
„ „ with fracture of lower end of Ulna		7	
Other fractures of lower end of Radius		4	
Fractures of lower end of Ulna		2	
		——	144
			342

In addition to the above cases, which were treated as out-patients, the following were admitted to the wards:—

Olecranon—Compound fractures	2
Radius and Ulna—Shafts:—	
Greenstick fracture	1
Complete fractures—Simple	5*
Compound „	3
„ Comminuted fracture	1
„ „ fractures necessitating amputation	3
Radius alone—Simple fractures	3
Ulna alone—Simple fracture	1
	19

* In one of these cases both forearms were fractured 1½ inches above the wrist.

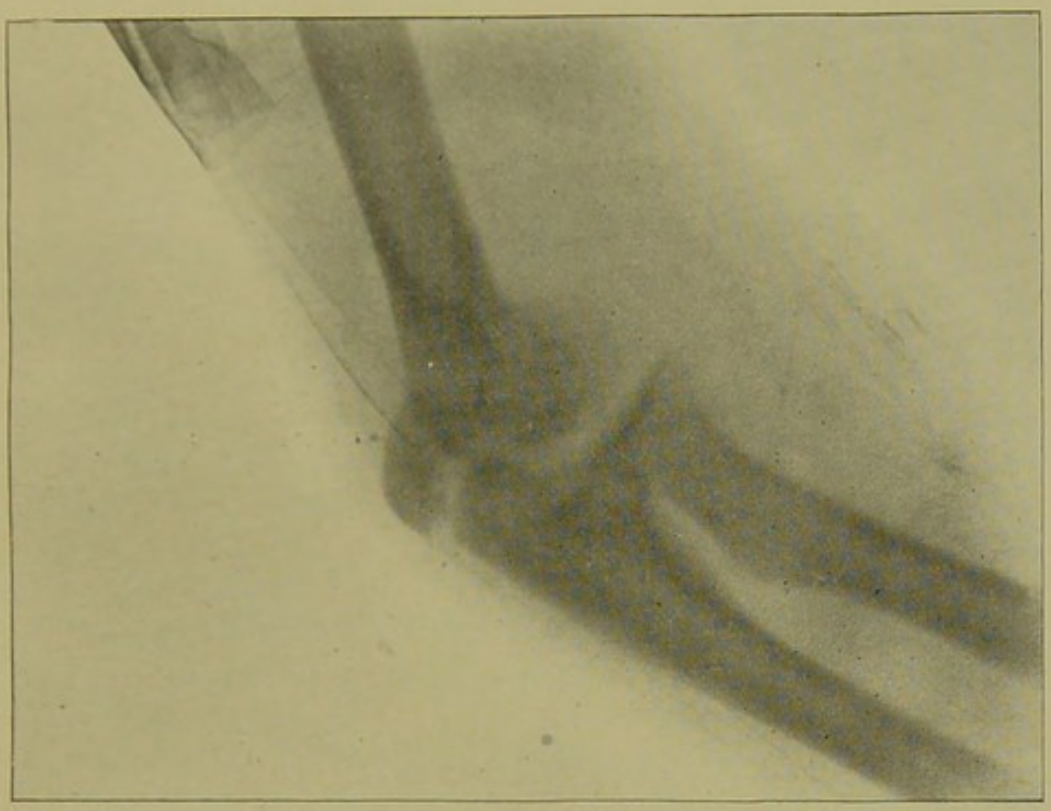

Fig. 14.

Fracture of Olecranon.

Patient a boy aged 16 years; accident due to a fall for a distance of seven or eight feet on elbow; skiagram taken three weeks after injury. (From a skiagram lent by Mr. G. A. Wright.)

Except in a few instances I have not full notes of the cases treated as in-patients, and I have therefore not included them in the subsequent tables.

Taking the cases collectively we find that the relative frequency with which the two bones were affected was as follows:—

Radius alone	180
Ulna alone	39
Both bones	142
	361

FRACTURES OF THE UPPER ENDS OF THE RADIUS AND ULNA.

FRACTURES OF THE OLECRANON PROCESS.

Twelve cases of this injury are classified in Table XVIII.

Sex and Age.—All the patients suffering from this injury were males; two were children under 10 years of age, and the rest were adults; five were over 50 years old.

Cause.—In 10 cases the injury was caused by direct violence; it was due to falls upon the elbow in eight, to a kick from a horse in one, and to the passage of a cart-wheel over the arm in one. In the remaining two cases the history of the accident was indefinite.

Malgaigne[1] refers to six cases in which the injury was supposed to be due to violent contraction of the triceps muscle, but he expresses considerable doubt as to whether muscular action was the sole cause in some of the cases.

The *Situation of the Fracture* was across the middle of the olecranon process in all cases save one. In this case it was at the base of the process.

Displacement of the loose fragment was absent in one patient. In the other eleven cases there was more or less displacement upwards.

The manner of displacement is illustrated by the accompanying skiagram (Fig. 14), which shows a fracture of the olecranon due to direct violence, with some drawing upwards of the fragment.

The tendinous fibres of the triceps muscle, which pass over the back of the olecranon process, were probably untorn in two of my cases; in one of these there was no displacement, and in the other displacement was very slight, and the power of extension of the elbow-joint was retained.

Complications.—One patient was said to have had a dislocation of the elbow-joint, which had been reduced before he came to hospital. In another case the injury was accompanied by fracture of the external condyle of the humerus and of the head of the radius. A third was complicated by fracture of the clavicle on the same side of the body.

TABLE XVIII.—Fractures of Olecranon Process.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	Passive Movement.	How long fixed.	Result.
222	25	M	1895 May 29	R	Fall on point of elbow	None	Fibres of triceps untorn; distinct crepitus on lateral movement of olecranon	Curved splint on inner side of arm; elbow extended; forearm pronated	....	..	Last seen 6 days after injury
223	27	M	June 14	R	Fall on elbow	Upwards	Elbow said to have been dislocated, but reduced before coming to hospital	Curved internal splint (too much swelling to bring fragments together)	....	..	Last seen 7 days after injury
224	35	M	June 24	L	Fall on elbow	Upwards (slight)	Not much swelling; inability to extend elbow	Curved internal splint	11 days after accident; afterwards at intervals of a week	25 days	Last seen on day of removal of splint; there was then good union and not much stiffness of the elbow-joint
225	7	M	July 2	R	Fall on elbow	Upwards	Also oblique fracture of external condyle of humerus (No. 187) and fracture of head of radius (No. 239)	Internal angular splint	Many times after removal of splint	28 days	Olecranon joined by bone, and 12 months after accident was quite right, except for slight thickening. Condyle permanently displaced upwards. Movements of elbow fully restored. Upper radio-ulnar joint left very stiff. *Ulnar paralysis* noticed 2 months after accident, but completely recovered in another 2 months.
226	52	M	July 9	L	Fall on tip of elbow	Upwards for ¼in.—1in. on flexion of elbow	.....	Curved internal splint; splint afterwards changed to outer side because of swelling and blistering	Twice after removal of splint	38 days	Patient only seen twice after removal of splint; the stiffness of the elbow had not then disappeared
227	5	M	Aug 15	L	Kick of horse	Upwards (slight)	Patient first seen 4 days after accident; in the meantime the arm had been kept on an external angular splint	Curved internal splint	None	29 days	Good *bony* union. There was never much stiffness of the elbow. After removal of splint there was some "weakness" of arm, but recovery was complete 2½ months after accident
228	56	M	Sept 3	L	Fall from tram-car	Upwards for ½in.	Also fracture of clavicle on same side—No. 64	Arm fastened to side with elbow flexed	None	14 days	Good union. Six weeks after accident there was no stiffness of the elbow, and he could flex and extend perfectly

229	43	M	Sept 25	R	Fall from scaffold (height of 6ft.) on elbow	Upwards	.....	Curved internal splint	None	27 days	Fibrous union—distance between fragments very slight. Considerable stiffness of elbow when splint removed, but this disappeared in course of next 2 months. Patient returned to his work as a labourer 5 months after the accident, but he still had some weakness of the joint when he was last seen two months later
230	52	M	Oct 1	L	Fall on tip of elbow	Upwards	.....	Straight splint on inner side of arm	....	..	Patient only seen twice
231	28	M	Oct 24	R	Fall on elbow	Very slight: only a chink to be felt	.....	Straight splint on inner side of arm	....	..	Patient not seen again
232	66	M	Nov 7	L	Direct violence: Arm run over by cart-wheel	Upwards (slight)	Fracture transverse at base of olecranon—power of extension not lost	Curved internal splint	None	40 days	Union fibrous, but firm; not much stiffness of elbow when splint removed; patient only seen once afterwards
233	53	M	Dec 26	?	?	Upwards (slight)	Fibres of triceps untorn; power of extension not lost	Curved internal splint	....	..	Patient not seen again

TABLE XIX.—Fractures of Coronoid Process.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Remarks.	Treatment.	Passive Movement.	How long fixed.	Result.
236	20	F	1895 June 7	R	Fall on hand, forcing the forearm backwards	Dislocation of radius and ulna backwards; easily reduced, but as easily returned; crepitus felt on reduction	Internal angular splint and evaporating lotion	14 days after accident; afterwards twice at intervals of a week.	28 days	Some stiffness of elbow when splint removed; union apparently good; patient not seen afterwards
237	34	M	Nov 24	?	Fall on hand	Dislocation of radius and ulna backwards; reduction and redislocation easy	Anterior angular splint	None	8 days	Only slight subsequent stiffness of elbow; movements completely regained, and patient perfectly well 5½ weeks after accident.
238	12	M	Dec 9	L	Fall on elbow (?)	Dislocation of radius and ulna backwards: examined under chloroform on Dec. 10; radius and ulna were easily pushed in and out of place; crepitus felt, but not very distinctly	Anterior angular splint and cotton-wool pressure	None	22 days	Never much stiffness of elbow; patient quite well 5 weeks after accident.

Treatment.—Most of the cases (eight) were treated by a slightly-curved splint placed along the inner side of the arm and forearm, the latter being fully pronated and the elbow almost completely extended. Two were fixed on straight internal splints, and two (the cases in which fracture of the olecranon was associated with fracture of the external condyle and fracture of the clavicle respectively) were treated with the elbow flexed. The average time that the splint was retained was a little over four weeks.

Passive movement of the elbow was carried out in one case during the earlier stages of the treatment, and in two cases after the removal of the splint. The remaining cases were treated without passive movement.

Results.—The results were as follows:—

Cases lost sight of soon after accident	5
Bony union	2
Fibrous union	2
Good union, but nature of uniting material not ascertained	3
	12

The cases in which bony union took place were (1) a boy, aged 7, in whom a considerable amount of callus was thrown out around the fragments of the olecranon, and (2) a boy, aged 5, whose injury was caused by a kick from a horse, but in whom there was never much separation of the fragments. Hamilton[2] secured bony union in five out of 19 cases which came under his care.

The subsequent stiffness of the elbow-joint in my cases, as a rule, was not great. One boy, whose fracture was complicated by fracture of the head of the radius, suffered for a prolonged period from stiffness of the upper radio-ulnar joint. Two patients were perfectly well at periods of six weeks and 2½ months respectively after the accident.

Primary Wiring of a Fractured Olecranon.—Considering the frequency with which the usefulness of the arm is impaired owing to fibrous union or non-union after this fracture, some surgeons have advocated immediate wiring of the fragments. With proper antiseptic precautions the operation can be performed with safety, and very good results have been obtained. At the time of operation the joint should be emptied of blood-clot as far as possible. Adenot[3], Wallis[4], Kamen[5], and others have recently recorded cases in which they have adopted this treatment with marked success.

Secondary Wiring, in cases of non-union and in cases where the fragments have become united by a long band of fibrous tissue, has been performed in a large number of instances with excellent results.

COMPOUND FRACTURE OF THE OLECRANON.

Two cases of this injury were treated as in-patients:—

Case 234.—Compound Comminuted Fractures of Olecranon and of Lower End of Humerus.—A man, aged 24, was admitted on February 24th, 1896, suffering from severe injuries to the elbow, caused by the passage of a cart-wheel over the arm. There was a large lacerated wound opening the joint, with extensive comminution of the olecranon and the lower end of the humerus. Primary excision of the joint was performed. The progress of the case was good up to the time of his discharge on April 15th, but I do not know the ultimate result.

Case 235.—Compound Comminuted Fracture of Olecranon.—Male, aged 21; accident caused by machinery in a cotton mill. There was a large lacerated wound over the back of the elbow, and the olecranon process was comminuted. There was not much separation of the fragments, but the elbow-joint was opened. The joint was flushed out with weak perchloride lotion, the wound was carefully cleaned, and its edges, having been pared, were brought together with silk sutures. Healing took place by first intention, and the man made a good recovery. In addition to the injury to the elbow, there were also lacerated wounds of the buttocks and head.

SEPARATION OF THE UPPER EPIPHYSIS OF THE ULNA.

This epiphysis, from which is developed about one-third of the whole olecranon, usually begins to ossify about the tenth year of life, and unites with the diaphysis at the age of seventeen. In rare cases ossification begins earlier than the tenth year. Occasionally the appearance of the centre is delayed. Not infrequently a second ossific centre appears during the fifth year, and forms the outer side of the upper part of the sigmoid cavity.

Poland[6] gives an account of six cases in which separation of the epiphysis has been proved by inspection. Eames[7] and Hamilton[8] have recorded cases in which the diagnosis rested upon an external examination only. Eames' patient was a child, aged 4, and the injury was due to a fall upon the point of the elbow. Hamilton's case was caused by an attempt to reduce an old-standing dislocation of the elbow-joint. Separation of the epiphysis is said to be easily produced in the cadaver.

FRACTURES OF THE CORONOID PROCESS.

Very different opinions have been expressed from time to time as to the frequency with which the coronoid process is fractured. Many writers have stated that the accident is of common occurrence, and this view is supported by the fact that the coronoid is often found to be fractured when dislocations of the elbow are produced in the dead body. Hamilton[9], however, thinks that the sign upon which most reliance is placed (easy reduction and re-dislocation of the elbow) may be due to other conditions. He enumerates fractures of the internal condyle or trochlea of the humerus, splitting of the condyles, or some other derangement of the articular surfaces, or of the ligaments or muscles concerned in the articulation.

Many cases have now been placed on record which have been proved by inspection, and the number has been largely increased during recent years, chiefly owing to the greater frequency with which operations have been undertaken for complicated fractures in the neighbourhood of the elbow-joint.

Hamilton[9] gives an account of 12 cases, collected from various sources, many of which were associated with fracture of the other bones of the articulation. Bruns[10], who collected 21 cases of fracture of the head of the radius, found that the lesion was frequently accompanied by fracture of the coronoid process. Similar cases in which these two injuries were associated have been reported by Bryant[11], Ashhurst[12], Wainewright[13], and Stimson[14]. Malgaigne[15] recorded two cases, one of which was complicated by fractures of the trochlea, the olecranon, and the head of the radius, the other by fractures of the olecranon and the head and neck of the radius. Cates[16] has published a case in which the injury was associated with fractures of the head of the radius and the capitellum. In a case reported by Watson Cheyne[17], there were also fractures of the olecranon and of the external condyle.

Examples in which the injury was diagnosed from an external examination only have frequently been placed on record. Hamilton mentions a number of cases, and others have recently been recorded by Charsley[18] and by Nash[19]. Three cases in which I diagnosed this injury have come under my own observation. Details are given in Table XIX. (page 87).

From the table it will be seen that two of the patients were males and one a female. Their ages were 12, 20, and 34 years respectively.

Cause.—In most cases where the nature of the injury has been proved anatomically the cause has been a fall upon the out-stretched hand, by which the forearm has been pushed backwards and the coronoid process broken off against the lower end of the humerus. In a few cases the cause has been extreme flexion of the elbow or a fall upon the elbow. Amongst my own cases the injury was caused in two instances by a fall upon the out-stretched hand; in the remaining case the patient was stated to have fallen upon the elbow, but there was some doubt as to the correctness of the statement.

The *Signs* by which the injury is usually diagnosed are two: (1) dislocation backwards of the elbow, easily reduced and re-dislocated; (2) crepitus. The first sign was well marked in all my three cases; crepitus was felt in two. I do not think that in any of the cases was there any fracture of the condyles or the articular surface of the humerus. One patient was placed under an anæsthetic in order that a more thorough examination might be made. Consider-

ing the large number of cases in which fracture of the coronoid has been proved by anatomical examination, I think we are justified in diagnosing this injury in certain cases which present the above-mentioned signs.

Complications.—As will be seen from the cases already mentioned fracture of the coronoid process is in almost all cases accompanied by other injuries, either dislocation of the elbow-joint or fracture of the neighbouring bones.

Treatment.—All my cases were treated with the elbow flexed to a right angle. An anterior angular splint was applied in two cases, and an internal splint in one.

Results.—One patient was not seen after the day of removal of the splint. The other two patients made complete recoveries, and were apparently perfectly well 5 weeks and 5½ weeks respectively after the receipt of the injury. I am unable to express any opinion as to the nature of the union—fibrous or bony—in these cases. None of the patients had very much subsequent stiffness of the elbow-joint.

FRACTURES OF THE UPPER END OF THE RADIUS.

The following varieties of fracture have been met with in this situation, but with the exception of the first they appear to be of exceedingly rare occurrence.

(1) *Fracture of the Head.*—Bruns[10], in 1880, collected 21 cases of this injury, which had been verified by anatomical examination. He says that the fracture usually takes a vertical or oblique course through the head. In some cases it is incomplete, extending vertically downwards for a certain distance from the articular surface and ending blindly; in other cases it is complete, one or more fragments of bone being detached. In only five of the cases was the injury unaccompanied by fracture of the ulna or humerus, the most frequent complication being fracture of the coronoid process. The injury may be produced by direct violence or by a fall upon the hand with the elbow in an extended position. Under the latter circumstances the radial head is broken by being driven violently against the capitellum, and the coronoid process is very liable to give way at the same time.

Other cases in which the injury was associated with fracture of the coronoid process have been recorded by Bryant[11], Ashhurst[12], Wainewright[13], and Stimson[14]. Malgaigne[15] has described two cases, both complicated by fractures of the coronoid and olecranon, and one with fracture of the trochlea as well. Cates[16] has published a case of multiple fractures affecting the capitellum, the coronoid, and the head of the radius. Adams[20], Pinner[21], Hamilton[22], Cheyne[17],

and Gordon[23] have recorded cases in which the radial head alone was injured. The only case which has come under my own notice was the one from which the accompanying skiagram (Fig. 15) was taken.

Case 239.—A boy, aged 7 years, was brought to the Infirmary on July 2nd, 1895, having received a direct injury to the elbow. He had an oblique fracture of the external condyle of the humerus, and also a fracture of the olecranon, but at that time no injury to the radial head was suspected. He ultimately made a good recovery, with the exception that the upper radio-ulnar joint remained very stiff. Three years after the accident there was still very little movement in this joint, and grating was felt when the forearm was rotated. The skiagram shows that the radial head is greatly thickened and distorted, and it is evident that there has been a fracture in this situation.

Probably skiagraphy will show in the future that fracture of the head of the radius occurs much more frequently than is usually supposed.

(2) *Fractures of the Neck.*—This injury would appear to be of exceedingly rare occurrence, except in cases where the fracture extends downwards from the head of the bone. Hamilton[24] says that he has only seen one undoubted specimen from the cadaver, but he refers to other specimens described by Velpeau and by Bérard. Cases in which transverse fracture of the neck was accompanied by vertical fracture of the head have been recorded by Malgaigne[15] and by Gordon[23]. Poland[25] figures two skiagrams from a case of this injury.

(3) *Separation of the Epiphysis.*—Ossification begins in this situation about the beginning of the 6th year, and union with the diaphysis takes place during the 16th or 17th year. Speaking of separation of the epiphysis Hutchinson[26] says that he sees no reason to believe that it is "other than an extraordinarily rare accident and probably always due to direct violence." He further says that there are only two undoubted cases on record. Most of the recorded cases have probably been examples of subluxation of the head of the radius.

It is not uncommon to meet with cases of children who have been lifted or dragged by the hand, and who have pain in the neighbourhood of the upper radio-ulnar joint. On rotation of the radius the pain is increased, and frequently a "click" is felt. I have notes of several such cases in which separation of the upper radial epiphysis has at first been suspected, but almost all of them have recovered completely after a few days' rest upon a splint, and I have no doubt that the true nature of the injury was a sprain or subluxation of the upper radio-ulnar articulation.

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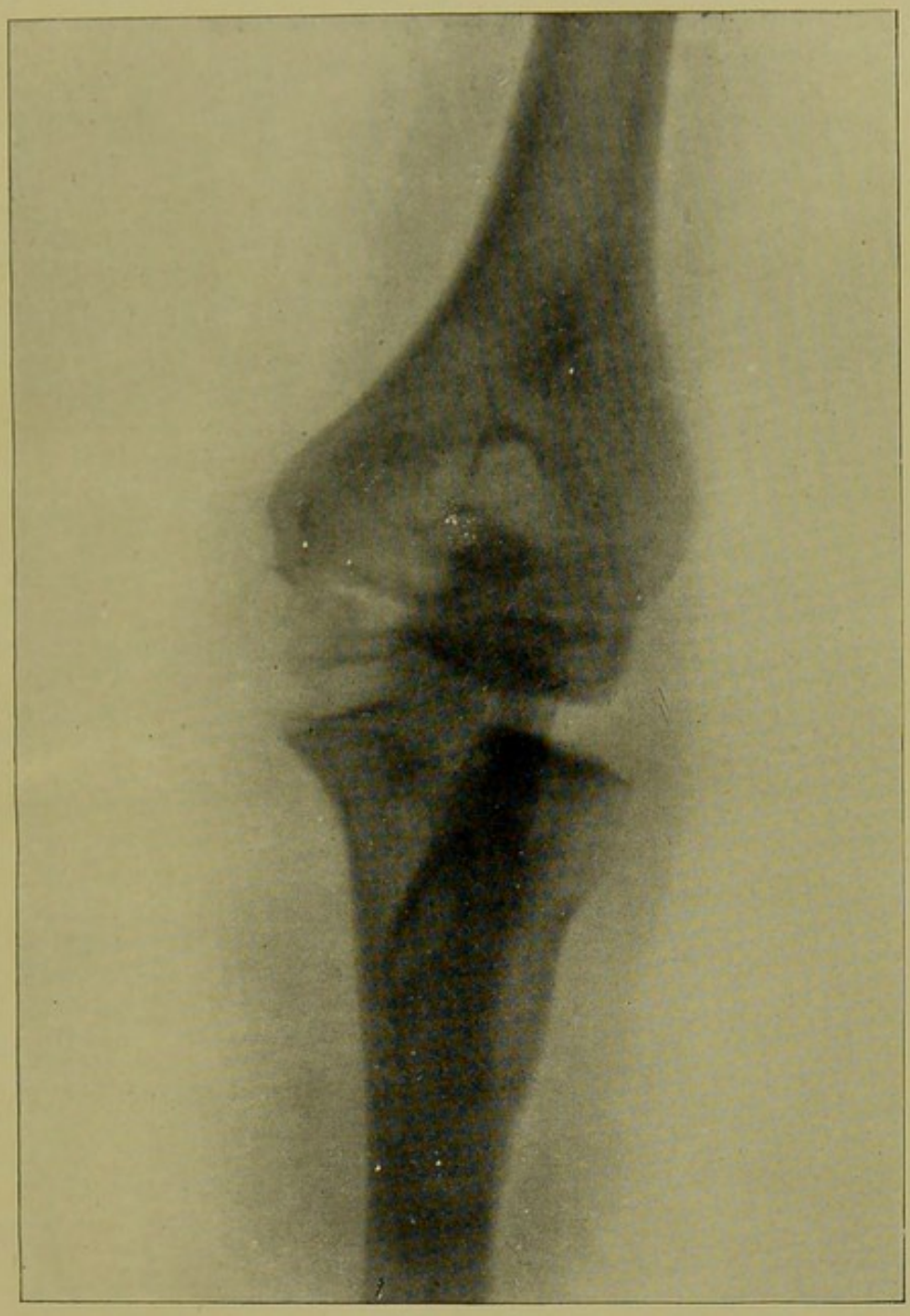

Fig. 15.

Distortion of Head of Radius from Old Fracture.

Case 239.—Skiagram taken about three years after injury. The patient had also fracture of the olecranon and oblique fracture of the external condyle of the humerus.

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FRACTURES OF THE SHAFTS OF THE RADIUS AND ULNA.

The 182 cases in which the shafts of these bones were broken were as follows:—

	Radius and Ulna.	Radius only.	Ulna only.	Totals.
Incomplete Fractures ...	62	9	5	76
Complete „	50	39	13	102
Compound „	4	—	—	4
	116	48	18	182

From an analysis of the cases, taken collectively, we learn the following facts:—

Sex.—144 of the patients were males and 38 females.

Age.—The ages of the patients were—

	Incomplete Fractures.	Complete Fractures.	Totals.
Under 10 years	39	24	63
10 and under 20 years	36	37	73
20 „ 30 „	1	13	14
30 „ 40 „	—	11	11
40 „ 50 „	—	12	12
50 „ 60 „	—	6	6
Over 60 years.....	—	3	3
	76	106	182

It would thus appear that the great majority of these fractures occur during the first 20 years of life—three-fourths of the total number of cases.

Side of Body affected.—This was recorded in 170 cases; the right arm was broken in 68 and the left in 102.

The *Situation of the Fracture* was as follows:—

	Upper Third.	Junction of Upper and Middle Thirds.	Middle Third.	Junction of Middle and Lower Thirds.	Lower Third.	Situation not recorded.	Totals.
Incomplete Fractures:							
Radius and Ulna.	1*a*	6	33*b*	15	7	—	62
Radius alone... ..	1	1	5	—	1	1	9
Ulna alone.....	1	1	2	—	1	—	5
Complete Fractures:							
Radius and Ulna..	2	3	31	7	7	—	50
Radius alone	7	7	10	7	7	1	39
Ulna alone	—	4	4	3	2	—	13
Compound Fractures:							
Radius and Ulna.	1*a*	—	2	—	1*c*	—	4
	13	22	87	32	26	2	182

a.—In these cases the radius was fractured in the upper third and the ulna in the middle third.

b.—Includes one case of fracture of radius at junction of upper and middle thirds, and fracture of ulna at middle of bone.

c.—Fracture of radius at junction of lower and middle thirds and ulna one inch from lower end.

Of the 116 cases in which both bones were fractured, it was noted in 15 that they were not broken at the same level; in seven the fracture of the radius was the upper of the two, in eight the fracture of the ulna. Voillemier[1] says that when one bone is broken at a higher level than the other, it is generally the radius.

From the above list it will be seen that the middle third of the bone is most frequently broken; next in order of frequency comes the point of junction of the middle and lower thirds, then the lower third, then the junction of the upper and middle thirds, and least frequently the upper third.

The *Cause of the Fractures* is shown in the following table:—

	Incomplete Fractures.			Complete Fractures.			Compound Fractures.	
	Radius and Ulna.	Radius.	Ulna.	Radius and Ulna.	Radius.	Ulna.	Radius and Ulna.	Totals.
Indirect force transmitted from hand	19	—	—	16	20*	—	2	57
Direct force at seat of fracture	13	5	1	23	9	11	—	62
Exact cause doubtful.....	30	4	4	11	10	2	2	63
	62	9	5	50	39	13	4	182

* This number includes two cases in which the fracture was due to the hand being violently pronated.

The number of cases caused by direct and by indirect violence was thus almost equal—57 and 62 respectively. Fracture of the ulna alone was probably in all cases due to direct violence.

Muscular action is very rarely indeed the cause of fracture of these bones. Gurlt[2], however, collected five cases, in three of which both bones were broken, in one the radius only, and in one the ulna only. Two of the five cases occurred whilst the patients were wringing out wet clothes, one whilst digging with a spade, one whilst moving earth with a shovel, and the fifth, which is open to great doubt, whilst the patient was in the act of sitting up in bed.

INCOMPLETE FRACTURES OF THE RADIUS AND ULNA.

Of the 76 incomplete fractures, one was a general bending of the bones and the remaining 75 were "greenstick" fractures.

GENERAL BENDING OF THE RADIUS AND ULNA.

Case 240.—R. G., aged 24, a rubber-worker, came to hospital on January 1st, 1896, with a recent injury to the left forearm. He stated that the forearm had been crushed between a strap and a pulley. The arm had been carried round between the strap and the pulley with the flexor surface against the pulley. There was a general bowing of the radius and ulna towards the extensor surface, and slightly towards the ulnar side. There was no distinct point of fracture, and no crepitus or unusual mobility at any part of the forearm. The curvature involved about the middle two-fourths of the bones. There was some general contusion of the soft parts. The muscles of the forearm were fairly well developed. The right arm was perfectly straight, and the curvature of the left was entirely due to the accident. The bones were forcibly straightened, but it was necessary to exert a considerable amount of force before they could be returned to their proper shapes. They did not break across during the process. Anterior and posterior splints were applied, and were retained for 20 days. At the end of that time the man had perfectly recovered; the bones were quite straight, and there was no interference with the full use of the forearm.

In relation to this case I may mention a matter which has received a considerable amount of attention, viz., whether it is possible for a bone to be bent without partial fracture and for the curvature to be maintained without some other agency. Malgaigne[3] and Hamilton[4] have both discussed the matter at some length, and their opinions may be summed up in the statement that such curvatures can only occur in the young, and that they are unable to maintain themselves except through the aid of a fracture with displacement of a neighbouring bone. In the above case it is probable that some of the osseous tissue was ruptured all along the parts of the bones, which were bent. The special features of the case were doubtless due to the unusual way in which the accident occurred, viz., the application of severe direct force to all sides of a considerable length of the forearm at the same time.

GREENSTICK FRACTURES OF THE RADIUS AND ULNA.

Table XX. gives an account of the 61 cases of this accident.

Displacement of the Broken Ends.—From the table it will be seen that the displacement was as follows:—

Backwards	26
„ and outwards	1
„ „ inwards	1
Forwards	18
„ and outwards	2
„ „ inwards	1
Inwards	5
Outwards	4
No appreciable displacement	3
	61

In two cases of forward displacement, and in one of backward displacement, the radius was twisted into a state of pronation.

Complications.—One patient (No. 246) also had separation of the lower epiphysis of the radius of the other arm.

Five patients had previously had fractures of the bones in the same situations (Nos. 255, 275, 288, 289, and 297). The time which had elapsed since the former accident was 24 days, 26 days, 7 weeks, 3½ months, and 7 months respectively. Four of them came under my treatment on each occasion, and are therefore included twice in the table.

Treatment.—In straightening the bones I think it is of importance to attempt to do so without making the fracture complete. With complete fractures, and even to some extent if incomplete, there is a great tendency to bowing of the ulna backwards towards its subcutaneous border, a tendency which will be lessened if the bones be not broken across. In a certain number of cases, if the arm be firmly grasped on each side of the fracture and if slow and steady force be applied, the bones will bend back again into place without the fracture becoming complete, or it may be that only one bone will give way. I have a note upon this point in 16 cases, and I find that both the bones snapped across in eight, the radius only in one, and the ulna only in three, whilst in four the fragments were bent back into place without any further fracture taking place.

The *Splints* I have almost invariably used in these cases have been a long posterior splint extending from the elbow to the knuckles, and a short anterior splint from the bend of the elbow to the wrist. The average time that the splints were retained was 27 days (average of 53 cases). The anterior splint should not be long enough to

impinge upon the thenar and hypothenar eminences. The fingers should be left free from the first.

Results.—The results in these cases were—

Union without deformity	34
with more or less angular displacement	11
Bones thickened by callus when patient last seen, but no angular displacement	4*
Patients who fell and broke the arm again shortly after the removal of the splints	3†
Patients lost sight of soon after the accident	8
Patient lost sight of after removal of splints	1
	61

* In two other cases the ulna was at first considerably thickened by callus, but absorption was complete in one case at the end of 4 months, and in the other at the end of 3 months.

† This number does not include two patients who refractured the arm 3½ and 5 months respectively after the previous accident.

GREENSTICK FRACTURES OF THE RADIUS.

The nine cases in which there was incomplete fracture of the radius alone are arranged in Table XXI. These fractures present few features distinct from greenstick fractures of both bones. The cause of the injury was direct violence in a larger proportion of the cases.

Case 309 was probably an example of spiral or helicoidal fracture. The bone was broken near the junction of the upper and middle thirds, and was twisted into a position of excessive pronation.

GREENSTICK FRACTURES OF THE ULNA.

The five cases of this injury are classified in Table XXII. They present no special features. The cause of the fracture was definitely ascertained in one case only, but probably in all it was direct violence. Greenstick fracture of the ulna alone is of less frequent occurrence than a similar fracture involving the radius only.

COMPLETE FRACTURES OF THE SHAFTS OF THE RADIUS AND ULNA.

Table XXIII. gives an account of the 50 cases of this accident. Some remarks have already been made with regard to the age and sex of the patients, and the etiology of these fractures. (Pages 93-95).

Displacement.—The manner of displacement of the fractured ends in these cases is open to the greatest variation, and I have found it impossible to analyse my cases satisfactorily. The following may occur:—

(1) The bones may retain their proper positions.

(2) Anterior, posterior, or lateral displacement may occur.

TABLE XX.—GREENSTICK FRACTURES OF RADIUS AND ULNA.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
241	4	F	1895. May 18	R	Fall on hand	Junction of lower and middle thirds	Convexity backwards	Did not come for treatment for 4 days after accident	Arm forcibly straightened; long posterior and short anterior splints	21 days	1 month	None	.....
242	1 3/12	M	May 23	R	Fall—probably on palm of hand	Middle third	Forwards	.....	Posterior splint	..	..	.....	Last seen 12 days after accident
243	15	M	June 10	L	Fall—probably on forearm	Junction of upper and middle thirds	Backwards (slightly)	.....	Anterior and posterior splints	32 days	5 weeks	None	.....
244	13	M	July 9	L	Crush of forearm between two waggons	Lower third	Backwards	.....	Anterior and posterior splints	21 days	4 weeks	None	.....
245	13	M	July 7	L	Fall on hand	Junction of lower and middle thirds	Backwards	.....	Anterior and posterior splints	18 days	4 weeks	None	.....
246	9	M	July 26	L	Fall on hand	Lower third	Backwards	Also separation of lower radial epiphysis on right side; see No. 427	Anterior and posterior splints; ulna tended to bow backwards, and was straightened under chloroform on Aug. 8	23 days	..	Some bowing backwards of ulna	Patient not seen after day of removal of splints
247	11	M	July 27	L	Fall on hand, probably on palm	Middle of bones	Forwards	.....	Anterior and posterior splints	20 days	..	None	Four days after removal of splints the boy fell and broke the arm again; No. 255
248	4	F	Aug 11	L	Fall? on hand	Just above middle of bones	Backwards	Fracture became complete when bones were straightened	Anterior and posterior splints	23 days	1 month	None	.....
249	8		Aug 12	L	Fall? on hand	Just above middle of bones	None	.....	Anterior and posterior splints	37 days	6 weeks	None	.....

250	1 11/12	F	July 31	R	?	Just above middle of bones	Backwards	Fracture untreated for a fortnight	Anterior and posterior splints	14 days	5 weeks	None	.....
251	2	F	Aug 14	R	Fall down stairs	Middle of bones	Backwards	.....	Anterior and posterior splints	27 days	5 weeks	None	.....
252	12	M	Aug 15	L	Fall with arm under body	Junction of lower and middle thirds	Forwards	.....	Anterior and posterior splints	33 days	..	Slight bowing backwards of ulna	Last seen on Oct. 22; quite well except for bowing of ulna, and this was very slight.
253	10	M	Aug 18	R	Fall on hand	Middle of bones	Backwards	.....	Anterior and posterior splints	27 days	..	Slight bowing backwards of both bones	Quite well 5 weeks after accident except for bowing of bones
254	6	M	Aug 20	R	Fall with arm under body	Just above middle of bones	Outwards	.....	Anterior and posterior splints; tendency to bowing backwards remedied Sep. 10	35 days	..	Considerable bowing backwards of ulna	Kept under observation for 6 months; not much change in condition of ulna
255	11	M	Aug 21	L	Fall	Middle of bones	Inwards	Previous fracture in same place on July 27; No. 247	Anterior and posterior splints	27 days	..	Considerable prominence on ulna at seat of fracture	Not much change in ulna when last seen 2½ months after accident
256	10	F	Aug 25	L	Fall on hand?	Middle of bones	Backwards	.....	Anterior and posterior splints	30 days	..	Rather marked backward bowing of bones	Last seen on day of removal of splints
257	8	F	Sept 6	L	Fall on palm of hand	Lower third (1½in. from lower ends)	Backwards and slightly to radial side	Ulna fractured across when straightened; radius did not	Anterior and posterior splints	28 days	..	. ....	Slight thickening of bones when splints removed; patient not seen again
258	8	M	Sept 16	L	Fall	Junction of lower and middle thirds	Forwards	.....	Anterior and posterior splints	22 days	4 weeks	None	.....
259	11	M	Sep 17	R	Crush of fore-arm	Just above middle of bones	Outwards	Radius fractured across when arm straightened	Anterior and posterior splints	28 days	4 m'ths	None	Ulna thickened by callus; all absorbed in 4 months; arm broken again on April 22, 1896. No. 288

TABLE XX.—GREENSTICK FRACTURES OF RADIUS AND ULNA—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
260	10	M	1895. Sep 18	L	Fall forwards with arm under chest	Junction of middle and lower thirds	Forwards and slightly outwards	.....	Anterior and posterior splints	..	..	.....	Patient only seen once afterwards
261	11	M	Sep 21	R	Fall	Junction of middle and lower thirds	Backwards and inwards	Both bones broke across when straightened	Anterior and posterior splints	29 days	..	None	Not seen after day of removal of splints
262	11	M	Sep 30	L	Fall	Just below middle of bones	Inwards	.....	Anterior and posterior splints; tendency to bowing forwards counteracted by splint on inner side	36 days	8 weeks	None	.....
263	4½	M	Oct 10	L	Fall	Lower third—2ins. from lower ends	Backwards	Both bones snapped when straightened	Anterior and posterior splints; tendency to bowing forwards counteracted by small pad over fracture	33 days	6 weeks	None	Complete fracture of bones in same place 5 months later. No. 342
264	16	M	Oct 11	R	Crush of forearm between strap and pulley	Lower third—2ins. from lower ends	Backwards (slight)	Did not come for treatment until Oct. 15	Anterior and posterior splints	20 days	1 month	None	.....
265	2	M	Oct 18	R	Fall on elbow and forearm	Radius in upper third; ulna at middle of bone	Backwards (very slight)	.....	Internal angular splint	28 days	3 m'ths	None	Ulna thickened for some time by callus; completely absorbed in 3 months
266	13	M	Nov 4	R	Fall on hand	Lower third	Backwards	Old fracture ulna at junction of upper and middle thirds with dislocation of head of radius, not properly reduced, 2 years before	Anterior and posterior splints	18 days	1 month	None	.....

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267	15	M	Nov 13	R	Fall on arm	Junction of upper and middle thirds	Forwards and inwards	.....	Anterior and posterior splints; tendency to bowing of ulna counteracted by straight splint from middle of upper arm to wrist; elbow extended	32 days	..	.....	Some thickening, but no bowing, of ulna when patient last seen 5 months after accident
268	6	F	Nov 23	L	Fall down steps	Just below middle of bones	Forwards (slight)	Bones snapped across when straightened	Anterior and posterior splints	..	..	.....	Last seen 20 days after injury; still in splints
269	3	F	Dec 2	L	Fall down steps	Junction of upper and middle thirds	Backwards	.....	Anterior and posterior splints	26 days	..	.....	Not seen after day of removal of splints
270	14	M	Dec 7	L	Fall on hand	Just below middle of bones	Forwards	.....	Anterior and posterior splints	24 days	..	.....	No bowing, but some thickening from callus; after union the movements of pronation and supina- were limited; these were improved, but not fully restored when last seen, 4½ months after accident
271	9	M	1896 Jan 4	L	Fall ? on hand	Junction of upper and middle thirds	Forwards	Both bones snapped across when straightened	Anterior and posterior splints	24 days	..	Some tendency to bowing backwards of ulna	Again fractured on April 26. No. 289
272	12	M	Jan 19	L	Fall on hand	Just above middle of bones	Forwards (marked)	Both bones snapped across when straightened	Anterior and posterior splints	19 days	4 m'ths	None	Ulna at first thickened by callus; absorbed at end of 4 months
273	8	M	Feb 6	?	Fall with hand under body	Middle third	None	.....	Anterior and posterior splints	..	..	.....	Patient only seen twice afterwards
274	18	M	Feb 20	L	Arm crushed by machine	Junction of lower and middle thirds	Backwards	Ulna snapped when straightened; radius did not	Anterior and posterior splints	29 days	5 weeks	None	.....

TABLE XX.—Greenstick Fractures of Radius and Ulna.—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
275	13	M	1896. Feb 29	L	The boy had his hands on a lurry, in the act of getting off, when the bones gave way	Junction of lower and middle thirds	Forwards	Fracture in same place 7 weeks before	Anterior and posterior splints; great trouble from radius tending to bow first forwards and afterwards outwards	45 days	3 m'ths	None	Supination limited for a time; recovery ultimately perfect
276	$1\frac{5}{12}$	M	Feb 27	L	Fall	Middle of bones	Backwards	Did not come for treatment until March 6; bones straightened without breaking across	Anterior and posterior splints	18 days	..	Some projection backwards of ulna	Last seen 2 months after accident
277	$2\frac{8}{12}$	M	Mar 9	L	Fall on arm	Middle of bones	Backwards	.....	Anterior and posterior splints	31 days	6 weeks	None	.....
278	12	M	Mar 10	L	Fall on arm	Middle of bones	Backwards	.....	Anterior and posterior splints	28 days	5 weeks	None	.....
279	12	M	Mar 11	R	Direct violence; fall on arm	Radius at junction of upper and middle thirds; ulna at middle of bone	Outwards (slight)	.....	Anterior and posterior splints; tendency to bowing forwards of radius counteracted by small pad	41 days	2 m'ths	None	.....
280	12	M	Mar 13	L	Fall on arm	Junction of middle and lower thirds	Backwards	Bones straightened without breaking across	Anterior and posterior splints	27 days	5 weeks	None	.....
281	12	F	Mar 23	L	Fall on palm of hand	Lower third	Forwards	.....	Anterior and posterior splints	29 days	5 weeks	None	.....
282	$2\frac{9}{12}$	M	Mar 22	L	Fall	Junction of middle and upper thirds	Forwards	.....	Anterior and posterior splints	23 days	4 weeks	None	.....

283	14	M	April 4	R	Fall on palm of hand	Radius at junction of lower and middle thirds; ulna ½in. higher up	Forwards and slightly outwards	Bones snapped when straightened	Anterior and posterior splints	27 days	..	.....	Union in good position; on May 26 patient fell and broke the arm again in the same place; on the second occasion the fracture was complete. No. 352
284	4	F	April 5	R	Fall down stairs (? on palm of hand)	Ulna at junction of middle and lower thirds; radius ½in. higher	Forwards and some rotation from bones not being broken at same level	Ulna broke across when staightened; radius did not	Anterior and posterior splints	31 days	..	None	Apparently quite right on removal of splints; patient not seen again
285	3	F	April 5	R	Fall on hand	Middle of bones	Forwards	Bones straightened without breaking	Anterior and posterior splints	19 days	..	None	Apparently quite right on removal of splints; patient not seen again
286	15	M	April 20	R	Fall	Just below middle of bones	Forwards	Bones straightened without breaking	Anterior and posterior splints	29 days	5 weeks	None	.....
287	7	M	April 20	L	Fall with arm under body	Just above middle of bones	Outwards	.....	Anterior and posterior splints	22 days	..	Some displacement of bones with convexity outwards	.....
288	12	M	April 22	R	Fall on elbow (abrasion over external condyle)	Just above middle of bones	None	Fracture in same place 7 months before. No. 259	Anterior and posterior splints	20 days	..	Some prominence of ulna, probably callus	Prominence almost absorbed when last seen 5 months after injury
289	9	M	April 25	L	Fall on hand	Junction of upper and middle thirds	Inwards	Fracture in same place 3½ months before. No. 271	Anterior and posterior splints; great trouble from bowing of bones	31 days	..	Some bowing forwards of radius and backwards of ulna	.....
290	6	M	May 6	L	Fall on hand	Middle of bones	Inwards	.....	Anterior and posterior splints	20 days	4 weeks	None	.....
291	7	M	May 14	L	Fall	Middle of bones	Backwards	.....	Anterior and posterior splints	.	..	.....	Patient not seen again
292	5	M	May 28	?	Fall on back of hand	Middle of bones	Inwards	.....	Anterior and posterior splints	..	..	.....	Patient not seen again

TABLE XX.—Greenstick Fractures of Radius and Ulna.—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
			1896.										
293	$1\frac{6}{12}$	F	June 20	L	Fall with arm under body	Junction of middle and lower thirds	Forwards	.....	Anterior and posterior splints	24 days	..	.....	Patient fell and broke the arm again two days after removal of splints. No. 297
294	14	M	June 22	L	Arm crushed between strap and pulley	Junction of middle and lower thirds	Backwards; radius slightly backwards; ulna more backwards and displaced towards radius	.....	Anterior and posterior splints	27 days	5 weeks	None	.....
295	10	M	June 25	L	Fall with arm under body	Radius at junction of lower and middle thirds; ulna ½in. lower	Backwards	.....	Anterior and posterior splints	29 days	..	Slight bowing forwards of bones	.....
296	14	M	July 13	L	Arm crushed by machinery	Middle of bones	Backwards, and excessive pronation of radius	.....	Anterior and posterior splints	..	..	.....	Last seen 4 days after accident
297	$1\frac{7}{12}$	F	July 16	L	Fall	Junction of middle and lower thirds	Forwards	Previous fracture in same place 26 days before. No. 293	Anterior and posterior splints	33 days	6 weeks	None	.....
298	10	M	July 26	?	Fall on hand	Middle of bones	Forwards; radius over-pronated	Bones straightened without breaking	Anterior and posterior splints	30 days	6 weeks	None	.....
299	10	F	July 29	L	Fall on hand	Just above middle of bones	Forwards	.....	Anterior and posterior splints	27 days	..	Very slight bowing backwards of ulna	.....
300	12	M	Aug 3	L	Fall on palm of hand	Middle third	Backwards	.....	Anterior and posterior splints	..	..	.....	Patient only seen twice afterwards
301	11	M	Aug 3	L	Fall on palm of hand	Middle third	Backwards	.....	Anterior and posterior splints	29 days	6 weeks	None	.....

TABLE XXI.—Greenstick Fractures of Radius.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
302	8	F	1895. June 3	L	Fall on arm	Middle of bone	Forwards	....	Reduction of deformity; short anterior and long posterior splints	..	..	..	Last seen 22 days after injury
303	5	M	June 18	L	Fall on elbow	Upper third	None	? ulna also fractured	Internal angular splint	14 days	..	..	Last seen 21 days after injury
304	10	F	June 19	L	Fall on hand (?)	Lower third	Backwards	....	Anterior and posterior splints	18 days	..	None	Apparently quite right on removal of splints; patient not seen again
305	2	F	Aug. 18	L	?	Middle third	Backwards	....	Ditto	19 days	..	None	Ditto
306	2	M	Aug. 18	L	Fall with arm under body	Middle third	Backwards	....	Ditto	16 days	..	None	Ditto
307	12	M	Nov. 5	?	Arm crushed by door	Middle third	None	Some doubt as to the presence of a fracture	Ditto	21 days	..	None	Ditto
308	4	M	Dec. 2	R	Fall	Middle third	Inwards and slightly forwards	....	Ditto	22 days	4 weeks	None	....
309	5	M	1896. May 22	L	Fall on arm	Junction of middle and upper thirds (about)	Bone twisted into position of excessive pronation	Helicoidal fracture (?)	Ditto	21 days	4 weeks	None	....
310	3	F	July 8	L	Fall of shutter on arm	Not recorded	Backwards and outwards	....	Anterior splint	16 days	..	None	Apparently quite right on removal of splints; patient not seen again

TABLE XXII.—Greenstick Fractures of Ulna.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
			1895.										
311	11	M	Aug. 5	L	Direct violence—fall against a cart	Upper third	Backwards	....	Short anterior and long posterior splints	36 days	..	..	Last seen on day of removal of splints; some prominence at seat of fracture; otherwise quite right
312	8	M	Sept. 2	R	Fall from a wall; direct violence?	Junction of middle and upper thirds	Slight prominence at seat of fracture	....	Short anterior and long posterior splints	18 days	..	..	Last seen on day of removal of splints; some prominence at seat of fracture; otherwise quite right
313	2	M	Sept. 15	L	Fall	Middle third	None	....	Short anterior and long posterior splints	..	..	..	Patient only seen twice afterwards
314	3	F	Dec. 19	R	Fall	Lower third (2 inches from lower end)	None	....	Short anterior and long posterior splints	18 days	4 weeks	None	....
			1896.										
315	5	F	Mar. 22	L	Fall	Middle third	Backwards	Fracture in same place 9 months before	Short anterior and long posterior splints.	..	..	..	Patient only seen once afterwards

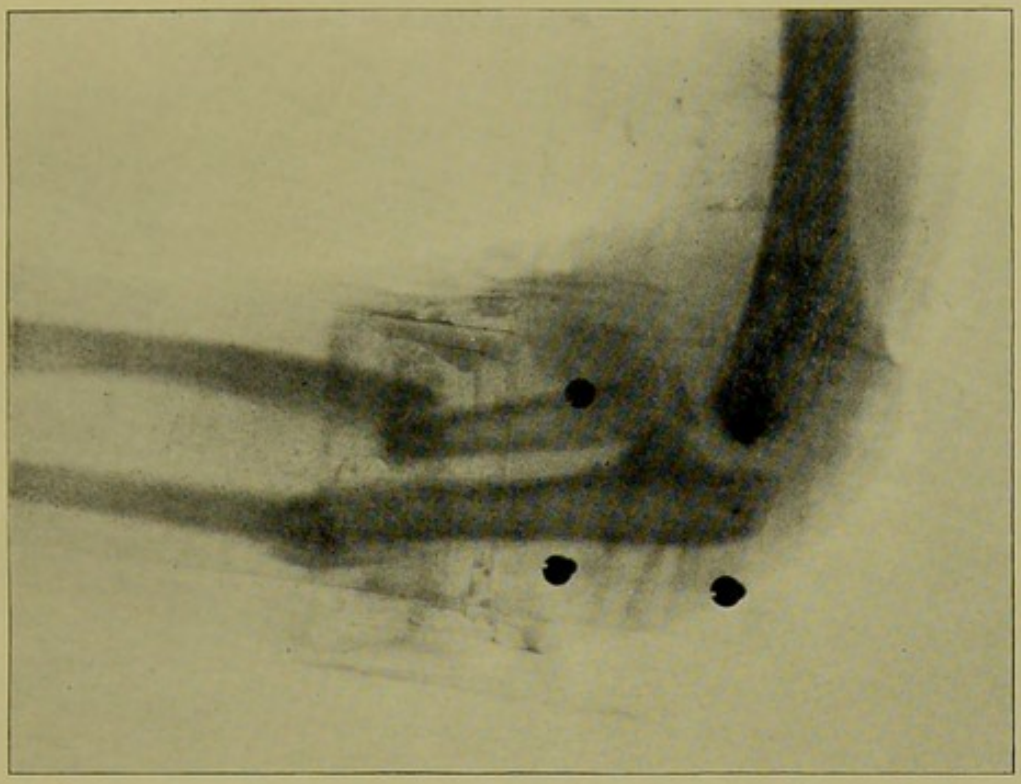

Fig. 16.

Fracture of Radius and Ulna—Upper Third.

Patient a girl, aged 7 years ; right arm broken ; tendency to bowing backwards of fragments. The outlines of an internal angular splint, on which the arm was fixed, are faintly shown ; also some marks due to strapping, and four screws with which the two parts of the splint were joined together. (From a skiagram lent by Mr. G. A. Wright.)

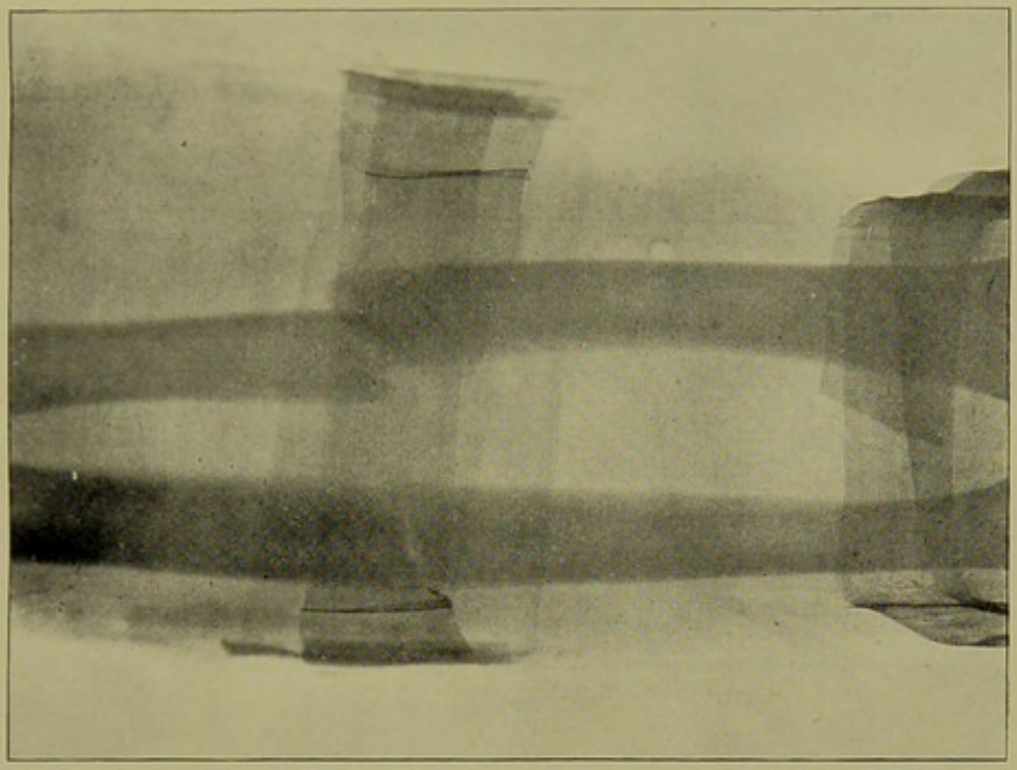

FIG. 17.

FRACTURE OF RADIUS AND ULNA—MIDDLE THIRD.

Patient a youth, aged 16 ; left arm broken ; no displacement of ulna, but lower fragment of radius displaced somewhat outwards ; marks of strapping very distinct. The skiagram, which was lent to me by Mr. G. A. Wright, was taken seven days afte the accident

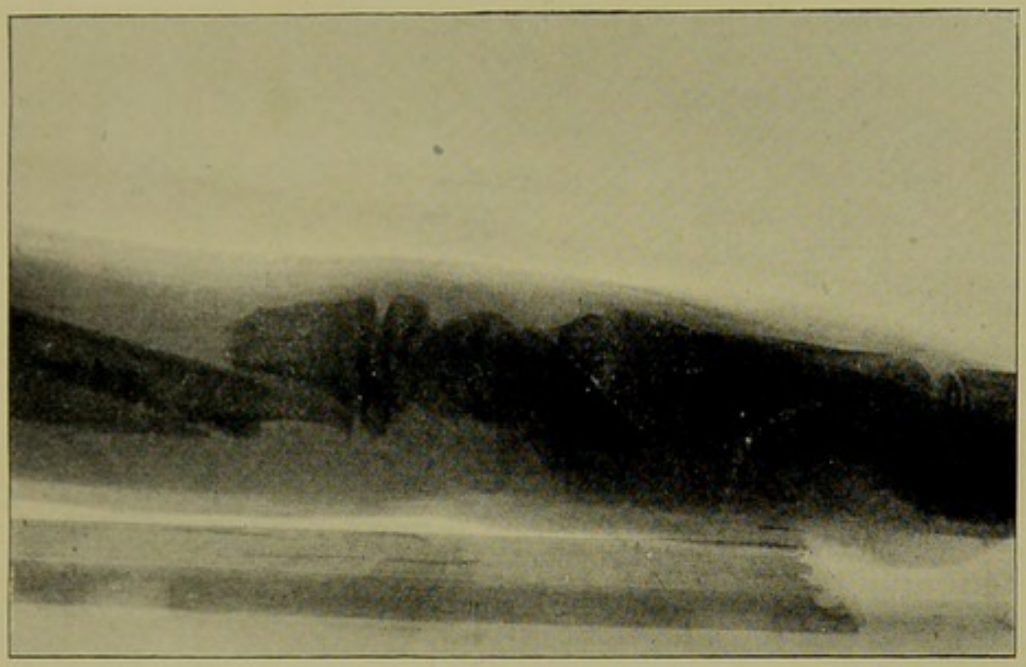

FIG. 18.

FRACTURE OF RADIUS AND ULNA—LOWER THIRD.

View from side ; patient a boy, aged 14 years : accident on November 1st, 1897, Skiagram taken a week later. Marked displacement backwards of lower fragment of radius ; some backward displacement of lower fragment of ulna. (From a skiagram lent by Mr. G. A. Wright.)

(3) If there be much laceration of the surrounding parts, it may be possible to move the bones in any direction.

(4) Only one bone may be displaced.

(5) The bones may be displaced in opposite directions; occasionally the radius projects forwards and the ulna backwards.

(6) The bones may be approximated.

(7) The fractured ends may over-ride.

(8) One part of the radius may be pronated and the other supinated.

Most frequently one of the following conditions will be met with:—

(1) In the majority of cases both bones project backwards or forwards, with or without some lateral deviation.

(2) In fractures from direct violence, the bones are usually displaced in the direction of the force which caused the fracture.

(3) In fractures above the insertion of the pronator radii teres, the upper fragment of the radius is often supinated by the supinator brevis and the biceps, whilst the lower fragment is pronated and drawn inwards by the pronators.

(4) In fractures below the insertion of that muscle the upper fragment of the radius may be drawn forwards by the biceps and pronator teres, and inwards by the latter muscle, whilst the lower fragments are approximated by the pronator quadratus.

(5) In fractures above the middle of the arm there is a very great tendency for the ulna to become displaced backwards and inwards towards its subcutaneous border.

(6) In fractures of the lower third, which frequently result from falls upon the hand, the lower fragments are usually displaced backwards.

The three accompanying skiagrams (Figs. 16, 17, and 18) represent fractures of both bones of the forearm in the upper, middle, and lower thirds respectively.

Fig. 16 illustrates the tendency to bowing backwards of the bones, which so frequently occurs with fractures in the upper part of the forearm.

Fig. 17 is a fracture in the middle third. The fragments of the ulna have retained their proper positions, but the lower part of the radius is displaced somewhat outwards.

Fig. 18 represents a side view of a fracture of both bones in the lower third. The lower fragment of the radius is displaced markedly backwards and over-rides the upper fragment. The ulna is displaced slightly backwards.

TABLE XXIII.—Complete Fractures of Shafts of Radius and Ulna.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
316	6	M	1895 May 25	R	Fall on forearm	Ulna at junction of upper and middle thirds; radius a little lower	Radius inwards; ulna not displaced	..	Short anterior and long posterior splints	31 days	6 weeks	None	.....
317	13	M	June 12	L	Fall on forearm	Just above insertion of pronator radii teres	Free mobility in any direction	..	Anterior angular splint and posterior splint along forearm; forearm supinated	32 days	..	..	Ulna much thickened by callus; this was being gradually absorbed when patient last seen 4 months after accident
318	9	M	July 4	?	Fall on forearm	Just above insertion of pronator radii teres	Bowing backwards of bones; some overriding	..	Anterior angular splint; July 30, redisplacement, arm fixed in plaster with elbow extended	47 days	..	..	Two months after injury was quite right, except that ulna was thickened by callus
319	20	M	July 20	R	Direct violence (arm caught in a machine	Middle of bones	Free mobility in any direction	..	Anterior and posterior splints	..	..	..	Patient not seen again
320	15	M	July 21	L	Fall on back of hand	Just above middle of bones	Lower fragments approximated	..	Anterior and posterior splints; August 23, backward displacement; arm fixed in plaster with elbow extended	54 days	..	..	Bones considerably thickened by callus; almost all absorbed at end of 6 months
321	17	M	July 29	L	Fall on forearm	Just above middle of bones	Backwards	Same radius fractured in lower third three years ago; slight degree of angular union ..	Anterior and posterior splints	36 days	..	Some bowing backwards of ulna	.....
322	14	M	Aug 5	L	Fall of about 6 or 8 feet on forearm	Middle of bones	Inwards and slightly backwards	..	Anterior and posterior splints	25 days	..	Slight bowing backwards of ulna	.....

323	11	M	Aug 8	L	Fall on hand	Upper part of middle third	Forwards	..	Anterior and posterior splints	29 days	6 weeks	None	.....
324	18	M	Aug 11	R	Fall with arm under body	Middle of bones	Forwards	..	Anterior and posterior splints	23 days	6 weeks	None	.....
325	4	M	Aug 19	R	Fall on forearm	Just above middle of bones	Backwards	..	Anterior and posterior splints	32 days	8 weeks	None	.....
326	30	F	Aug 31	R	Fall on hand	Radius 1 inch, ulna 2 inches from lower ends	Backwards and outwards of lower fragments	..	Anterior and posterior splints; redisplacement remedied on September 10	20 days	..	None	Last seen 5 weeks after accident; some stiffness of wrist; otherwise quite well
327	14	M	Sept 6	R	Fall	Just below middle of bones	Upper fragments forwards; bones approximated	..	Anterior and posterior splints	..	..	..	Patient only seen once afterwards
328	17	M	Sept 6	R	Fall on palm of hand	Middle of bones	Inwards	Fracture in same place 4 years ago	Anterior and posterior splints	21 days	6 weeks	..	Quite well 6 weeks after accident, except for thickening of ulna. This had almost disappeared 6 months after injury
329	9	M	Sept 11	L	Fall on arm	Just below middle of bones	None	..	Anterior and posterior splints	19 days	..	None	Patient not seen after day of removal of splints
330	4	F	Sept 20	L	Fall	Upper part of middle third	Forwards	..	Internal angular and posterior splint along forearm	36 days	8 weeks	None	.....
331	18	M	Sept 30	L	Crush between strap and pulley	Junction of lower and middle thirds	Upper fragments backwards; lower riding in front of upper	Also fracture of humerus of same arm —No. 148	Internal angular and posterior splint along forearm	43 days	..	..	Paralysis of ulnar nerve during convalescence; quite well 3½ months after accident, except for callus at seat of fracture
332	13	M	Oct 9	L	Fall on arm	Middle of bones	Lower fragments inwards and backwards	..	Anterior and posterior splints	34 days	..	..	Considerable thickening from callus when last seen 3½ months after accident
333	16	M	Oct 21	?	Fall on palm of hand	Radius at junction of lower and middle thirds; ulna 1 inch higher	Forwards and inwards	..	Anterior and posterior splints; Nov 1, tendency to displacement of radius towards ulna	29 days	..	..	Some thickening of ulna when last seen 5 weeks after accident

TABLE XXIII.—Complete Fractures of Shafts of Radius and Ulna—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
334	17	M	1895 Nov 30	R	Fall on forearm	Middle of bones	None	Did not apply for treatment until Dec 2	Anterior and posterior splints	27 days	..	..	Quite right except slight thickening of ulna when last seen 4 months after accident
335	43	M	Dec 25	R	Direct violence (arm trodden upon by a horse)	Junction of middle and lower thirds	Fragments could be displaced in any direction	Fracture comminuted; great contusion of soft parts	Anterior and posterior splints; union delayed, but quite firm on removal of splints	51 days	..	..	Considerable amount of callus; pronation and supination afterwards very limited and not fully restored when patient last seen 7 months after accident
336	18	M	1896. Jan 6	R	Fall with arm under body	Middle of bones	"Slight"	..	Anterior and posterior splints	26 days	..	..	4½ weeks after accident was quite right except for slight thickening of bones
337	15	M	Feb 2	R	Fall with arm under body	Just above middle of bones	Forwards (not marked)	..	Internal angular splint; posterior and internal splints along forearm	23 days	..	Very slight bowing forwards of radius	Patient fell and fractured the radius again on March 31; ulna not broken—No. 390
338	14	M	Feb 13	L	Fall with arm under body	Middle of bones	Upper fragment of radius slightly pronated	..	Anterior and posterior splints at first; afterwards internal angular and short splints along forearm	33 days	..	Slight bowing of ulna to inner side	.....
339	13	M	March 2	R	Fall on hand	Lower third (1½in. from lower ends)	Forwards	..	Anterior and posterior splints	25 days	2½ months	None	Considerable amount of callus at first; all absorbed in 2½ months
340	23	M	March 10	R	Forearm crushed by strap of machine	Lower third—radius 2in., ulna 1in., from lower ends	None	..	Anterior and posterior splints	23 days	6 weeks	None	.....
341	4	M	March 10	L	Fall	Upper third	None	..	Anterior and posterior splints: March 17, slight bowing forwards; internal angular and posterior splint along forearm	28 days	5 weeks	None	.....

342	5	M	March 12	L	Fall on hand	Lower third (2in. from lower ends)	Very marked bowing forwards	Fracture complete; there had been a greenstick fracture in the same situation 5 months before. No. 263	Anterior and posterior splints	47 days	..	Radius bowed outwards and slightly forwards	Beyond the deformity, the patient was quite well 3 months after the injury
343	4	M	April 8	R	Fall on arm	Junction of lower and middle thirds	Lower fragments backwards and upwards	..	Anterior and posterior splints	27 days	6 weeks	None	.....
344	41	F	April 19	R	Fall	Lower third—Radius 1½in., ulna 1in., from lower ends	Lower fragment radius slightly backwards; ulna not displaced	....	Anterior and posterior splints	..	..	..	Patient only seen twice afterwards
345	17	M	April 24	R	Arm crushed by strap	Radius 1½in. from upper end: ulna at junction of upper and middle thirds	Ulna bowed towards radius; lower fragment radius displaced forwards	....	Anterior angular splint	19 days	..	None	Movements of pronation and supination were limited after union, and were not fully restored when patient last seen, 5½ months after injury
346	16	M	May 2	L	Fall	Middle of bones; radius ½in. lower than ulna	Forwards	....	Anterior and posterior splints; great trouble from redisplacement, and internal angular splint applied	45 days	..	Some bowing inwards of ulna	With exception of deformity, patient was quite right when last seen, 3½ months after injury
347	13	M	May 3	L	Fall on palm of hand	Lower third—1½in. from lower ends	Lower fragments backwards	....	Anterior and posterior splints	30 days	..	None	Pronation and supination afterwards limited, but improving when last seen, 5 weeks after accident
348	23	M	May 5	R	Forearm crushed by rollers	Middle of bones	Very slight	....	Anterior and posterior splints	24 days	8 weeks	None	.....
349	11	M	May 18	R	Fall on palm of hand	Junction of middle and lower thirds	Backwards	....	Anterior and posterior splints	29 days	..	..	Some thickening of ulna from callus; not altogether absorbed 3 months after injury

TABLE XXIII.—Complete Fractures of Shafts of Radius and Ulna—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
350	10	M	1896. May 20	L	Fall (?) on hand	Junction of middle and upper thirds	Forwards	....	Anterior and posterior splints	27 days	..	None	Last seen on day of removal of splints; good union, without deformity
351	10	M	May 25	R	Fall on arm	Middle third	Backwards	....	Anterior and posterior splints. Redisplacement corrected on May 29	25 days	3½ m'nths	..	Callus almost absorbed 3 months after injury
352	15	M	May 26	R	Fall on hand	Radius at junction of middle and lower thirds; ulna ½in. lower	Radius bowed outwards	Greenstick fracture in same place 7 weeks before. No. 283	Anterior and posterior splints	31 days	..	..	Last seen 5 weeks after accident; all right, except some callus at seat of fracture
353	8	M	May 27	L	Fall on arm	Middle third	Inwards	....	Anterior and posterior splints. Redisplacement corrected on May 29	23 days	3 m'nths	..	Callus almost absorbed 3 months after injury
354	7	F	May 29	L	Fall on hand	Middle third	Backwards	....	Anterior and posterior splints. Redisplacement corrected on June 10	25 days	..	None	Last seen on day of removal of splints; union in good position
355	12	M	May 31	L	Fall on arm	Middle third	Inwards	....	Anterior and posterior splints. Redisplacement corrected on June 5 and 19	40 days	..	None	Last seen on day of removal of splints; union in good position

356	15	M	June 14	R	Fall on hand	Middle third	None	....	Anterior and posterior splints	26 days	..	..	Union in good position. Six days later patient broke the radius again in the same position. (See No. 400.)
357	13	M	June 22	L	Fall on palm (distance of 8 feet)	Lower third (2in. from lower ends)	Backwards	....	Anterior and posterior splints	19 days	1 month	None	.....
358	12	M	July 4	L	Fall on arm	Junction of upper and middle thirds	Radius bowed forwards; ulna backwards	....	Anterior angular splint	27 days	3 m'nths	Slight bowing of ulna	.....
359	5	M	July 8	L	Fall on hand	Middle third	Forwards	....	Anterior and posterior splints	27 days	..	Some bowing of ulna	... ..
360	6	M	July 12	L	Fall on arm	Middle third	None	....	Anterior and posterior splints	26 days	..	Some bowing of ulna	.....
361	21	M	July 18	?	Fall with arm under body	Middle third	Could be moved in any direction	....	Anterior and posterior splints	..	..	..	Patient only seen once afterwards
362	8	M	Aug 2	L	Fall on hand	Junction of lower and middle thirds	Lower fragments backwards	....	Anterior and posterior splints	23 days	5 weeks	None	.....
363	6	M	Aug. 6	L	Fall on arm	Middle third	Forwards	....	Anterior and posterior splints	26 days	7 weeks	None	.....
364	4	M	Aug. 6	L	Fall on arm	Radius at junction of middle and lower thirds; ulna middle of bone	None	....	Anterior and posterior splints	26 days	7 weeks	None	.....
365	21	M	Aug. 7	L	....	Junction of lower and middle thirds	Radius bowed outwards	Ulna comminuted	Anterior and posterior splints	31 days	..	..	Last seen 5 weeks after accident; all right, except some thickening at seat of fracture

Complications.—One case (No. 331) was accompanied by fracture of the humerus of the same arm. Two cases (Nos. 335 and 365) were comminuted.

Three patients had previously had fractures in the same situations; in one the previous fracture had occurred four years before, whilst two had recently been under my treatment with greenstick fractures.

In a few recorded cases injury to the median or ulnar nerve has accompanied fracture of these bones.

Treatment.—The *splints* usually recommended for the treatment of these cases are—

(1) In the upper half of the forearm, an anterior angular or a posterior angular splint, the hand being fully supinated.

(2) In the lower half of the forearm, anterior and posterior straight splints, the hand being semi-pronated.

The most frequent difficulty with which one has to contend is a bowing of the ulna backwards and inwards towards its subcutaneous border. I have in some cases been able to check this tendency by placing a narrow, straight splint along the inner side of the forearm, in addition to the anterior and posterior splints. In two cases where I could not keep the bones in good position by other means, I forcibly straightened them, and afterwards fixed the arm and forearm in plaster of Paris with the elbow fully extended. When the plaster was removed in each case the bones had united in good positions, and the ultimate result was satisfactory.*

The average time (46 cases) that the splints were retained was 30 days.

Results.—These were as follows:—

Union without deformity	22
„ with more or less bowing of the bones	8
Bones thickened by callus when patients last seen, but no evident angular displacement	14
Cases lost sight of soon after the accident	4
Patients who re-fractured the arm	2
	50

Three patients had some interference with the movements of pronation and supination after the fractures had united; in two it was temporary, and was improving when they were last seen, between five and six weeks after the occurrence of the accident. The third case was a badly comminuted fracture, caused by a horse treading upon the forearm; a great deal of callus was thrown out, but the

* The remarks which will be made subsequently on the choice and application of splints for the treatment of Colles' fracture also apply to a large extent to fractures of the shafts of the radius and ulna.

radius and ulna did not become fused; the movements gradually improved, but they were far from being fully restored when I last saw the patient, seven months after the accident.

In all the above cases firm union of the fragments took place, although in one instance the process of union was delayed. Non-union is but seldom met with in the forearm.

COMPLETE FRACTURES OF THE SHAFT OF THE RADIUS.

Table XXIV. gives details of the 39 cases of this accident.

The etiology of these cases has already been considered. (Pages 93-95).

Displacement.—The manner of displacement of the broken ends in these cases, as in fractures of both bones of the forearm, is open to great variation. It was as follows:—

Slight or absent	14
Upper fragments supinated, lower pronated and drawn forwards	3
Both fragments inwards towards ulna	4
„ „ forwards	2
„ „ backwards	1
„ „ outwards	1
Lower fragment backwards	6
„ „ forwards	1
„ „ outwards	1
„ „ inwards	1
Fragments movable in any direction	1
Displacement not recorded	4
	39

The most common condition would thus appear to be absence of displacement. When the relations are altered the fractured ends most frequently move backwards or inwards, or one fragment is supinated, whilst the other is pronated.

Complications.—Comminution of the bone was noted twice (Cases 382 and 384). Two patients had had the radius and ulna previously fractured. The time which had elapsed since the former accident was $4\frac{1}{2}$ weeks and 8 weeks respectively, but in each case on the second occasion only the radius gave way.

Results.—The results in these cases were as follows:—

Union without deformity	26
Union with displacement	2
Bone considerably thickened by callus when patients were last seen	3
Cases lost sight of	8
	39

TABLE XXIV.—Complete Fractures of Shaft of Radius.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
366	8	F	1895 June 4	R	Fall of brick on arm (?) Direct violence	Junction of upper and middle thirds	None	..	Short anterior and long posterior splints	24 days	5 weeks	None	.....
367	29	M	June 10	R	Striking a "round-arm" blow	Above insertion of pronator radii teres	Upper fragment supinated; lower pronated	..	Short anterior and long posterior splints	32 days	..	None	Last seen on day of removal of splints; firm union without deformity; no stiffness
368	28	M	June 26	R	Excessive pronation of hand	Junction of middle and lower thirds	None	The man's hand was twisted violently; he heard the bone snap at the time	Short anterior and long posterior splints	24 days	4½ weeks	None	.....
369	40	F	July 1	L	Kick on forearm	Not recorded	None	..	Short anterior and long posterior splints	..	..	..	Patient not seen again
370	52	F	July 20	R	Fall on hand (?)	Middle third	Both fragments inwards	..	Short anterior and long posterior splints	18 days	..	None	Last seen 4 weeks after accident; quite right except some stiffness of wrist
371	23	M	Aug 2	R	Blow on forearm	Upper part of middle third	None	..	Short anterior and long posterior splints	21 days	..	None	Last seen on day of removal of splints; union in good position
372	34	M	Aug 19	R	Fall of plank on forearm	Just below middle of bone	Both fragments inwards	..	Short anterior and long posterior splints	25 days	..	None	Last seen on day of removal of splints; union in good position
373	17	M	Aug 19	L	Fall on hand	Junction of middle and lower thirds	Both fragments inwards	..	Short anterior and long posterior splints	25 days	..	None	Last seen on day of removal of splints; union in good position

I														
	374	42	M	Aug 22	L	Fall on palm of hand	Lower third—1½in. above wrist	Lower fragment slightly backwards	Fracture oblique from before, upwards and backwards	Short anterior and long posterior splints	19 days	..	None	Last seen 26 days after injury; considerable stiffness of wrist
	375	5	M	Aug 22	L	Fall on arm	Upper third	None	..	Short anterior and long posterior splints	19 days	..	None	Last seen on day of removal of splints; good union, no stiffness
	376	11	M	Sept 7	L	Fall on palm of hand	Junction of upper and middle thirds	Upper fragment forwards; lower backwards	..	Short anterior and long posterior splints	24 days	6 weeks	None	.....
	377	3	M	Sept 15	L	Fall on forearm	Upper third	Little or none	..	Short anterior and long posterior splints	17 days	..	None	Last seen on day of removal of splints; good union, no stiffness
	378	45	M	Sept 27	L	Direct violence—fall of box on arm	Upper third	Both fragments towards ulna; upper also drawn forwards	..	Anterior angular splint	22 days	11 weeks	None	.....
	379	29	M	Oct 18	R	Striking a "round-handed" blow	Lower third—3in. from wrist	None	..	Anterior and posterior splints	..	..	..	Patient not seen again
	380	30	M	Oct 25	R	Fall on arm	Lower third	None	..	Anterior and posterior splints	..	..	..	Last seen 10 days after injury
	381	28	M	Nov 11	?	Direct violence	Above insertion of pronator teres	Not recorded	..	Anterior angular and straight splint along back of forearm	29 days	..	None	Considerable subsequent interference with pronation and supination; improving when last seen 2 months after injury
	382	42	M	Nov 19	R	Fall of heavy girder on forearm	Just below middle of bone	Fragments easily moved in any direction	Fracture comminuted; considerable extravasation of blood	Anterior and posterior splints; union greatly delayed and tendency to displacement inwards of fragments	94 days	..	..	Union ultimately firm; but with much thickening of the bone; Some subsequent stiffness of wrist, but improving when last seen 3½ months after injury
	383	38	F	Nov. 22	L	Fall down stairs (? direct violence)	Upper third, just below neck of bone	Upper fragment slightly backwards; lower forwards and inwards	..	Anterior angular and posterior splint along forearm	18 days	..	None	Patient complained of pain after removal of splints, but this was improved when last seen, 6½ weeks after injury

TABLE XXIV.—Complete Fractures of Shaft of Radius—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result.
384	55	M	1895. Nov. 26	R	Kick of horse	Lower third, 1½in. from lower end	Slight	Fracture comminuted; much swelling	Anterior and posterior splints	24 days	..	..	Some thickening of bone and pain at seat of fracture when last seen, 6 weeks after accident
385	54	M	1896 March 14	L	?	Junction of upper and middle thirds	Not recorded	..	Anterior and posterior splints	..	..	..	Patient not seen again
386	32	M	March 14	R	Direct violence; fall of box on arm	Junction of middle and lower thirds	Lower fragment backwards	..	Anterior and posterior splints	26 days	..	Some displacement backwards	.....
387	42	M	March 17	L	Fall with arm under body	Junction of middle and lower thirds	Lower fragment backwards and slightly outwards	..	Anterior and posterior splints	..	..	..	Patient not seen again
388	14	M	March 24	L	Direct violence; fall with right forearm crossing left	Junction of middle and lower thirds	Both fragments slightly backwards	..	Anterior and posterior splints	22 days	5 weeks	None	.....
389	53	M	March 30	L	Fall down stairs	Lower third—1½in. from lower end	Lower fragment slightly backwards	..	Anterior and posterior splints	..	..	..	Last seen 9 days after accident
390	15	M	March 31	R	Fall on hand	Middle third	Both fragments forwards	Radius at same place, and ulna fractured on Feb. 2, 1896. No. 337	Anterior and posterior splints	42 days	..	None	Last seen on day of removal of splints; union in good position
391	32	M	April 5	R	Fall on hand (? on back of hand)	Middle of bone	Lower fragment pronated and drawn up in front of upper	..	Anterior angular splint	..	..	..	Last seen 12 days after accident
392	30	M	April 20	R	Fall	Junction of upper and middle thirds	Lower fragment riding in front of upper	..	Anterior angular splint	22 days	..	Some displacement forwards of lower fragment	.....
393	58	M	May 13	L	Direct violence	Middle third	Lower fragment inwards	..	Anterior and posterior splints	23 days	5 weeks	None	.....

394	44	M	May 13	R	Fall on palm of hand	Junction of middle and lower thirds	Lower fragment slightly outwards	Double Colles' fracture 4 years ago; deformity not fully reduced	Anterior and posterior splints	23 days	..	None	Last seen on day of removal of splints; good union
395	22	F	May 14	R	Violent twist of forearm	Junction of upper and middle thirds	Not recorded	..	Anterior and posterior splints	19 days	..	None	Last seen on day of removal of splints; good union
396	41	M	May 18	L	Direct violence; fall of beam of wood on forearm	Junction of lower and middle thirds	Both fragments slightly backwards	..	Anterior and posterior splints	22 days	6 weeks	None	.....
397	45	M	June 9	L	Fall on arm	Middle third	Both fragments outwards	..	Anterior and posterior splints	24 days	..	None	Last seen on day of removal of splints; good union
398	71	M	June 18	L	Fall on arm from a cart	Upper third	None	..	Anterior and posterior splints	29 days	..	None	Complained of considerable subsequent pain in arm; improved when last seen, 6 weeks after injury
399	28	M	July 2	R	Arm run over by a lurry	Middle third	None	..	Anterior and posterior splints	..	..	..	Patient not seen again
400	15	M	July 16	R	Said to have been caused by lifting a kettle of water from the fire (?)	Middle third	None	Radius and ulna fractured on June 14; Splints removed July 10. Radius alone broken on this occasion. See No. 356	Anterior and posterior splints	33 days	..	..	Last seen on Aug. 25. Radius somewhat thickened, but otherwise quite right
401	15	M	July 27	R	Fall on hand	Lower third	Lower fragment backwards	..	Anterior and posterior splints	22 days	..	None	Last seen on day of removal of splints; good union; no stiffness
402	2	M	July 27	R	Fall on arm	Lower third	None	..	Anterior and posterior splints	18 days	1 month	None	.....
403	8	M	Aug 1	R	Fall	Upper third	Not recorded	..	Anterior and posterior splints	31 days	5½ weeks	None	.....
404	3	M	Aug 6	L	Fall	Upper third	None	..	Internal angular splint	26 days	5 weeks	None	....

COMPLETE FRACTURES OF THE SHAFT OF THE ULNA.

Thirteen cases of this accident are classified in Table XXV.

Cause.—The cause of the fracture in all cases, except two, was direct violence; in the other two cases the exact cause was doubtful.

Displacement.—Displacement was absent in nine of the cases. Of the rest, two were associated with dislocation of the head of the radius, and in two the fragments were driven towards the middle line of the arm by the force of the injury.

In one instance the bone was comminuted. One patient had had a greenstick fracture of the radius and ulna (ulna in same situation) five months before.

Results.—In all cases which were followed throughout the fracture united without deformity; in several the ulna was thickened by callus when the patient was last seen.

FRACTURE OF THE ULNA WITH DISLOCATION OF THE HEAD OF THE RADIUS.

Hamilton[5] has pointed out the frequency with which these two lesions are combined. Dislocation of the radius was present in 12 out of 36 fractures of the ulna which he observed, and he further says that he has seen nine examples of unreduced dislocations of the head of the radius after fracture of this bone. This condition does not appear to have received quite so much attention as its frequent occurrence merits. I have met with six or seven cases, two of which are included in Table XXV.

Case 407.—*Fracture of Ulna at junction of upper and middle thirds with outward and slightly forward Dislocation of head of Radius.*—The ulna at the seat of fracture was bowed with the convexity outwards and somewhat backwards.

Case 410.—*Fracture of Ulna at junction of upper and middle thirds with forward Dislocation of head of Radius.*—The ulna was bowed backwards and was comminuted.

Another patient who came for treatment with a recent greenstick fracture of the radius and ulna in the lower third of the forearm, presented an old-standing example of the accident under consideration.

Case 266 (Table XX.).—*Mal-united fracture of Ulna at junction of upper and middle thirds with unreduced Dislocation forwards of head of Radius.*—The accident had occurred two years previously. The dislocation of the radius had not been fully reduced, and the ulna was curved backwards at the seat of the old fracture.

The accompanying skiagram (Fig. 19) was taken from a patient, who was under the care of Mr. Thomas Jones, to whom I am indebted for permission to publish the following account:—

F.D., male, aged 22, received on March 11th, 1898, a direct injury to the left elbow caused by a fall from a ladder for a distance of ten to fifteen feet. He first

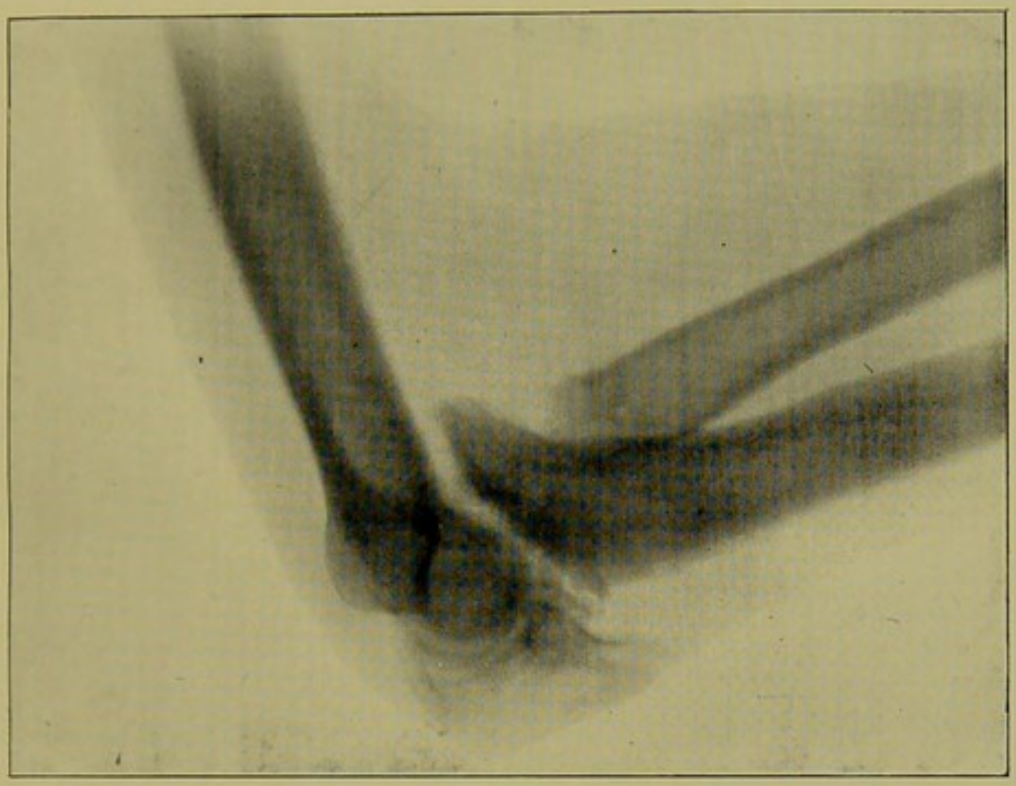

Fig. 19.

Old Fracture of Upper End of Ulna with Dislocation Forwards of Head of Radius—Excision of Head of Radius (Mr. Jones's Case).

came under the care of Mr. Jones about twelve weeks later, and he then presented an unreduced dislocation forwards of the head of the radius and a mal-united fracture of the ulna. The latter bone had been fractured a little way below the olecranon, and the lower fragment was displaced markedly forwards. The elbow-joint was almost completely fixed at an angle of about 120° with the upper arm. Mr. Jones advised removal of the head of the radius, and this was done on June 11th. The union between the two parts of the ulna was not firm, and was broken down during the manipulation of the joint. After the operation the condition of the arm was greatly improved. Six months later, when the skiagram was taken, the movements of pronation and supination were fully restored, and the patient could flex the elbow-joint to an angle of 70° and extend it to 160°. He stated that he had regained almost full muscular power over the limb. On manipulation it was found that there was still a certain amount of movement between the two parts of the ulna. The skiagram shows that the fracture of the ulna has extended from the lower part of the sigmoid cavity backwards and somewhat downwards to the posterior border of the bone. The lower fragment is displaced markedly forwards, and it is evident from the great displacement that there can be but little union between the fragments.

A somewhat similar skiagram has been figured by White[6]. In this case the head of the radius was excised for an old-standing dislocation forwards, and the skiagram shows that there has been a fracture of the ulna about three or four inches below the elbow.

M'Leod[7] has described four cases of this accident, in all of which the radius was dislocated forwards, and the ulna broken in its upper fourth.

Naidu[8] has published the case of a boy, aged 8, who had a compound dislocation forwards of the radial head, and fracture of the ulna one inch from the lower end of the bone. The head of the radius was excised, and the boy made a complete recovery.

Schwarz[9] has recorded the case of a man, aged 20, who, as a result of a kick from a horse, sustained a dislocation forwards of the radial head and fracture of the ulna in the middle third. Five months later the upper end of the radius was excised, owing to the movements of the elbow-joint being limited. The patient was greatly benefited by the operation.

Herbet[10] has published a case in which the radius was dislocated backwards and the ulna fractured in two places—in the upper third and near the middle of the bone. Two skiagrams of this case are given.

Winnett[11] has reported a case of outward and forward dislocation of the radial head with fracture of the ulna at the junction of the upper and middle thirds. In this case the muscles supplied by the posterior interosseous nerve were paralysed.

With the exception of the patient from whom the accompanying skiagram was taken, all the cases which have come under my own notice have had the ulna broken about the junction of the upper and

TABLE XXV.—Complete Fractures of Shaft of Ulna.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Remarks.	Treatment.	How long fixed.	Period of Recovery.	Permanent Deformity.	Remarks on Result
405	9	F	1895 May 27	L	Fall on hand (?)	Middle third	None	Greenstick fracture of radius and ulna on same side 5 months before	Short anterior and long posterior splints	22 days	..	.....	Last seen 4 weeks after accident; quite right except for some callus at seat of fracture
406	16	M	June 20	L	Direct blow	Lower third—2ins from styloid process	None	.....	Short anterior and long posterior splints	22 days	1 month	None	.....
407	9	M	July 14	R	Fall on outer side of elbow and forearm	Junction of upper and middle thirds	Ulna bowed outwards and slightly backwards	Also outward and slightly forward dislocation of head of radius	Reduction by extension in line of forearm; internal angular splint	33 days	..	.....	Last seen 5 weeks after accident; some callus at seat of fracture
408	70	M	Aug 27	L	Direct blow	Middle third	None	.....	Anterior and posterior splints	..	..	.....	Last seen 9 days after accident
409	31	F	Aug 30	L	Direct blow	Junction of middle and lower thirds	None	.....	Anterior and posterior splints	..	..	.....	Last seen 6 days after accident
410	38	M	Sep 13	R	Arm caught in a belt of a machine	Junction of upper and middle thirds	Ulna bowed backwards	Ulna comminuted; dislocation forwards of head of radius; great bruising of soft parts	Anterior angular splint; Oct. 1, chloroform; head of radius somewhat displaced forwards; reduced	29 days	..	None	Great stiffness in pronation and supination after removal of splints; improved when last seen 2½ months after accident
411	31	F	Oct 1	?	Direct blow	Junction of middle and lower thirds	Lower fragment towards radius	.....	Anterior and posterior splints	..	..	.....	Last seen 3 days after accident
412	43	F	Oct 1	L	Direct blow	Middle of bone	None	.....	Anterior and posterior splints	28 days	6 weeks	None	.....
413	21	F	Oct 20	L	Direct blow	Junction of middle and lower thirds	None	.....	Anterior and posterior splints	26 days	..	None	Apparently quite right on removal of splints; 3 days later kick on arm near seat of fracture; bone not broken again, but considerable pain and tenderness
414	68	F	Oct 19	?	Direct blow	Junction of upper and middle thirds	None	.....	Anterior and posterior splints	24 days	..	None	Last seen on day of removal of splints; apparently quite right
415	49	F	Nov 9	R	Direct violence?	Lower third	None	Some contusion of skin over seat of fracture	Anterior and posterior splints	20 days	..	None	Last seen on day of removal of splints; apparently quite right

416	39	F	1896 Feb 2	?	Direct violence (kick)	Junction of upper and middle thirds	None	.....	Anterior and posterior splints	19 days	..	None	Last seen on day of removal of splints; quite right except some thickening at at seat of fracture
417	41	M	Aug 8	R	Direct blow	Upper part of middle third	Both fragments driven towards radius	Radius and ulna of same arm broken lower down 15 years ago; union with some angular displacement backwards	Anterior and posterior splints	24 days	..	None except for old fracture	Last seen when splints removed; apparently quite right

TABLE XXVI.—Compound Fractures of Shafts of Radius and Ulna.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Position of Fracture.	Displacement.	Treatment.	How long fixed.	Permanent Deformity.	Remarks on Result.
418	15	M	1895 Aug 30	R	Direct violence (?)	Middle of bones	Bowing backwards of ulna	Wound dressed antiseptically; short anterior and long posterior splints applied; during after-treatment great trouble from bowing of ulna; on Sept. 27 arm straightened and fixed in plaster of Paris with elbow extended	63 days	None	When last seen the ulna was was quite straight, but there was still some thickening at seat of fracture; wound healed without suppuration
419	10	M	1896 Mar 16	L	Fall on palm of hand	Radius at junction of middle and lower thirds; ulna 1in. from lower end	Lower fragments backwards	Dressed antiseptically; anterior and posterior splints	29 days	Slight projection of ulna (? callus)	Otherwise quite well one month after accident; healed by first intention
420	12	M	June 28	R	Fall backwards with arm under body	Middle of bones	Forwards	Dressed antiseptically; internal angular and posterior splint along forearm	37 days	.....	Considerable amount of callus, but otherwise quite well 2 months after accident; healed by first intention
421	8	M	July 22	(?)	Fall on hand (6 feet)	Radius in upper third; ulna at middle of bone	Lower fragment of ulna displaced inwards causing punctured wound	Dressed antiseptically; anterior and posterior splints	44 days	Considerable bowing backwards	Wound healed by first intention

middle thirds of the shaft. The radius was dislocated forwards in all cases save two, and the ulna was bowed backwards at the seat of fracture. In one of the exceptional cases the radius was dislocated outwards and slightly forwards, and the ulna was curved outwards; in the other the radius was displaced backwards and the ulna curved forwards.

Cause.—It is probable that this accident is always due to direct violence. Dörfler[1,2], from experiments made upon the cadaver, came to the following conclusions: (1) Direct violence which breaks the ulna, if it continues to act, tends to dislocate the head of the radius. (2) A force, which acts upon the upper third of the radius, produces a luxation more often than a fracture. (3) The nature of the luxation depends upon the direction of the violence, and consequently, from the position of the radial head, one can form an idea of how the force has acted. M'Leod[7], in an experiment upon the dead body, found that "the head of the radius had slipped forwards through the anterior ligament of the elbow-joint, the orbicular ligament having slid on to its neck."

Practical Considerations.—From a study of this accident the following points would appear to be of practical importance: (1) The two-fold nature of the injury is very apt to be overlooked, and hence, in fracture of the shaft of the ulna, it is always advisable to examine for dislocation of the head of the radius. (2) Unless the radius be replaced, the ulna will unite in bad position. (3) Even if reduced, there is a tendency for the radius to become re-dislocated.

Treatment.—In none of the recent cases of this accident which I have seen, have I had any great difficulty in overcoming the dislocation. The return of the radius to its proper position has remedied the displacement of the ulna at the same time. If difficulties be encountered, an attempt at reduction should be made under an anæsthetic, and, should this be unsuccessful, I am of opinion that the best treatment is incision with antiseptic precautions and division of the resisting ligaments. In old-standing cases there is usually great interference with the movements of the elbow-joint. Under such circumstances excision of the head of the radius has given excellent results.

COMPOUND FRACTURES OF THE SHAFTS OF THE RADIUS AND ULNA.

Four cases of compound fracture of these bones were treated as out-patients. (Table XXVI.).

None of these cases were severe compound fractures; the wound was treated antiseptically, and in each case healed without suppuration.

In addition to these cases, three compound fractures, one compound comminuted fracture, and three hopelessly crushed forearms, demanding amputation, were treated as in-patients.

With regard to amputation in these cases, an attempt should be made to save the hand whenever there is the slightest chance of doing so. In one case of very badly comminuted fracture of the radius and ulna, with extensive laceration of the soft parts, I excised about 1½ inches of the broken ends, and wired the fragments with silver wire. Much sloughing and profuse suppuration took place, and afterwards necrosis at the seat of fracture, but ultimately the man recovered with a useful hand.

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FRACTURES OF THE LOWER ENDS OF THE RADIUS AND ULNA.

The 144 fractures involving these portions of bones may be classified as follows:—

	Radius alone.	Radius and Ulna.	Ulna alone.	Totals.
Epiphysial separations	36	6	1	43
Fractures	92	7	2	101
	128	13	3	144

SEPARATIONS OF THE LOWER EPIPHYSIS OF THE RADIUS.

This epiphysis commences to ossify about the end of the 2nd year of life, and unites with the shaft at the age of 19 or 20. The 36 cases of separation are arranged in Table XXVII.

TABLE XXVII—SEPARATIONS OF LOWER EPIPHYSIS OF RADIUS.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Permanent Deformity.	Subsequent Stiffness of Wrist.	Period of Recovery	Remarks on Result.
			1895.											
422	13	M	May 20	R	Fall with hand under body	Backwards	.....	Reduction of displacement; short anterior & long posterior splints	22 days	None	None	None	1 month	.....
423	9	F	June 20	R	Fall on hand	Backwards	.....	Do.	21 days	None	None	.....	....	Patient not seen after day of removal of splints
424	14	M	June 29	L	Fall on hand	Forwards	.....	Do.	18 days	None	None	None	....	Patient not seen after day of removal of splints
425	14	M	July 12	R	Fall on closed fist	Backwards	.....	Do.	18 days	None	None	None	1 month	.....
426	17	F	July 17	L	Hand caught in machine: direct violence	Backwards	Some contusion and abrasion of skin	Do.	20 days	Several times after removal of splints	None	Some stiffness after removal of splints; slow in disappearing	....	Much trouble afterwards from effusion into flexor tendon sheaths at wrist; almost well when last seen, 3 months after accident
427	9	M	July 26	R	Fall on hand	Backwards	Also green-stick fracture of left forearm. — See No. 246	Do.	17 days	None	None	None	1 month	.....
428	1½	M	Aug 26	R	Twist of arm	None	.....	Do.	11 days	None	None	None	3 weeks	.....
429	14	M	Aug 27	R	Fall on hand?	None	.....	Do.	21 days	None	None	None	4 weeks	.....
430	8	M	Aug 28	L	Fall	None	.....	Do.	15 days	None	None	None	....	Last seen on day of removal of splints; apparently quite well
431	9	M	Sept 2	L	Fall on hand	Backwards	.....	Do.	15 days	None	None	None	....	Last seen on day of removal of splints; apparently quite well

432	2	M	Sept 9	R	Fall on hand	None	.....	Do.	18 days	None	None	None	....	Last seen on day of removal of splints; apparently quite well
433	12	M	Sept 18	L	Fall with arm under body	Backwards	.....	Do.	..	....	....	.....	....	Patient only seen twice afterwards
434	18	M	Oct 1	R	Blow on dorsum of hand	Backwards	.....	Do.	21 days	None	None	None	....	Effusion into flexor tendon - sheaths; slow in disappearing, but almost absorbed when patient last seen, 7 weeks after accident; it was unaccompanied by pain or tenderness
435	18	M	Oct 5	R	Fall	Backwards	.....	Do.	20 days	None	None	None	4 weeks	.....
436	13	M	Oct 21	L	Fall on hand, 8ft	Backwards	.....	Do.	18 days	None	None	None	4 weeks	.....
437	7	M	Nov 7	L	Fall on hand: probably on palm	Backwards; slight	.....	Do.	..	....	....	.....	....	Patient only seen twice afterwards
438	13	M	Nov 9	L	Fall on hand	Backwards—markedly; slightly outwards	Also separation of styloid process of ulna (?)	Do.	20 days	None	None	None	5 weeks	.....
439	16	M	Nov 12	R	Fall on hand	Backwards; slight	.....	Do	20 days	None	None	None	1 month	.....
440	14	M	1896 Jan 20	L	Hand forcibly twisted backwards	Backwards; slight	.....	Do.	21 days	None	None	None	4 weeks	.....
441	17	M	Feb 2	L	Fall on hand, (?) dorsum	None	.....	Do.	29 days	None	None	None	....	Patient not seen after day of removal of splints
442	17	M	Feb 6	R	Fall with arm unbody	None	.....	Do.	19 days	None	None	None	4 weeks	.....
443	15	M	Feb 22	R	Fall on palm of hand	None	.....	Do.	17 days	None	None	None	4 weeks	.....
444	8	M	Feb 23	R	Fall on hand	Backwards; slight	.....	Do.	21 days	None	None	None	4 weeks	.....

TABLE XXVII.—Separations of Lower Epiphysis of Radius—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed	Passive Movement.	Permanent Deformity.	Subsequent Stiffness of Wrist.	Period of Recovery.	Remarks on Result.
			1896.											
445	14	M	Mar. 13	R	Fall on hand	Backwards; slight	.....	Reduction of displacement; short anterior and long posterior splints	..	....	....	.....	....	Patient only seen once afterwards
446	15	M	Mar. 28	R	Fall on palm of hand	Backwards	.....	Do.	23 days	None	None	None	4 weeks	.....
447	14	M	May 3	L	Fall on hand	Backwards	.....	Do.	16 days	None	None	None	....	Patient not seen after day of removal of splints
448	16	M	May 8	?	Fall on back of hand	Backwards	.....	Do.	..	....	None	None	....	Patient next seen 6 weeks later; complete recovery
449	8	F	May 10	L	Fall on palm of hand	Backwards; slight	.....	Do.	16 days	None	None	None	3½ weeks	.....
450	5	M	June 15	R	Fall	Forwards	.....	Do.	18 days	None	None	Slight stiffness; disappeared in a week	4 weeks	.....
451	6	M	June 15	R	Fall	Backwards; slight	.....	Do.	22 days	None	None	None	4 weeks	.....
452	14	M	June 18	?	Fall on back of hand (?)	Backwards; slight	.....	Do.	19 days	None	None	Slight stiffness on removal of splints	....	Patient not seen after day of removal of splints
453	16	M	June 20	L	Fall on hand	Backwards	.....	Do.	20 days	None	None	Do.	....	Patient not seen after day of removal of splints
454	12	M	July 12	R	Fall on hand	Backwards	.....	Do.	22 days	None	None	None	....	Patient not seen after day of removal of splints
455	10	F	July 14	L	Fall on hand	Backwards	.....	Do.	21 days	None	None	None	4 weeks	.....
456	18	M	July 18	L	Fall with arm under body	Backwards	.....	Do.	20 days	None	None	None	....	Patient not seen after day of removal of splints
457	8	M	July 27	L	Fall on hand	Backwards	.....	Do.	22 days	None	None	None	4 weeks	.....

Age.—The epiphysis may be separated at any age up to the time of its junction with the diaphysis. Hutchinson[1] collected 54 cases, the ages of which varied from 3 to 20 years, the majority being over the age of 10. My own patients were from 16 months to 18 years old; two were under 5 years of age, nine between 5 and 10, thirteen between 10 and 15, and twelve between 15 and 18. It would thus appear that this accident is of infrequent occurrence during the first few years of life, and is most common after 10 years of age.

Sex.—Thirty-two of the patients were males and only four females.

Side of body affected.—Of 34 cases the right arm was broken in 18, and the left in 16.

Cause.—The cause of the accident was as follows:—

Falls on the hand (probably all on palm of hand)	20
Fall upon back of hand	1
Fall upon closed fist	1
Blow upon back of hand	1
Hand crushed in a machine (direct violence)	1
Twists of hand	2
Exact cause doubtful	10
	36

The great majority of the cases, as in cases of Colles' fracture, thus result from falls upon the palm of the hand. A few are due to direct violence. Muscular action alone probably cannot produce the injury, although it may help to maintain displacement which is already present.

Displacement.—The displacement of the separated epiphysis was—

Backwards	26
Backwards and outwards	1
Forwards	2
Displacement absent	7
	36

In none of the cases was the epiphysis completely dislocated from the end of the diaphysis. Complete displacement is uncommon, and can only take place when there is extensive laceration of the periosteum and other soft structures. Forward displacement is of much less frequent occurrence than backward displacement; it was met with in two cases only. In a fair number of the cases the epiphysis was in its normal position when the patient came for treatment, but could easily be pushed out of place by pressure in an antero-posterior direction. These cases are important, because the true nature of the injury is very liable to be overlooked, and because the accident may be followed by arrest of growth of the bone.

The accompanying skiagram (Fig. 20) was taken from a boy, aged 10 years, who had partial displacement backwards of the epiphysis. The deformity was unreduced owing to no medical man having been consulted until some months had elapsed from the time of the accident.

Pathological Anatomy.—Poland[2] has made an exhaustive examination of the available specimens of this injury. From his researches it would appear that in the majority of cases small portions of the diaphysis, most frequently from the posterior part of the bone, are separated with the epiphysis. Less frequently the separation follows the line of junction of diaphysis and epiphysis throughout. In a few cases separation takes place through the epiphysis itself.

Complications.—With the exception of accompanying separation of the ulnar epiphysis (the examples of which are included in a separate table) my cases showed no complications of any serious moment. Hutchinson[1], however, says that complications are of frequent occurrence, and enumerates the following:—

(1) Compound separation of the epiphysis—10 out of 54 cases.

(2) Interposition of tendons between the broken surfaces.

(3) Extensive extravasation of blood.

(4) Separation of the lower epiphysis of the ulna, or more frequently fracture of the shaft of the ulna, one inch from the lower end, or fracture of the styloid process of the ulna.

(5) Vertical fracture of the epiphysis—rare.

(6) Obstruction of the main arteries from pressure.

(7) Extensive detachment and separation of the periosteum from the front of the shaft of the radius.

Other complications which have been met with are dislocation of the lower end of the ulna, pressure upon the median or radial nerve, injury to the wrist-joint, and laceration of the pronator quadratus muscle (Poland).

Diagnosis.—The diagnosis of this injury is usually very easy. It is sometimes mistaken for Colles' fracture, but, although the latter injury may be met with before the age of 20 years, its occurrence is exceptional. The chief distinguishing features in cases of epiphysial separation are—(1) the age of the patient, (2) the character of the crepitus, (3) the acuteness with which the diaphysis projects forwards, when there is much displacement of the epiphysis, (4) the absence of obliquity of the hand, (5) the transverse direction of the sulcus above the dorsal prominence, (6) the ease with which reduction is effected in most cases, and (7) the very slight tendency to redisplacement of the epiphysis.

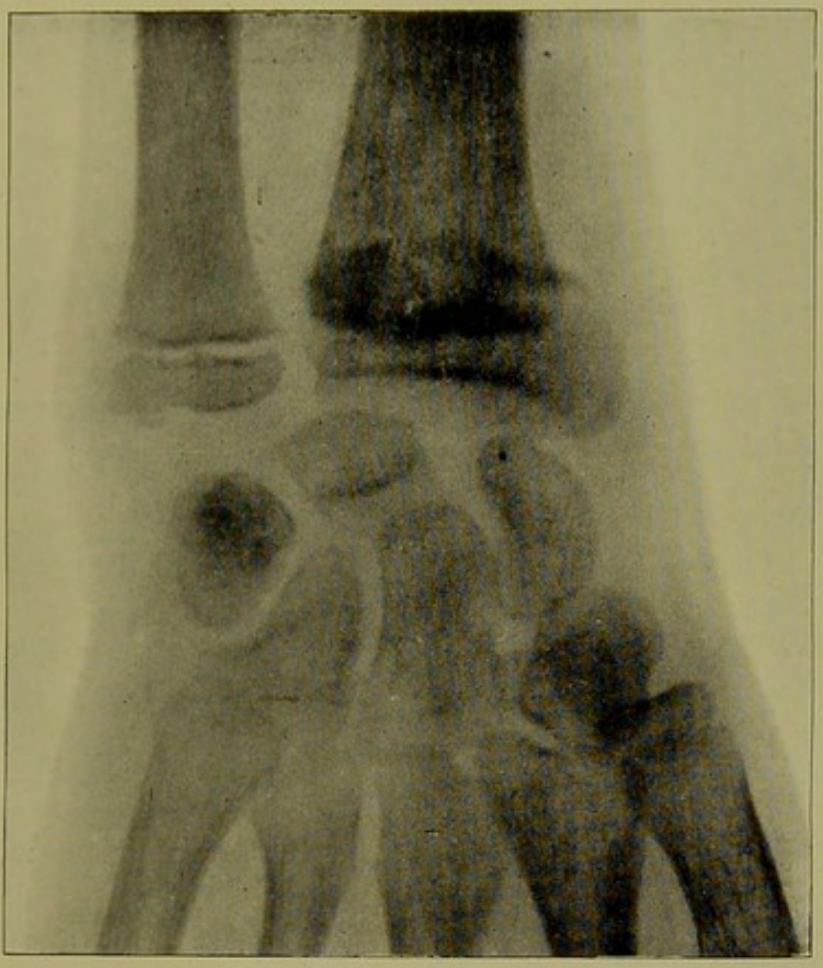

FIG. 20.

SEPARATION OF LOWER EPIPHYSIS OF RADIUS.

Patient a boy aged 10; left side; accident due to a fall upon the hand; no medical man was consulted until some months had elapsed. Epiphysis partially displaced backwards; ulna normal. (From a skiagram lent by Mr. G. A. Wright.)

Treatment.—Reduction of the displacement is easily accomplished by traction upon the hand, with pressure upon the projecting epiphysis. I have never seen a case of separation of the radial epiphysis alone which has presented any difficulty in the retention of the loose fragment in proper position. Anterior and posterior splints, the former reaching to the wrist and the latter to the back of the hand have been applied, and have been retained, as a rule, for a little under three weeks—the average of 32 cases was 19 days. Passive movement of the wrist was carried out in one case, and then only after the union of the fracture.

Results.—Three patients were lost sight of shortly after the occurrence of the accident; the remaining 33 cases all united readily without any permanent deformity. Twenty patients were kept under observation until they were quite well; the average time taken for complete recovery was one month. Eleven patients were last seen on the day the splints were removed—nine of them were apparently quite well; two had slight stiffness of the wrist.

Subsequent stiffness of the wrist-joint was present in four cases only; in one it disappeared within a week; in two it was slight, but the patients were not seen after the day of removal of the splints; in the fourth case it was rather more severe, and was slow in disappearing.

Effusion into the Sheaths of the Flexor Tendons occurred in two instances:—

(1) A case due to direct violence. There was some subsequent stiffness of the wrist, and the effusion was slow in being absorbed, but the patient was almost well when he was last seen, three months after the accident.

(2) A case due to a blow on the dorsum of the hand. The effusion was very marked, but was unaccompanied by pain or by stiffness of the wrist-joint. It had almost disappeared when the patient was last seen, seven weeks after the injury.

This complication was also present in one case of separation of the lower epiphyses of the radius and ulna (Case 459), and I have also noted its occurrence after Colles' fracture (Case 542).

Ankylosis of the Wrist-Joint is said to have been met with as a result of this accident.

Subsequent Arrest of Growth has been met with in a number of recorded cases, but, considering the frequency of the accident, it must be of very exceptional occurrence. Poland[3] gives a table of 18 cases and refers to several others. In some cases the resulting deformity has been very great, especially when the accident has taken place at an early age. Interference with the growth of the bone is most likely

to occur in cases where the displacement of the epiphysis is not fully reduced.

The accompanying skiagram (Fig. 21), which was lent to me by Mr. G. A. Wright, shows arrest of growth following separation of the lower radial epiphysis 3½ years before. The epiphysial cartilage of the radius has almost disappeared, whilst that of the ulna is intact. The lower end of the ulna is very prominent, and the hand is deflected to the radial side.

In young subjects, where growth is still active, excision of the epiphysial cartilage of the ulna may be performed for the relief of the deformity; in adults, a portion of the shaft of the ulna has been successfully removed.

SEPARATIONS OF THE LOWER EPIPHYSES OF THE RADIUS AND ULNA.

Six cases in which this accident was diagnosed are included in Table XXVIII.

The ages of the patients varied from 7 to 19 years. The causes of the injury were similar to those which produced separation of the radial epiphysis alone, but probably in most cases the violence was more severe.

The *Displacement* was as follows:—

Both epiphyses backwards	4
„ „ outwards and slightly backwards	1
No displacement, but epiphyses easily moved backwards	1
	6

In one case, due to a fall for a distance of 12 feet, the ulnar epiphysis was freely movable independently of the radial, and there was probably extensive rupture of the ligaments.

The *Treatment* of these cases presented much greater difficulties than the treatment of separation of the radial epiphysis alone. In three cases there was trouble from redisplacement of the fragments.

The *Results* were:—

Union in good position	2
„ with slight backward displacement of both epiphyses	2
„ with ulnar epiphysis displaced somewhat backwards and outwards	1
Patient lost sight of	1
	6

One patient had effusion into the neighbouring tendon-sheaths for some time afterwards, but absorption was complete at the end of two months. Considerable subsequent stiffness of the wrist-joint was present in the case where the ligaments were extensively torn, and was not much improved when the patient was last seen, two-and-a-half months after the injury.

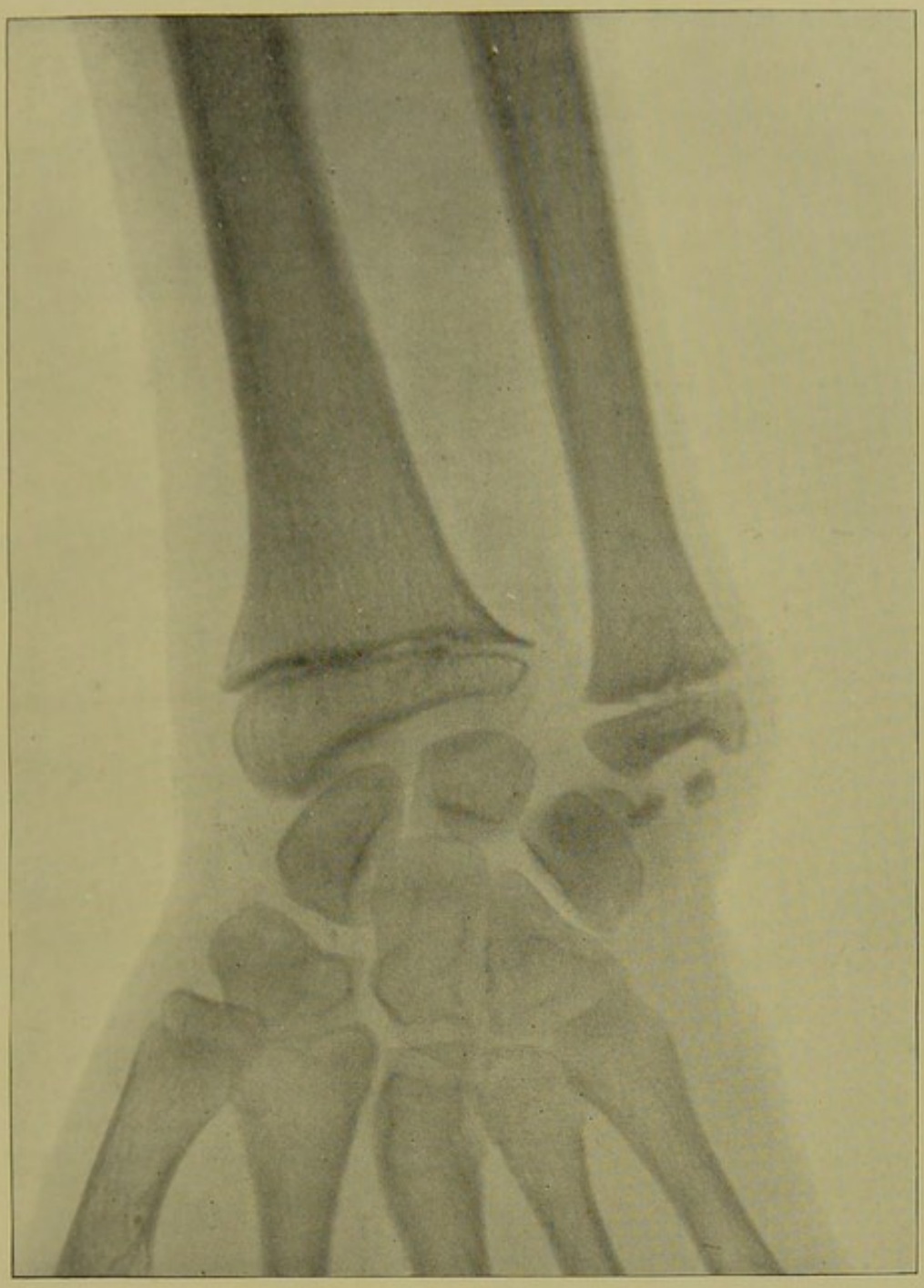

Fig. 21.

Arrest of Growth of Radius following Separation of the Lower Epiphysis.

Patient a boy, aged 12; accident 3½ years previously; ulnar growth unaffected; head of ulna very prominent and hand deflected to radial side. (From a skiagram lent by Mr. G. A. Wright.)

TABLE XXVIII.—Separations of Lower Epiphyses of Radius and Ulna.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Treatment.	How long fixed.	Passive Movement.	Permanent Deformity.	Subsequent Stiffness.	Period of Recovery.	Remarks on Result.
458	12	F	1895. June 3	L	Fall on palm of hand	Both epiphyses backwards	Reduction of displacement, short anterior and long posterior splints	25 days	None	None	None	1 month	.....
459	7	M	Sep 8	L	Fall with arm under body	Outwards and slightly backwards	Anterior and posterior splints; redisplacement reduced on Sep. 13	23 days	None	Ulnar epiphysis displaced somewhat backwards and outwards	None	2 months	Recovery delayed by effusion into tendon sheaths; all absorbed in 2 months
460	9	M	Oct 12	L	Fall on palm (?)	Backwards	Anterior and posterior splints	..	.....	.....	.....	..	Patient not seen again
461	8	F	1896. March 7	L	Fall on hand	Backwards	Anterior and posterior splints; attempt to prevent redisplacement by small pad over posterior surface only partially successful	33 days	None	Slight displacement backwards of both epiphyses	None	2 months	.....
462	19	M	April 7	L	Fall from height of 12 feet; position unknown	None, but both epiphyses easily displaced backwards, and ulna movable independently of radius	Anterior and posterior splints	24 days	None	None	Considerable stiffness of wrist, slow in disappearing	..	Stiffness of wrist not much improved when patient last seen 2½ months after accident
463	13	M	April 27	L	Fall on hand; distance of 14 feet	Backwards	Anterior and posterior splints; redisplacement reduced on following day	18 days	None	Very slight displacement backwards of both epiphyses	None	..	Except for displacement quite well 1 month after accident

SEPARATION OF THE LOWER EPIPHYSIS OF THE ULNA.

The lower epiphysis of the ulna is developed from a centre which makes its appearance in the 4th, 5th, or 6th year, and which joins the diaphysis at the age of 20. Occasionally an additional centre appears about the 12th year in the summit of the styloid process.

Separation of this epiphysis alone, without injury to the radius, is a very rare accident. It may occur, however, from direct violence. The following case came under my notice:—

Case 464.—Separation of Lower Epiphysis of Ulna.—W. J. S., aged 13, received, on November 26, 1895, a blow on the side of the left wrist with a piece of iron; the lower ulnar epiphysis was separated, and was displaced slightly forwards. It was easily reduced into position, and the hand and forearm were fixed on an anterior splint. At the end of 14 days the splint was removed; union had taken place in good position, and there was no stiffness of the wrist. A week later the patient was discharged, quite well. In January, 1899, he wrote to me, saying that he had had no bad effects as a result of the accident.

COLLES' FRACTURE.

This term is usually held to include transverse and oblique fractures of the lower extremity of the radius close to the wrist-joint. These fractures, which occur more frequently than any other variety of fracture, are almost invariably due to falls upon the palm of the hand, and are usually accompanied by backward displacement of the lower fragment. The exact position of the fracture has given rise to some discussion; Colles[4] himself supposed that it was always situated about 1½ inches from the wrist, but R. W. Smith,[5] from an anatomical examination of 20 specimens, found that its position was from ¼ to 1 inch from the joint. Dupuytren held very similar views. Hamilton[6] extends the term of fractures occurring within 1½ inches of the articulation. In analysing my own cases I have included under Colles' fracture only those in which the fracture was situated within one inch of the wrist. The cases altogether number 95, but seven of them, which were accompanied by fracture of the lower end of the ulna, I have classified in a separate table, and one in which the ordinary direction and displacement of the fracture were reversed, I shall describe independently. Details of the 87 typical cases are given in Table XXIX.

The chief points which are illustrated by the above series of cases are as follows:—

Sex.—Twenty-nine of the patients were males, and 59 females. The greater frequency of this accident in the female sex has often been pointed out, and it is chiefly in women advanced in life that this occurs. Amongst the youngest of my patients suffering from Colles' fracture there was a preponderance of males; in middle life

the proportion of males and females was almost equal; in advanced life the great majority were females.

Side of Body Affected.—This was recorded in 84 cases—right side 35, left 49.

Age.—The ages of the patients are shown in the following table:—

	Males.	Females.	Total.
Under 10 years of age	0	0	0
10 and under 20 years	8	1	9
20 „ 30 „	2	2	4
30 „ 40 „	5	7	12
40 „ 50 „	12	14	26
50 „ 60 „	1	17	18
60 „ 70 „	1	12	13
Over 70 years	0	5	5
	29	58	87

The greatest number were thus between the ages of 40 and 60. The oldest patient was aged 74, but amongst the cases of Colles' fracture, with fracture of the lower end of the ulna, was an old woman aged 84.

Nine patients were under 20 years of age, and these cases were all Colles' fractures, and not examples of separation of the epiphysis. The youngest patient was a youth, aged 15, with a fracture of the radius one inch from the lower end. Two cases were aged 16, two 17, three 18, and one 19 years.

Cause.—The cause of the injury was as follows:—

Falls upon the palm of the hand	33
„ „ „ „ (probably)	7
„ „ back „	4
„ „ „ „ (probably)	4
„ „ hand, front or back not stated	27
Direct violence to the wrist	2
Exact cause doubtful	10
	87

A very large proportion of these fractures thus result from falls upon the palm of the hand. In a few cases the cause would appear to be falls upon the back of the hand, and this is recognised by R. W. Smith[5], who says "Colles' fracture may be the result of a fall either upon the palmar or dorsal surface of the hand." The cases resulting from falls upon the back of the hand have been accompanied by the usual backward displacement of the lower fragment—in most cases not very marked. Hamilton[7] mentions a case of ordinary backward displacement due to a fall upon the back of the hand with the fingers closed.

TABLE XXIX.—COLLES' FRACTURES.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed	Passive Movement.	Permanent Deformity.	Subsequent Stiffness of Wrist.	Period of Recovery.	Remarks on Result.
			1895.											
465	46	M	May 23	L	Fall on palm (?)	Usual	Impacted	Reduction; short anterior and long posterior straight splints	..	.....	.....	.....	..	Patient only seen once
466	27	F	May 23	L	Fall on palm	Outwards; very slightly backwards	Impacted	Do.	22 days	None	None	Slight	..	Last seen when splints removed; good movement in wrist and fingers
467	34	M	June 2	L	Fall for 22 feet on palm	Usual	Not impacted	Do.	23 days	None	None	Slight	..	Last seen when splints removed; fair movement in wrist
468	60	F	June 8	L	Fall on hand	Usual	Also dislocation of shoulder on same side	Do.	20 days	Several times after removal of splints	None	Moderate	..	Last seen 8 weeks after injury; stiffness not quite disappeared
469	43	M	June 27	R	Fall on hand	Usual	Impacted	Do.	19 days	Twice after removal of splints	Very slight displacement back of lower fragment	Moderate	..	Last seen 4 weeks after injury; stiffness not quite gone
470	42	F	July 1	L	Fall with arm under body	Usual	.....	Do.	..	.....	.....	.....	..	Patient only seen twice
471	48	M	July 3	R	Fall on hand	Usual	.....	Do.	23 days	None	None	Slight	..	Last seen when splints removed
472	38	F	July 6	R	Kick on wrist	Usual	.....	Do.	20 days	None	None	?	..	Last seen when splints removed
473	50	F	July 7	?	Fall with arm under body	Usual	.....	Do.	..	.....	.....	.....	..	Patient not seen again

474	72	F	July 15	R	Fal on palm	Usual	Impacted	Do.	22 days	Once after removal of splints	None	Slight	..	Stiffness not quite gone when patient last seen, 4 weeks after accident
475	52	F	July 21	R	Fall down stairs with arm under body	None, but fragment easily pushed back	Not impacted	Do.	19 days	None	None	Slight; soon disappeared	8 weeks	.....
476	50	F	Aug 8	R	Fall on palm	Usual	Not impacted	Do.	20 days	None	None		..	Last seen when splints removed
477	46	F	Aug 11	R	Fall on hand	None	Not impacted	Do.	19 days	None	None	?	..	Last seen when splints removed
478	26	M	Aug 21	L	Fall on palm (?)	Slight or none	Not impacted	Do.	..	.....	.....	.....	..	Last seen 14 days after accident
479	41	M	Aug 22	R	Fall on palm	Usual	.....	Do.	19 days	None	None	None	4 weeks	.....
480	74	F	Aug 23	L	Fall on hand	Usual	Not impacted	Do.	21 days	None	None	Slight on removal of splints; disappeared in next 6 weeks	5 months	Patient complained of pain over styloid process of ulna, but this had disappeared five months after injury
481	62	F	Aug 24	L	Fall on hand	Usual (slight)	Not impacted	Do.	20 days	None	None	Slight	..	Last seen when splints removed
482	44	M	Aug 27	R	Fall on palm	Usual	Impacted	Do.	..	.....	.....	.....	..	Patient only seen twice afterwards
483	34	M	Sep 2	L	Fall on back of hand (?)	Usual (slight)	.....	Do.	22 days	Twice; after removal of splints	Styloid process of ulna rather prominent	Moderate	..	Stiffness not disappeared when last seen, 5 weeks after accident
484	67	F	Sep 5	R	Fall on hand	Usual	Impacted; much swelling	Reduction; short anterior and long posterior straight splints (deformity not properly reduced until Sep. 10)	19 days	None	None	Slight	..	Last seen when splints removed

TABLE XXIX.—COLLES' FRACTURES—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Permanent Deformity.	Subsequent Stiffness of Wrist.	Period of Recovery.	Remarks on Result.
485	44	F	1895 Sep 6	R	Fall on palm	Usual(slight)	.....	Reduction; short anterior and long posterior straight splints; Sep. 17, some redisplacement; splints reapplied with small pad over projection	25 days	None	None	Slight	..	Almost right when last seen, 11 weeks after accident
486	60	F	Sep 11	L	Fall with hand under body	Usual	.....	Reduction; short anterior and long posterior straight splints	..	.....	.....	.....	..	Patient only seen twice afterwards
487	69	F	Sep 13	R	Fall on palm	Usual	.....	Reduction; short anterior and long posterior splints	18 days	None	None	Slight	..	Almost well when last seen 6 weeks after accident
488	49	F	Sep 17	R	Fall on palm	Usual	.....	Do.	..	.....	.....	.....	..	Only seen once afterwards
489	73	F	Sep 20	L	Fall on palm	Usual	.....	Reduction; short anterior and long posterior splints; Sep 21, return of displacement and very great swelling; splints removed and evaporating lotion applied; displacement reduced under chloroform on Sep 28	..	.....	.....	.....	..	Patient last seen on Oct. 3
490	42	M	Sep 22	L	Fall on hand	Usual	Not impacted	Reduction; short anterior and long posterior splints	16 days	None	None	?	..	Last seen when splints removed

491	39	M	Sep 27	R	Fall on palm	Usual	.....	Reduction; short anterior and long posterior splints; redisplacement rectified Oct 1	18 days	Once, after removal of splints	None	Moderate	..	Stiffness improving when last seen, 5½ weeks after accident
492	44	M	Oct 5	R	Fall on palm	Usual	.....	Reduction; short anterior and long posterior splints	..	.....	.....	.....	..	Last seen 6 days after accident
493	33	F	Oct 6	L	Fall on palm	Usual	Not impacted	Do.	19 days	None	None	Not much stiffness when splints removed, but wrist became swollen, painful, and stiff afterwards	..	Last seen on Nov. 5, not much improved
494	39	M	Oct 8	L	Fall on palm	Usual	Not impacted	Do.	..	.....	.....	.....	..	Patient not seen again
495	42	F	Oct 12	L	Fall on palm?	Usual	Impacted	Do.	20 days	None	None	Moderate	..	Last seen when splints removed
496	69	F	Oct 16	L	Fall on hand	Usual	Not impacted	Reduction; short anterior and long posterior splints; displacement not properly reduced when first seen; attempt to reduce on Oct 22	29 days	None	Some displacement of hand to radial side	Moderate; slow in disappearing	..	Stiffness not quite gone when patient last seen, 3 months after accident
497	68	F	Oct 17	L	Fall	Usual	.....	Reduction; short anterior and long posterior splints	..	.....	.....	.....	..	Not seen again
498	44	F	Oct 20	L	Fall on back of hand	Usual (slight)	.....	Do.	30 days	None	None	Slight	..	Last seen when splints removed
499	39	F	Oct 21	L	Fall on hand	Usual	.....	Do.	32 days	Fingers moved on Nov 15, and twice after removal of splints	None	Considerable (fingers and wrist), slow in disappearing	4½ months	.....

TABLE XXIX.—COLLES' FRACTURES—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Permanent Deformity.	Subsequent Stiffness of Wrist.	Period of Recovery.	Remarks on Result.
500	52	F	1895 Oct 22	L	Fall on hand	Usual	Impacted	Reduction; short anterior and long posterior splints; tendency to redisplacement counteracted by small pad between fragment and posterior splint	28 days	None	None	Slight, but slow in disappearing	4 months	.....
501	19	M	Oct 23	R	Fall on hand	Usual	Impacted	Reduction; short anterior and long posterior splints	27 days	None	None	None	6 weeks	.....
502	54	F	Nov 2	L	Fall on palm	Usual(slight)	.....	Do.	27 days	None	None	Slight; gradually disappeared	About 3 months	.....
503	65	F	Nov 4	L	Fall on hand	Usual	Not impacted	Reduction; short anterior and long posterior splints (splints removed early because skin very irritable and several blisters formed)	15 days	None	None	Considerable; wrist and fingers	..	Stiffness improving when last seen, 1 month after accident
504	66	F	Nov 9	L	Fall on hand	Usual	.....	Reduction; short anterior and long posterior splints; tendency to redisplacement prevented by small pad over lower fragment	27 days	None	None	Moderate: wrist and fingers	..	Improving when last seen, 4 months after accident

505	48	F	Nov 18	L	Fall on hand	Usual	.....	Reduction; short anterior and long posterior splints	29 days	None	None	Slight, but slow in disappearing	..	Almost well when last seen, 3 months after injury
506	74	F	Dec 15	R	Fall on palm	None	Not impacted	Do.	23 days	None	None	Slight; gradually improved	2 months	.....
507	18	M	Dec 18	R	Fall on palm	Usual	Not impacted	Do	..	.....	.....	.....	..	Not seen again
508	54	F	Dec 19	L	Fall on hand	Usual	.....	Do.	26 days	None	None	Slight	..	Stiffness not quite gone when last seen, 6 weeks after accident
509	52	F	Dec 24	R	Fall—probably on palm	Usual	Not impacted	Do.	21 days	None	None	Moderate; gradually improved	3 months	.....
510	18	M	Dec 26	R	Fall on palm	Usual	Not impacted	Do.	15 days	None	None	None	4 weeks	.....
511	57	F	Dec 27	L	Fall on back of hand	Usual	. ....	Do.	18 days	None	None	Very slight	..	Almost well when last seen, 4 weeks after injury
512	36	F	Dec 31	R	Fall on palm	Usual	Not impacted	Do.	15 days	None	None	Slight	..	Almost well when last seen, 5½ weeks after injury
513	60	F	1896 Jan 8	L	Fall on hand	Usual	.....	Do.	..	.....	.....	.....	..	Not seen again
514	57	F	Jan 17	R	Fall on hand	Usual	.....	Do.	21 days	None	None	?	..	Last seen when splints removed
515	64	F	Feb 12	L	Fall on palm	Usual	Not impacted	Do.	20 days	None	Slight displacement backwards of lower fragm'nt	Considerable; very slow in disappearing	7 months	.....
516	15	M	Feb 12	L	Fall on hand	Usual	Fracture 1 inch from lower end	Do.	20 days	None	None	None	..	Last seen when splints removed
517	34	F	Feb 12	R	Fall on palm	Usual	.....	Do.	20 days	None	None	Slight; soon disappeared	2 months	.....
518	43	F	Feb 15	L	Fall on hand	Usual	.....	Do.	20 days	None	None	Moderate	..	Last seen when splints removed

TABLE XXIX.—COLLES' FRACTURES—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement	Remarks.	Treatment.	How long fixed.	Passive Movement.	Permanent Deformity.	Subsequent Stiffness of Wrist.	Period of Recovery.	Remarks on Result.
			1896.											
519	16	M	Feb 15	R	Fall on palm	Usual	.....	Reduction; short anterior and long posterior splints	20 days	None	None	None	4 weeks	.....
520	45	F	Feb 19	R	Fall on palm	Usual	Comminuted; not impacted	Reduction; short anterior and long posterior splints; tendency to re-displacement, counteracted by small pad over lower fragment	27 days	None	None	Moderate	..	Last seen when splints removed
521	52	F	Feb 22	R	Fall on palm	Usual	.....	Reduction; short anterior and long posterior splints	20 days	None	Slight displacement backwards of lower fragm'nt	Moderate	..	Last seen 4½ weeks after injury; stiffness not much improved
522	18	M	March 5	R	Fall on palm	Usual	Impacted	Do.	22 days	None	None	None	4 weeks	.....
523	17	M	March 6	R	Direct violence	Usual	.....	Do.	21 days	None	None	None	4 weeks	.....
524	45	F	March 18	L	Fall on hand	Usual	Impacted	Do.	..	.....	.....	.....	..	Not seen again
525	59	F	March 18	R	Fall on palm (?)	Usual	Not impacted	Reduction; short anterior and long posterior splints; tendency to re-displacement, counteracted by small pad of lint over back of lower fragment	20 days	None	None	Moderate	..	Stiffness improving when last seen, 4 weeks after accident

526	17	F	March 18	L	Fall on palm	Usual	..	Reduction; short anterior and long posterior splints; great tendency to return of displacement	27 days	None	Slight displacement back of lower fragm'nt	Slight	..	Stiffness almost gone when last seen, 8 weeks after accident
527	70	F	March 19	L	Fall	Usual	..	Reduction; short anterior and long posterior splints	26 days	None	None	Slight; gradually improved	..	Considerable subsequent trouble from swelling of fingers
528	65	F	March 25	?	Fall	Usual	..	Do.	..	..	..	..	..	Not seen again
529	52	F	April 5	L	Fall	Usual	Not impacted	Reduction; short anterior and long posterior splints; tendency to redisplacement counteracted by small pad over lower fragment	20 days	None	None	Slight	..	Last seen when splints removed
530	50	F	April 15	R	Fall	Usual	..	Reduction; anterior and posterior splints	16 days	None	?	Considerable	..	Much swelling of fingers, caused by tight application of splints; stiffness and swelling not much improved when last seen, 6 weeks after accident
531	32	F	April 17	R	Fall	Usual	Impacted	Do.	18 days	None	None	Slight	..	Almost well when last seen, 25 days after injury
532	45	F	May 2	L	Fall on back of hand (?)	Usual	Not impacted	Do.	20 days	None	None	Moderate; gradually disappeared	4 months	..
533	50	F	May 11	L	Fall on palm	Usual	Not impacted	Do.	..	..	..	..	..	Afterwards attended by own medical man; result good
534	44	M	May 20	L	Fall on palm	Usual	Not impacted	Do.	20 days	None	None	Considerable; rapidly disappeared	2 months	..

TABLE XXIX.—COLLES' FRACTURES—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Permanent Deformity.	Subsequent Stiffness of Wrist.	Period of Recovery.	Remarks on Result.
535	45	M	1896. May 26	R	Fall on hand	Usual	..	Reduction; anterior and posterior splints	24 days	None	None	Slight	..	Nearly well when last seen, 7 weeks after accident
536	47	M	June 2	L	Fall on palm	Usual	Not impacted	Do.	21 days	None	None	Slight	..	Nearly well when last seen, 5½ weeks after accident
537	38	M	June 5	L	Fall on hand	Usual	..	Reduction; anterior and posterior splints; June 12, redisplacement; pad of wool under back of hand flexing wrist somewhat	18 days	None	Slight displacement backwards of lower fragm'nt	Moderate	..	Last seen when splints removed
538	50	M	June 7	L	Fall on back of hand (?)	Usual	Not impacted	Reduction; anterior and posterior splints	21 days	None	None	Moderate	..	Patient only seen once after removal of splints
539	50	F	June 7	L	Fall on hand	Usual	Not impacted	Do.	..	–	–	–	..	Only seen once afterwards
540	47	F	June 11	L	Fall on palm	Usual	Impacted	Do.	22 days	None	None	Slight	..	Stiffness improved when last seen, 5½ weeks after accident
541	65	M	June 16	L	Fall on palm	Usual (slight)	Also sprain of right wrist	Do.	14 days	None	None	Slight	..	Trouble from swelling of fingers and hand after removal of splints; stiffness almost gone when last seen, 5 weeks after accident

542	49	F	June 18	L	Fall on hand	Usual	Comminuted (?)	Do.	22 days	None	Slight displacement of lower fragm'nt to radial side	Moderate; slow in disappearing, but improving when last seen	..	Some effusion into flexor-tendon sheaths; slow in being absorbed; patient last seen 10 weeks after accident
543	51	F	June 25	L	Fall on back of hand	Usual (slight)	..	Do.	19 days	None	None	Slight	..	Last seen when splints removed
544	56	F	July 4	R	Fall on palm	Usual	Impacted	Do.	24 days	None	None	Moderate	..	Improving when last seen, 5 weeks after accident
545	28	F	July 7	L	Fall on palm	Usual	..	Do.	21 days	None	None	None	4 weeks	..
546	46	F	July 12	L	Fall on palm	Usual	Not impacted	Do.	19 days	None	None	Slight	..	Improving when last seen, 4 weeks after accident
547	16	M	July 15	R	Fall on hand	Usual	Impacted	Do.	20 days	None	None	Slight	..	Stiffness almost gone when last seen, 5 weeks after accident
548	40	M	July 20	L	Fall on back of hand	Usual	Not impacted	Do.	22 days	None	Some displacement back of lower fragm'nt	Considerable	..	Stiffness much improved when last seen, 2 months after accident
549	20	M	Aug 1	?	Fall on hand from bicycle	Usual	..	Do.	..	..	..	..	..	Patient not seen again
550	36	F	Aug 5	L	Fall on palm	Usual	Not impacted	Do.	20 days	None	None	Very slight	..	Almost well when last seen, 4 weeks after accident
551	24	M	1895 June 7	R	Fall on back of hand, the wrist being flexed	None	..	Do.	21 days	Once; on removal of splints	None	Very slight	..	Last seen when splints removed

Situation and Direction of the Fracture.—R. W. Smith[5], from an examination of 20 specimens, came to the conclusion that the seat of the fracture varies from ¼ to 1 inch from the wrist-joint. Gordon[8], after an examination of 27 old specimens, stated that the line of fracture posteriorly varied from ⅜ to 1¾ inches, and anteriorly from ⅜ to 2 inches from the articulation. Smith and also Voillemier[9] are of opinion that the direction of the fracture is usually transverse from before backwards, although they admit that there may be a certain amount of obliquity from side to side. On the contrary, most observers, including Gordon, say that there is in the majority of cases a certain amount of obliquity from before backwards and upwards. The latter opinion is the one generally accepted. Hamilton[10] and Pickering Pick[11] found that the line of fracture was markedly oblique in an antero-posterior direction in a number of specimens which they examined.

Displacement.—The displacement of the lower fragment, which gives rise to the typical "silver-fork" deformity, is best described, I think, by a modification of Mr. Pickering Pick's description:—

(1) The lower fragment is carried backwards.

(2) It is also carried somewhat upwards.

(3) In many cases there is also more or less outward displacement.

(4) It is rotated backwards on a transverse axis passing through the upper end of the fragment.

(5) It is also partially rotated upwards through a segment of a circle, the centre of which is the radio-ulnar joint and the radius a line from that joint to the styloid process of the radius.

The lower fragment is seldom displaced sufficiently far back to escape entirely from the upper; in the rare cases where it does so, there is usually extensive rupture of the lower radio-ulnar ligaments.

Amongst my own cases, 83 presented the above displacement more or less well marked. In some the lower fragment was only slightly displaced backwards, whilst in others the deformity was very marked. The outward displacement was subject to much more variation; in some cases it was absent, in most it was present, in a few it was very marked. One case (No. 466) presented well-marked outward, but very little backward displacement.

In four patients the lower fragment was not displaced when the patient came under observation, but in all it could easily be pushed backwards, thus giving rise to a more or less typical deformity.

The primary cause of the displacement is now usually admitted to be the force of the injury. R. W. Smith[5], however, thought that it was due to muscular action, and Clement Lucas[12] considers that the extensor muscles play an important part in maintaining the displacement and in reproducing it, after it has once been reduced.

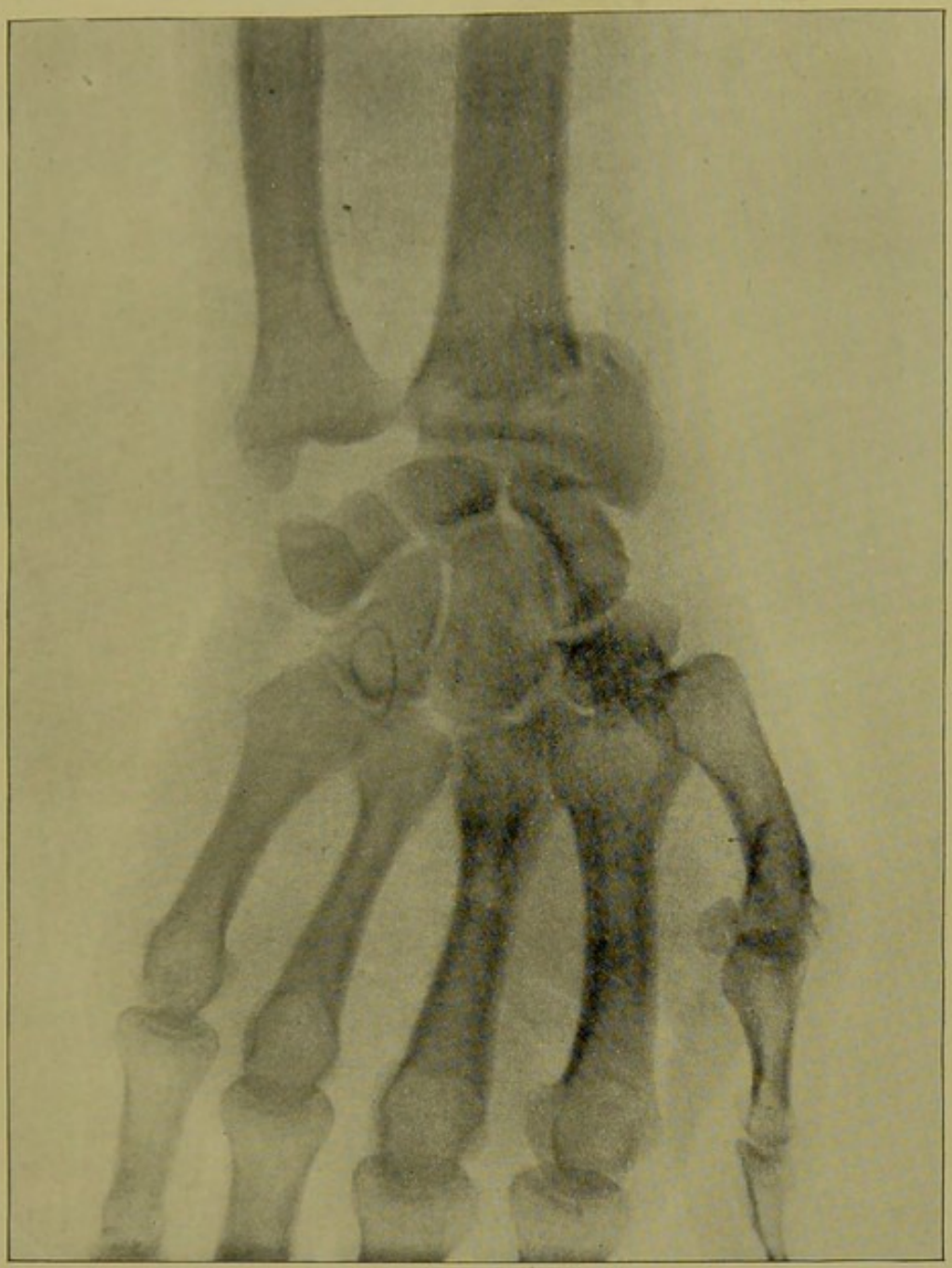

FIG. 22.

COLLES' FRACTURE.

Left side; lower fragment displaced backwards and outwards; ulna normal. (From a skiagram lent by Mr. G. A. Wright.)

The accompanying skiagram (Fig. 22) was taken from a case of Colles' fracture with typical deformity. The lower fragment is displaced markedly backwards and outwards. The ulnar styloid process is normal.

Impaction of the Fragments.—Voillemeir[9] was the first to advance the view that impaction almost always takes place in these fractures, but his statements were denied by R. W. Smith[5]. More recently Callender[13] has upheld the view that impaction generally occurs, and Hamilton[14] states that posterior impaction is quite common. I have a note upon this point in 44 cases; of these 15 were impacted and 29 not impacted.

Comminution of the lower fragment is said by many observers to be of very common occurrence—more than one half the cases (D'Arcy Power[15]). Amongst my own cases it was noted in two only (one of which was doubtful), but it is not improbable that it was not recognised in many cases. Power states that comminution frequently cannot be recognised until the parts are dissected.

Complications.—One case (No. 468) had a dislocation of the shoulder on the same side; another (No. 541) had a sprain of the other wrist.

Laceration of the Ligaments of the Wrist-Joints, especially of the internal lateral ligament, is present in many cases of Colles' fracture. In a large number of specimens examined by dissection the triangular fibro-cartilage has also been ruptured.

Fracture of the Lower End of the Ulna was present in seven of my cases, but these are included in a separate table. I shall also defer for the present the consideration of co-existing fracture of the ulnar styloid process.

Fracture of the Styloid Process of the Radius was present in two cases mentioned by Hamilton[16]. I have not met with this complication in Colles' fracture, but I have seen it in a case of Barton's fracture, and also in a case where the anterior border of the articular surface of the radius was detached.

Dislocation of the Lower End of the Ulna with Colles' Fracture.—Professor Moore[17], of Rochester, has shown that in some cases the internal lateral ligament of the wrist and the triangular fibro-cartilage are torn, and the lower end of the ulna is thrust through or under the anterior annular ligament, and that in these cases the radius cannot be reduced until the ulna is released. He described a special method of reduction by extension and circumduction.

TREATMENT OF COLLES' FRACTURE.

Reduction of the Displacement.—Too much stress cannot be laid upon the importance of thorough reduction of the deformity in the

initial stages of the treatment of Colles' fracture. Without complete reduction we cannot hope to have good results, and I have noticed on several occasions that cases with some permanent deformity have a protracted stage of convalescence, being very apt to suffer from excessive stiffness of the wrist-joint and pain, especially in the neighbourhood of the styloid process of the ulna. When the fragments are impacted, it is necessary to use a very considerable degree of force in the reduction, and it may be advisable in many cases to administer an anæsthetic. In carrying out the necessary manipulations, it is most convenient to use the knee as a fulcrum in the manner recommended by Professor MacLeod. I have first reduced the backward displacement by forcibly flexing the patient's wrist over the front of the knee, and have afterwards corrected the deviation of the hand to the radial side by producing ulnar flexion over the lower part of the thigh. If necessary, these manipulations must be repeated until the deformity is entirely corrected. It is important that both the antero-posterior and the lateral (if any) deviation of the fragment receive attention.

Splints.—For some time past I have invariably used two straight splints for the treatment of this fracture, an anterior splint reaching from below the bend of the elbow to the front of the wrist, and a posterior splint reaching to the knuckles. All the cases included in the above table were treated in this way. In some of my earlier cases—before I commenced to keep these records—I used pistol-shaped splints, but I failed to find any particular advantage in them. I have had no experience of the special splints recommended by Gordon, Carr, Hewit, and others, but am inclined to think that the majority of these special supports are wrong in principle, and that the permanent deformities which they were devised to prevent, were really due to the displacement not having been properly remedied in the first instance. Unless the displacement be fully reduced when the patient is first seen, no form of splint will give good results. Taking my own cases, I was able to record the manner of union in 68. Of these 59 united with the fragments in good position; 9 united with some deformity—in no case very marked—but in 6 of this number, either owing to swelling or other reason, the presence of displacement was overlooked during the subsequent visits until the fracture had united. Leaving out of consideration these cases, we find that 59 out of 62 cases treated by straight splints united without deformity.*

* In a few cases, as will be mentioned later, the splints were supplemented by small pads over the displaced fragments.

In the choice and the application of the splints, the following points should receive attention:—*

(1) They must not be too broad. All that is necessary is to have them a little broader than the forearm at the wrist. One frequently reads directions that the splints should be of such a width that the strapping at no point comes in contact with the skin of the forearm. As a result of this, and as the splints are usually made of the same width throughout, one finds not infrequently an arm fixed in splints which are nearly one and a half times as broad as the forearm at the wrist, and thus lateral deviation of the fragments is not prevented. It matters little if the strapping touch the skin in the upper part of the forearm, provided that it be not applied too tightly.

(2) The anterior splint must not be too long. It should not reach the thenar and hypothenar eminences; otherwise the wrist, which has a smaller antero-posterior diameter than the proximal part of the hand, is not properly supported, and tends to sink downwards between the splints.

(3) In applying the splints care must be taken to keep them in parallel planes. If the splints are too broad, I have often found that their upper borders tend to become approximated, whilst the lower borders are widely separated, or *vice versâ*.

(4) It is best to fix first the upper parts of the splints, the surgeon holding them in contact with the arm with a sufficient amount of pressure, whilst an assistant applies a narrow band of strapping a little way below the elbow. Afterwards the surgeon makes extension upon the hand, and then puts the lower parts of the splints into position, whilst a second piece of strapping is applied at the wrist. The strapping is afterwards taken over the back of the posterior splint and then across the palm of the hand. In doing this, care is necessary to avoid too much pressure, and further (1) the strapping should not confine the metacarpo-phalangeal joints, and (2) it must not press in the interval between the thumb and the base of the forefinger. Neglect of the former precaution will lead to interference with the movements of the fingers, and of the latter to pain and swelling.

(5) The fingers should be left entirely free, so that the patient may move them from the first; by this precaution the amount of subsequent stiffness will be greatly diminished.

I have described the application of the splints at some length, because I am convinced that it is attention to such details which largely influences the results of the treatment.

* These remarks also apply to a great extent to the choice and application of splints for fractures of the shafts of the radius and ulna.

During the *After-Treatment* the splints should be removed from time to time in order that any redisplacement may be recognised, and means taken for its correction. In forming an estimate of the position of the fragments, it is important that the wrist be looked at, not only from the side, but also from the front or the back, in order that any lateral deviation will be noticed. Any swelling of the fingers or hand from undue pressure must be at once corrected. The patient should be encouraged to move the fingers freely.

Redisplacement in six of my cases was treated by again reducing the deformity, and by reapplying the splints with a small pad of lint between the posterior splint and the lower fragment; all these cases united without permanent deformity. In one case I placed a pad of wool between the posterior splint and the back of the hand so as to produce flexion of the wrist, but this did not act successfully. In six of the nine cases which united with some deformity, the presence of redisplacement was overlooked until the fracture had united.

Removal of the Splints.—The splints, as a rule, have been discarded at the end of three weeks—average of 69 cases. At one time I tried removal of the splints at the end of a fortnight, but I formed the opinion that many of these cases, although there was not much stiffness of the wrist at the time the splints were removed, became more stiff subsequently, and I came to the conclusion that union is not sufficiently firm at the end of 14 days to permit of the removal of all supports.

Passive Movement of the Wrist during the earlier stages of the treatment is, in my opinion, unnecessary. I tried this method of treatment in many cases which were under my care before I commenced to keep these records, and came to the conclusion that it does not hasten recovery. If the fingers be left free from the first, there is seldom much subsequent interference with their use, and if the patient will practise active movements after the removal of the splints, the stiffness of the wrist, as a rule, soon begins to disappear. Friction with liniment hastens the restoration of the wrist-movement. Amongst the above tabulated cases passive movement of the wrist was carried out in 6 cases only, and then only after the fracture had united.

During recent years a large number of writers have recommended that early massage be adopted as a part of the treatment of Colles' fracture.

Results.—The results in the 87 cases were as follows:—

Patients lost sight of soon after accident	18
Union without deformity	59
„ with some displacement backwards of lower fragment	6
„ „ „ outwards „	3
Position of fragments not recorded	1
	87

Eighteen patients remained under observation until they were quite well, the average period of recovery being 2½ months. Amongst these 18 cases I have only included those in which there was complete restoration of the movements of the wrist and fingers, but a large number of other cases had almost recovered when I last saw them. Sixteen patients were last seen on the day the splints were removed.

The *Stiffness of the Wrist-joint* at the time the splints were removed was recorded as follows:—

None	8
Very slight	3
Slight	29
Moderate	18
Considerable	6
	64

In five cases no note was taken upon this point.

Forty-two of these patients still had some stiffness when they were last seen, but very few of them attended for any long period, and many of them had almost recovered at the time of their last visits.*

Effusion into the Flexor Tendon-Sheaths was noted in Case 542. This complication is said by Hamilton[18] to be not infrequent, and to occur most often and to continue for the longest period in old and feeble persons. I have already referred to a similar complication after separation of the lower radial epiphysis.

Persistent Pain in the neighbourhood of the Styloid Process of the Ulna occurred in several cases, especially in those accompanied by some permanent displacement. Pain in this situation is not an infrequent symptom soon after the occurrence of the accident, and is said by R. W. Smith[5] to be due to stretching of the internal lateral ligament of the wrist. Clement Lucas[12], however, has shown that the pain is frequently due to direct pressure upon the dorsal branch of the ulnar nerve, which is stretched over the projecting lower end of the ulna.

DOUBLE COLLES' FRACTURE.

This is not of common occurrence. One case came under my care about 5 years ago, but as I did not take notes at the time I cannot give details. The nearest approach to this accident that has recently come under my notice was a man, aged 34, who was admitted

*In looking over my records, I find that 16 patients (including 5 in whom no note was taken about the stiffness of the wrist) were last seen when the splints were removed; 16 were last seen within one month of the accident, 16 between one and two months, 4 between two and three months, and 1 four months afterwards. From this it will be seen that only 5 of these patients attended for a period equal to the average period of recovery in these cases.

as an in-patient on April 16th, 1896. He had fallen from a crane for a distance of 12 or 13 feet, and his head and hands came in contact with some stones. He was unconscious at the time of his admission, owing to concussion of the brain. The radius and ulna of both arms were fractured about 1½ inches above the wrist, and the lower fragments in each case were displaced backwards. As I have limited the term Colles' fracture to fractures within one inch of the wrist-joint, I have classified this case amongst fractures of the shafts of the bones.

A patient (Case 394) who came under treatment with recent fracture of the radius, presented deformity of both wrists, due to double Colles' fracture four years before.

COLLES' FRACTURE WITH REVERSED DISPLACEMENT.

From time to time examples of this accident, which is sometimes called Smith's fracture, have been recorded, and there are few surgeons who have not seen one or more cases. R. W. Smith[19] described and figured one such case. Hamilton[20] mentions another, and says that he has been able to produce a similar condition by forced palmar flexion in the cadaver. Two cases have come under my notice.

Case 552.—M. K., a woman, aged 48, came to hospital on September 28th, 1895, with an injury to the left wrist, caused by a fall upon the back of the hand. The radius was broken obliquely from behind, forwards and upwards ; so far as could be diagnosed, the lower fragment was half-an-inch long posteriorly and one inch in front. It was displaced somewhat forwards, and the lower end of the ulna was consequently more prominent than normal. The fracture was not impacted, and the deformity was easily reduced. Anterior and posterior splints, as used in the treatment of ordinary Colles' fracture, were applied. They were removed at the end of 20 days ; union had then taken place in good position, and there was not much stiffness of the wrist. Ten days later the stiffness had entirely disappeared, and the patient was quite well.

Another case in a woman, aged 61, and also due to a fall upon the back of the hand, came under my notice on January 15th, 1895, but I have no notes of the subsequent progress of the patient.

R. W. Smith, in speaking of these cases, says that the fracture is situated from half to one inch above the articulation, and that the condition is apt to be mistaken for forward dislocation of the wrist-joint. It must not be forgotten that an ordinary Colles' fracture, with backward displacement, results in some cases from a fall upon the back of the hand.

Clement Lucas has recorded a case of compound Colles' fracture, due to a fall upon the palm of the hand, in which the lower fragment was displaced forwards.

This fracture has recently been the subject of an elaborate and exhaustive investigation by J. B. Roberts[21]. He considers that it is

not of very rare occurrence, for he has met with four cases during a few years. From experiments upon the dead body and from an examination of museum specimens he has come to the conclusion that the mechanism of the fracture is as follows: (1) Extreme flexion of the wrist from force applied to the back of the hand; (2) crushing of the cancellous tissue on the front of the radius; and (3) rupture of the bony tissue at its weakest point from decomposition of the force to which the limb is subjected.

COLLES' FRACTURE WITH FRACTURE OF THE LOWER END OF THE ULNA.

Fracture of the styloid process of the ulna and rupture of the triangular fibro-cartilage have been stated by several observers to be very frequent concomitants of Colles' fracture (Nélaton, Cameron, Clement Lucas, and others). Clement Lucas[19] says that the process was detached in 17 out of 31 specimens which he examined.

A great amount of interest has been taken in this subject since the advent of Röntgen photography, and the general opinion of writers is that fracture of the ulnar styloid process is of very common occurrence in cases of Colles' fracture. Lynn Thomas[22] has figured two skiagrams, both showing this complication, and says that he has noted its presence in four out of five cases. Conant[23] has found it in nearly every case which he has skiagraphed. Beck[24] says that, out of 44 cases of Colles' fracture which he submitted to this method of examination, there was fracture of the ulnar styloid process in seven, whilst 19 others showed a distinct transverse fissure above the head of the ulna. Of the skiagrams which I have examined myself, this complication has been present in many instances, but by no means in all.

One writer has compared Colles' fracture to Pott's fracture at the ankle, and has said that, as the latter injury is accompanied by fracture of the internal malleolus or rupture of the internal lateral ligament of the ankle-joint, so the former is accompanied by fracture of the styloid process of the ulna or rupture of the internal lateral ligament of the wrist-joint.

Amongst my own cases of Colles' fracture separation of the ulnar styloid process was only definitely recognised once; but many cases were doubtless overlooked, for it has not been my rule to examine specially with regard to this point. Moreover, it is often impossible to recognise this complication by examination through the unbroken skin.

Fracture of the head of the ulna or of the lower part of the shaft of the bone is more easily recognised and is more important, since it leads in many cases to very great difficulty in the retention of the

fragments in proper position. I am of opinion that the non-recognition of this complication is a frequent cause of mal-union after these fractures.

The seven cases of Colles' fracture, in which accompanying fracture of the lower end of the ulna was diagnosed, are included in Table XXX.

It is necessary to mention that the following four cases, which would be classified by some as Colles' fracture, have already been described amongst fractures of the shafts of the radius and ulna (Table XXIII.).

Case 326.—Radius fractured 1 inch and ulna 2 inches from wrist.

Case 344.—Radius fractured 1½ inches and ulna 1 inch from wrist.

Cases 339 and 346.—Both bones fractured 1½ inches from wrist.

Taking the cases in the table we find that the situation of the fracture of the ulna was as follows:—

Styloid process separated	1
Head of ulna separated	1
Fracture one inch from lower end	4
Exact position of fracture not determined	1

Age.—The ages of the patients varied from 16 to 84 years.

Cause.—In several cases the fracture was caused by the application of very severe force. It was due to falls upon the palm of the hand in five cases, to a fall with the hand under the body in one, and to a direct crush by a heavy weight in one.

Displacement.—The manner of displacement was backwards in three cases, and backwards and outwards in four. Impaction was noted in two of the cases.

Results.—The results were—

Union without deformity	1
Union with more or less backward displacement	4
Patients lost sight of	2

The subsequent stiffness of the wrist-joint was very considerable in two cases, moderate in amount in one, and slight in two.

BARTON'S FRACTURE.

J. Rhea Barton[25] has described a form of fracture extending very obliquely from the articular surface of the lower end of the radius upwards and backwards, thus separating and displacing the whole or a part of the posterior margin of the articular surface. The accident is usually accompanied by luxation of the wrist. Barton was not able to confirm his diagnosis by dissection, but Voillemier[26] quotes a case in which Lenoir found this fracture by post-mortem examination. Hamilton has produced the fracture several times in the

TABLE XXX.—COLLES' FRACTURES, WITH FRACTURES OF LOWER END OF ULNA.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Displacement.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Permanent Deformity.	Subsequent Stiffness of Wrist.	Remarks on Result.
553	40	M	1895. June 7	L	Fall on palm of extended hand	Backwards; slight deflection to radial side	Head of ulna broken off; old fracture of same radius 3ins. from wrist	Reduction: short anterior and long posterior splints; displacement not fully reduced until June 11	21 days	None	Lower end of ulna somewhat displaced backwards	Very little	Last seen 5 weeks after accident; quite well except for displacement of ulna
554	16	M	June 18	?	Fall down 13 steps on palm of hand	Both fragments backwards; radius also outwards; radius impacted	Styloid process of ulna separated	Reduction; anterior and posterior splints	..	....	....	....	Last seen 10 days after accident
555	55	F	July 31	L	Fall with hand under body	Both fragments backwards	Ulna fractured 1in from lower end; patient had wasting of muscles of both hands (median and ulnar areas) of old standing	Reduction; anterior and posterior splints; redisplacement reduced on Aug. 6	21 days	None	Both fragments somewhat displaced backwards	Great stiffness of wrist; slow in disappearing	Great subsequent disability of hand from deformity and paralysis; last seen 6 months after injury
556	84	F	Sept 24	L	Fall on palm of hand	Both fragments backwards	Radius impacted	Reduction; anterior and posterior splints	21 days	None	None	Practically none	Last seen when splints removed
557	40	M	1896. Jan 6	L	Crush by heavy bar of iron	Both fragments backwards, outwards, and slightly upwards	Large lacerated wound on front of wrist; fracture not compound; each bone broken 1in. from wrist	Reduction; anterior and posterior splints; displacement reduced under chloroform on Jan. 13	29 days	Fingers moved	Both fragments somewhat displaced backwards	Considerable stiffness fingers and wrist; disappeared 6 months after accident	Wound suppurated; quite well except for deformity 6 months after accident
558	57	F	June 10	R	Fall on palm of hand	Both fragments backwards and outwards	Both bones broken 1in. from lower ends	Reduction; anterior and posterior splints	..	....	....	....	Patient only seen twice afterwards
559	38	M	June 14	L	Fall from ladder — 13 feet — on palm of hand	Both fragments backwards and outwards	Both bones broken 1in. from lower ends	Reduction; anterior and posterior splints	24 days	None	Both fragments somewhat displaced backwards	Some stiffness; slow in disappearing	....

cadaver. The following case, which I believe to be an example of Barton's fracture, came under my notice:—

Case 560.—Fracture of Styloid Process and Posterior Border of Articular Surface of Radius, with Dislocation Backwards of the Carpus.—W. H., male, aged 39, came to hospital on February 15th, 1896, with an injury to the wrist, which was stated to have been caused by a fall upon the back of the hand, with the fingers flexed. There was a considerable prominence at the back of the wrist, formed by the carpal bones, which were dislocated backwards and slightly upwards. The outlines of the bones could be easily felt. The dislocation could be reduced and reproduced without much difficulty. The styloid process of the radius was separated, but did not appear to be displaced; it could be moved on the rest of the bone with crepitus. The thecal ubercles on the back of the radius were not felt; but on pressure in this situation after the reduction of the dislocation, crepitus was elicited, and crepitus was also produced when the wrist-joint was moved. No crepitus was felt when pressure was made over the dorsal prominence before reduction of the dislocation. The ulna appeared to be normal. The condition was diagnosed to be fracture of the posterior margin of the radial articular surface. After reduction of the dislocation the limb was fixed on anterior and posterior splints, on which it was kept at rest for 24 days. Union had then taken place in good position, and there was very little stiffness of the joint. The man had almost completely recovered when he was last seen, two months after the accident.

FRACTURE OF THE ANTERIOR BORDER OF THE ARTICULAR SURFACE OF THE RADIUS WITH SUBLUXATION OF THE WRIST.

This fracture is, I believe, not very uncommon. Two cases, one of which was subjected to a careful examination and measurements whilst the patient was under chloroform, and of which a skiagram is here reproduced, have come under my treatment.

Case 561.—Fracture of Styloid Process and of Anterior Border of Articular Surface of Radius with Subluxation Forwards of Wrist.—F. N., male, aged 18, applied for treatment on October 26th, 1895, with a recent injury to the right wrist caused by a direct crush from a packing-case. As the examination was painful an anæsthetic was administered, and the following conditions were made out:—There were two loose fragments detached from the radius; the first included the styloid process, and a piece of the outer border of the bone and was nearly one inch long; the second, which was [necessarily not so distinctly felt, consisted of a small portion of the anterior border of the radius. The two fragments, together with the carpus, were displaced upwards and forwards. On the dorsum of the wrist the lower end of the posterior surface of the radius was distinctly felt; careful measurements and comparison with the sound limb proved that the case was not one of separated epiphysis with forward displacement. Each fragment could be made to move upon the rest of the radius, crepitus being obtained. Reduction was effected by extension upon the hand with pressure upon the fragments. The limb was fixed in anterior and posterior splints. Union took place with some displacement forwards of the anterior border of the radius and the carpus.

At my request the patient presented himself for examination in January, 1899. He then stated that he had recovered full power over the wrist, and that the limb was as strong as its fellow. As

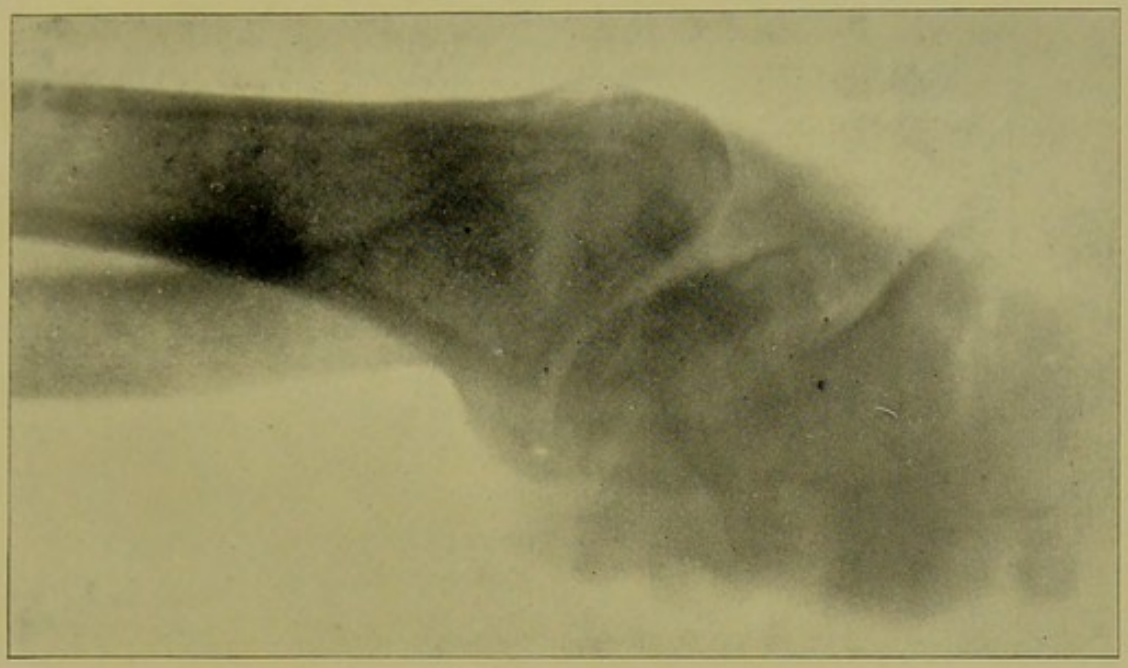

Fig. 23.

Old Fracture of Anterior Border of Lower End of Radius.

Union with displacement upwards of the fragment and with subluxation of the wrist.—*Case 561.*

it was evident that there was some deformity of the lower end of the radius, a skiagram was taken (Fig. 23). The figure shows a lateral view of the wrist, the hand being held in a horizontal position. It is evident that the anterior border of the lower end of the radius has been displaced upwards, leading to considerable obliquity of the articular surface. The carpal bones are also displaced somewhat upwards and forwards, but their outlines are not very distinct. I think that the skiagram fully confirms my original diagnosis of the case.

Case 562.—Fracture of Anterior Border of Lower End of Radius, with Subluxation of Wrist.—M. A. T., age 51, female, came under observation on October 8, 1895. The injury had been caused by a fall upon the hand, but there was doubt as to whether it was upon the palmar or dorsal surface. The carpus, which was in place when I first saw her, could be partially dislocated forward, and returned to position with the application of very little force, and during the process distinct crepitus was occasionally obtained. The hand and forearm were fixed on a posterior splint. The patient was not seen again.

The second case is open to doubt, but I think that there can be no question about the nature of the lesion in the first case. I have recently seen a boy who appeared to have had a similar fracture, and in whom mal-union had taken place with the carpus displaced somewhat forwards and upwards.

FRACTURE OF THE STYLOID PROCESS OF THE RADIUS.

Beyond the two cases already mentioned, one of which was accompanied by fracture of the posterior, and the other by fracture of the anterior border of the radius, no example of this accident has come under my notice. Hamilton[27] mentions two cases in which fracture of the radial styloid process accompanied Colles' fracture, and three cases in which it occurred independently. One of the latter cases was comminuted; in the other two the process was displaced upwards by the supinator longus muscle. Freeman[28] has recently published an excellent skiagram of this accident, which shows outward and upward displacement of the fragment.

FRACTURE OF THE ULNAR BORDER OF THE LOWER END OF THE RADIUS.

This is an accident which is not referred to in any of the standard works I have consulted, but of which an example came under my observation.

Case 563.—Fracture of Inner Border of Right Radius.—G. B., male, aged 16, came to hospital on October 18th, 1895, with a recent injury to the right wrist. The injury had been caused by a fall backwards, with the forearm under the body, and it was probable that the back of the hand had come in contact with the ground. There was a great deal of pain, but not much swelling of the wrist. No deformity was evident. On pronation and supination, crepitus was obtained. The lower end of the ulna, together with a fragment of the radius, could be pushed back-

wards and forwards to a certain degree on the rest of the radius, crepitus being obtained. It was evident that a portion of the radius was separated, and the fracture appeared to start near the upper border of the radio-ulnar articulation, and to extend downwards and outwards into the wrist-joint. There was no transverse fracture of the lower end of the radius, and the ulna was intact. A dorsal splint and evaporating lotion were applied, but the patient was not afterwards seen. A request that he would come for subsequent inspection was disregarded.

The only skiagram illustrating a similar injury with which I am acquainted, is one taken from a patient under the care of Mr. Lynn Thomas, and reproduced by Dr. Walsh[29] in his book on the Röntgen Rays in Medical Work. The skiagram shows a fracture starting on the inner side of the radius, about an inch above the lower end of the bone, and extending obliquely downwards and outwards to the articular surface. The fragment includes nearly one-half of the articular surface.

FRACTURES OF THE LOWER END OF THE ULNA.

Fracture of the lower end of the ulna, without fracture of the radius, was present in two of my cases. They were briefly as follows:

Case 564.—Male, aged 44, received an injury to the left wrist, caused by direct violence, on July 7th, 1895. There was a fracture of the ulna close to the lower end of the bone, but no displacement of the fragments. The limb was fixed on anterior and posterior splints, but the patient was last seen 11 days after the occurrence of the accident.

Case 565.—Male, aged 59, accident on March 7th, 1896. The left ulna was broken, one inch above the wrist. The accident was attributed to a fall upon the palm of the hand. There was no displacement. Anterior and posterior splints were applied, and were retained for 13 days. Union took place readily. There was a little subsequent stiffness of the wrist and fingers, which had not altogether disappeared when the patient was last seen, 26 days after the injury.

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Chapter VI.

FRACTURES OF THE CARPUS, METACARPUS, AND PHALANGES.

FRACTURES OF THE CARPUS.

Fractures of the carpal bones, excluding cases in which the limb has been subjected to a severe crushing force, are of rare occurrence. The only case of which I have notes is the following:—

Case 566.—F. B., male, age 17 years, came to the Infirmary on April 2nd, 1896, with an injury to the left wrist, caused by a sharp joiner's chisel. There was a wound about three-quarters of an inch in length over the outer part of the front of the wrist. The flexor carpi radialis tendon and the radial artery were severed. The scaphoid bone was cut cleanly across, and the two parts of the bone could easily be separated by drawing apart the edges of the wound. The artery was ligatured, the ends of the tendon joined together by silk sutures, and the wound, after being washed with antiseptic lotion, was closed. Healing took place by first intention, and the man made a complete recovery.

A few cases of simple fracture of the carpal bones have been placed on record, most of them being cases which have been examined after the death of the patient from other injuries received at the same

time. In a few cases the injury has been diagnosed by skiagraphy. The whole subject has recently been considered by Auvray[1], who has recorded a case in which he found fracture of the scaphoid with marked dorsal displacement of one part of the bone. Auvray collected five other cases in which the scaphoid had been broken, and mentions instances of fracture of the semilunar, os magnum, cuneiform, and pisiform bones. He describes at length a series of experiments which he undertook with the object of determining the mechanism of these fractures, and considers that they may be caused either by direct or indirect violence. He found that in certain cases forced flexion or extension of the wrist in the cadaver produced either fracture of the carpal bones or rupture of the ligaments which bind together these bones. It would appear that in cases of simple fracture, the scaphoid is the bone which most frequently gives way.

FRACTURES OF THE METACARPUS.

I have notes of 16 cases of fracture of the metacarpal bones, but as this number does not include all the cases which came under my treatment whilst I was recording cases of fracture, I have not arranged them in the form of a table. In one of the cases two of the bones were broken, and in another three bones.

Liability of the various Metacarpal Bones to Fracture.—Very different statements have been made as to the relative frequency with which the various metacarpal bones are fractured. Polaillon[2] says that the third and fourth metacarpals are the ones most liable to fracture, and attributes this to the greater length of these bones, which causes them to be more exposed to the force of blows received upon the knuckles. Hulke[3], on the other hand, says that the first metacarpal is the most subject to fracture, and Bennett[4] is of the same opinion. The following table gives an account of 102 cases collected by Polaillon and 78 by Hulke. To them I add 16 cases which came under the care of Hamilton[5], and 19 of my own.

	Polaillon.	Hulke.	Hamilton.	Author.	Total.
1st metacarpal ...	8	27	1	3	39
2nd ,, ...	16	16	8	4	44
3rd ,, ...	34	9	1	2	46
4th ,, ...	35	12	3	6	56
5th ,, ...	9	14	3	4	30
	102	78	16	19	215

With regard to the exact situation of the fracture, Hamilton found that, of his 16 cases, the bone was broken in the lower third in 7 cases, in the middle third in 5, and in the upper third in 4.

Bennett, who has paid particular attention to fracture of the first metacarpal bone, says that the fracture is usually at the carpal end of the bone, and passes obliquely from the articulating surface to the palmar aspect. As a rule the line of fracture does not reach the dorsal surface of the bone. The injury is usually accompanied by dorsal dislocation of the metacarpal. Probably the injury described by Bennett is present in many cases diagnosed as dislocation at the carpo-metacarpal joint of the thumb, and accounts for the occasional difficulty met with in maintaining the proper position of the bone after this dislocation. The recognition or non-recognition of the true nature of this injury may, to a certain extent, account for the varying statements of different writers as to the relative frequency of fracture of the first metacarpal bone.

Cause.—Fracture of the metacarpal bones may be caused either by direct or indirect violence. In more than one-half of my own cases the injury was produced by blows upon the knuckles. Polaillon says that the third and fourth metacarpal bones are most often broken by indirect violence, and the second and fifth by direct violence, whilst in the case of the first metacarpal these two causes act with equal frequency.

Displacement.—The most common conditions are absence of displacement or displacement backwards of one or both fragments. When the fracture has been produced by direct violence there may be forward displacement.

Prognosis.—Union with more or less deformity is very frequent after these fractures, but as a rule there is no impairment of the usefulness of the hand. Great difficulties are often encountered in retaining the broken ends in good apposition.

Treatment.—Either a dorsal or a palmar splint may be applied, according to the circumstances of the case. In addition, it is frequently advisable to place a small pad over the fragments in order to counteract the tendency to backward displacement.

Flexing of the fingers over a pad of wool placed in the palm of the hand, as recommended by Sir Astley Cooper[6] for fractures of the heads of the metacarpal bones, has proved disappointing in most of the cases in which I have tried it. When there has been any tendency to backward displacement of the fragments, I have usually found that the tendency has been rather increased than diminished by this method of treatment.

Union will usually be sufficiently firm for the removal of all supports at the end of three weeks.

SEPARATION OF THE EPIPHYSES OF THE METACARPAL BONES.

The epiphysis of the first metacarpal bone is situated at the proximal end of the bone. Ossification begins in the third year of life, and union with the diaphysis takes place about the 20th year. Poland[7] says that there are only two cases of separation of this epiphysis on record. Occasionally an epiphysis is formed at the distal end of the bone.

In the four inner metacarpal bones the epiphyses are situated distally. Ossification begins at from 2½ to 5 years of age, and union takes place about the 20th year. Seven cases of separation of one of these epiphyses, none of which were examined by dissection, are on record (Poland[8]).

FRACTURES OF THE PHALANGES OF THE FINGERS.

These injuries are of exceedingly common occurrence. Many hundred cases came under my notice whilst I was recording my cases of fracture, but, except in a few of the more complicated cases in which amputation was necessary, I have no notes of the nature of the injury. The fracture is usually the result of direct violence, and in a large proportion of the cases is of a compound nature. Occasionally fracture of the phalanges is produced by indirect violence, the force being received upon the end of the finger. Displacement may be absent, or there may be more or less lateral movement of the fragments. Occasionally the distal fragment is rotated, and in rare cases there is overlapping of the fractured ends.

Treatment.—The treatment of simple fractures of the fingers calls for no special remarks, but with regard to compound cases I would plead for more regard to antiseptic precautions than is often carried out. The tendon-sheaths are frequently opened, and thus afford a ready passage for septic material, leading to diffuse cellulitis of the hand, and, in the case of the thumb and little finger, to suppuration in the common flexor-tendon sheath. These accidents very frequently occur in workmen whose hands are covered with grease and dirt of various kinds, and it is consequently a work of no little trouble to clean the wound and the surrounding skin satisfactorily.

In cases of extensive injury to the fingers I think it is advisable to place the patient under an anæsthetic much more frequently than is usually done, in order that proper cleansing and antiseptic treatment can be carried out. My own practice has been first to scrub the hand thoroughly with soap and water, then to clean the skin with turpentine, and afterwards to soak the hand in perchloride lotion. Any parts requiring removal have then been cut away, tendons sutured

if necessary, and the wound stitched. A permanent dressing has then been applied. I have notes of 23 cases treated in this way, all of which had dirty, lacerated wounds, and all requiring amputation of parts of one or more fingers. In almost all the cases union took place without suppuration, and in most of the cases the dressing applied at the time of operation was not changed for two or three weeks. I have referred in detail to this subject because I am convinced that the great majority of cases of diffuse suppuration, leading frequently to much impairment of the functions of the hand and occasionally necessitating more extensive amputation, can be avoided by this method of treatment.

With regard to primary amputation in cases of crushed and fractured fingers, the rule which should be followed is to save as much as possible. Except in the case of the thumb, however, it is usually not advisable to amputate through the middle of the first phalanx, but to go back to the metacarpo-phalangeal joint. The rules with regard to removal of the head of the metacarpal bone have been frequently laid down, and do not require repetition.

SEPARATION OF THE EPIPHYSES OF THE PHALANGES.

According to Poland[9] there are on record two cases of this injury, which were diagnosed from an external examination only. A third case, reported by Roux, was proved by inspection.

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CHAPTER VII.

NERVE-LESIONS WITH FRACTURES OF THE UPPER EXTREMITY.

Nerve-lesions occur not very infrequently in connection with fracture of the bones of the arm, and it would appear that they may be the result of one of the following causes:—

(1) Direct tearing of the nerves at the time of injury.

(2) Pressure of the broken ends upon the nerves.

(3) Pressure of splints or pads.

(4) Pressure of exuberant callus.

(5) Neuritis from contusion of the nerve by the force producing the fracture, or possibly from other causes.

The following are the lesions which are most frequently met with in these fractures:—

Fractures of the Clavicle:—

(1) Direct pressure upon the brachial plexus at the time of the injury.*

(2) Direct injury to the plexus from the loose fragments in cases of comminuted fracture.

(3) Compression of the nerves against the humerus by a large axillary pad.

(4) Pressure of exuberant callus—one case on record.

A very large proportion of the recorded cases of ununited fracture of the clavicle have been accompanied by signs of pressure upon the brachial plexus.

Fractures of the Upper End of the Humerus:—

(1) Compression of the nerves by a large axillary pad.

(2) Pressure upon, or injury to, the nerves by the upper end of the shaft in fractures of the surgical neck.

(3) Pressure upon, or injury to, the nerves by the upper end of the diaphysis in cases of separated epiphysis.

Fractures of the Shaft of the Humerus:—

(1) Tearing of the musculo-spiral nerve by the broken ends.

(2) Pressure of callus upon the same nerve.

(3) Pressure upon the median nerve.

Fractures of the Lower End of the Humerus:—

(1) Pressure upon, or injury to, the ulnar nerve by a separated internal epicondyle.

(2) Pressure of callus or splints upon the median, ulnar, or musculo-spiral nerves.

Fractures of the Forearm:—

Injuries to nerves are not so frequent in this situation, although there are cases on record in which the radial, median, and ulnar nerves have been involved. The liability to pain from pressure of the head of the ulna upon the dorsal branch of the ulnar nerve in cases of Colles' fracture, has already been referred to.

* I have seen a case—afterwards proved by dissection—in which, from a severe blow on the clavicle, the bone, without being fractured, compressed and ruptured the cords of the brachial plexus against the transverse processes of the cervical vertebræ.

Five of the cases described in the preceding pages had signs of paralysis from pressure upon one or other of the large nerve-trunks during the period of convalescence. In all the cases the cause appeared to be pressure from the splints, possibly aided in some instances by the pressure of callus. Three of the five patients recovered completely in from one to two months from the time the paralysis was first noticed, and the other two cases were improving at the time the patients were last seen. The cases were as follows :—

(1) *Case 127.—Fracture of the Surgical Neck of the Humerus.*—Paresis of the muscles of the forearm and hands was noticed when the dressings were removed, probably owing to pressure having been made upon the *axillary nerves.* There was almost complete recovery in the course of the next month.

(2) *Case 148.—Fractures of Humerus, Radius, and Ulna.*—Ulnar paralysis was noticed after the removal of the splints : speedy recovery took place.

(3) *Case 163.—Separation of the Lower Epiphysis of the Humerus.*—Musculo-spiral paralysis was noticed four days after the removal of the splints. The epiphysis had given great trouble from re-displacement ; it had been replaced on one occasion with the patient under chloroform and an external angular splint had been applied. The epiphysis united with some inward displacement. The paralysis recovered completely in six weeks from the time it was first noticed.

(4) *Case 177.—Transverse Supra-condylar Fracture of the Humerus.*—Ulnar paralysis and wasting of the small muscles of the hand were noticed about two months after the injury. The arm had been treated on angular splints, which had been retained for 36 days. Recovery was not complete when the patient was last seen, three months after the injury.

(5) *Case 187.—Fracture of the External Condyle of the Humerus and of the Olecranon.*—The condyle united with some displacement upwards ; the olecranon united by bone and there was a great deal of callus thrown out around it. The arm had been treated on an internal angular splint for 28 days. Ulnar paralysis was noticed two months after the injury, but it disappeared entirely in the course of the next two months.

Part II.

DISLOCATIONS.

Chapter I.

GENERAL CONSIDERATIONS.

EXCLUDING dislocations of the individual carpal bones and of the metacarpus and phalanges, 129 dislocations of the bones of the upper extremity were treated at the Manchester Royal Infirmary during the same period of time in which the fractures, which have been recorded in the preceding pages, came under observation. The dislocations were situated as follows:—

	Out-Patients.	In-Patients.	Totals.
Sterno-clavicular joint	1	2	3
Acromio-clavicular joint	4	3	7
Shoulder-joint	73	4	77
Elbow-joint	33	0	33
Head of radius	6	0	6
Wrist-joint	3	0	3
	120	9	129

With the exception of one of the cases of sterno-clavicular dislocation I have more or less complete notes of all the cases, and shall give an account of them in the following pages. In addition, some remarks will be made upon dislocations of the carpal, metacarpal, and phalangeal bones, and details given of a few cases of these injuries.

In several instances, more particularly in the neighbourhood of the elbow and wrist-joints, dislocation and fracture have occurred together in the same patient. When this has been the case, the patient has already been referred to in the section dealing with fractures, and will be mentioned again in this section.

An analysis of the cases with regard to the age and sex of the patients is given in Table C.

TABLE C.—DISLOCATIONS OF UPPER EXTREMITY.

In and Out-Patients. Age and Sex of Patients.

	Age. 0-10.		Age. 10-20.		Age. 20-30.		Age. 30-40.		Age. 40-50.		Age. 50-60.		Age. Above 60.		Totals.		
	Sex.		Sex.		Sex.		Sex.		Sex.		Sex.		Sex.		Sex.		Sex. M. and F.
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
Sterno-clavicular..	...	...	1	...	1	...	...	...	...	...	1	...	...	...	3	...	3
Acromio-clavicular	...	...	1	...	1	...	2	...	...	...	2	...	1	...	7	...	7
Shoulder	...	..	...	...	11	1	22	1	5	4	7	5	11	10	56	21	77
Elbow	4	1	13	2	3	1	2	2	4	...	...	...	...	1	26	7	33
Head of radius ...	2	...	2	...	...	...	1	...	...	...	...	...	...	1	5	1	6
Wrist	...	...	1	...	...	...	1	...	...	...	...	1	...	...	2	1	3
Totals	6	1	18	2	16	2	28	3	9	4	10	6	12	12	99	30	129

Sex.—As will be seen from the table, more than three-fourths of the patients were males. The preponderance of males was especially marked in the patients under 40 years of age. After 60 the two sexes would appear to be about equally predisposed to these injuries.

Age.—All ages, except the first few years of life, were fairly evenly represented amongst the patients. The largest number of cases occurred between 30 and 40 years of age. It is worthy of note that of the patients under 20 years of age the great majority suffered from dislocations of the elbow-joint; over 20 there was a very great preponderance of dislocated shoulders.

Side of Body affected.—Information upon this point is given in Table D.

TABLE D.—SIDE OF BODY AFFECTED.

	Right.	Left.	Not Recorded.	Totals.
Sterno-clavicular	...	2	1	3
Acromio-clavicular	2	3	2	7
Shoulder	36	30	11	77
Elbow	5	19	9	33
Head of radius	4	2	...	6
Wrist	2	...	1	3
Totals	49	56	24	129

It will be noticed that amongst 105 cases, where the affected side was recorded, there was a slight majority of dislocations on the left side of the body. Amongst the fractures also, the left side claimed a larger proportion of the cases.

Chapter II.

DISLOCATIONS AT THE STERNO-CLAVICULAR JOINT.

The sternal end of the clavicle may be luxated in one of three directions—forwards, backwards, and upwards—forward dislocation being by far the most common variety. Of 13 cases which came under the care of Hamilton[1], 11 were examples of forward displacement, and 2 of upward displacement.

Whilst I was recording my cases, 3 dislocations of the sternal end of the clavicle were treated at the Manchester Royal Infirmary, two as in-patients and one as an out-patient. In two cases the clavicle was displaced forwards, and in one backwards.

DISLOCATION OF THE STERNAL END OF THE CLAVICLE FORWARDS.

The following case of this injury was treated as an out-patient:—

Case 567.—Dislocation of Sternal End of Clavicle Forwards, Inwards, and slightly Downwards.—W. K., male, aged 18 years, by occupation an ostler, came to the Infirmary on February 17th, 1896. The history given was that he had fallen from a horse and had struck the ground with the palm of the outstretched hand. The sternal end of the left clavicle was displaced forwards, inwards, and to a slight extent downwards. It rested upon the anterior surface of the manubrium sterni. From the great amount of displacement it is probable that there was extensive rupture of the sterno-clavicular and rhomboid ligaments. The dislocation was readily reduced by drawing backwards the shoulders, but was easily reproduced. An attempt was made to keep the bone in position by strapping applied as in Sayre's treatment for fractured clavicle, together with a pad of wool over the projecting end of the bone. This treatment was to a very great extent successful. The arm was kept at rest for three weeks, at the end of which time the clavicle was only slightly more prominent than normal.

The second case of forward dislocation was in a man aged 51, who came to the Infirmary on March 31st, 1896. He was treated as an in-patient, but I have no notes of his subsequent progress.

Cause.—In the great majority of cases this accident results from indirect violence. Most frequently the cause is a fall or blow upon the anterior part of the shoulder, by which the outer end of the clavicle is driven backwards, whilst the inner end is levered forwards. In a few cases, such as the one mentioned above, it has resulted from falls upon the hands stretched out in front of the body. Polaillon[2]

refers to a case in which the sternal ends of both clavicles were dislocated forwards in this way. Muscular action is occasionally the cause of this injury, as in a case recorded by Ducket[3], where the clavicle was dislocated whilst the patient was swimming. Lastly there are cases on record in which the bone has been gradually pushed forwards by the pressure of an aneurism at the root of the neck.

Pathological Anatomy.—Two varieties of forward dislocation are described—partial and complete. In cases of complete dislocation, which is the more common variety, there is necessarily extensive rupture of the sterno-clavicular and rhomboid ligaments. In incomplete cases the injury to the ligaments varies with the amount of displacement of the bone. Polaillon says that small portions of the anterior border of the sternal articular surface or of the clavicle are frequently torn away with the ligaments. Cases of dislocation of both clavicles have been recorded by Hamilton, Hotchkiss[4], and others.

Treatment.—Many complicated forms of apparatus have been devised for the treatment of this dislocation; but the general experience of surgeons has been that, although they may succeed in some cases, they cannot be depended upon to keep the clavicle in position in the majority of cases.

In my own case I adopted a modification of Sayre's treatment for fractured clavicle, and attempted to keep up some pressure upon the inner end of the bone.

The arm should be kept at rest for from three to six weeks in order to allow time for the repair of the ruptured ligaments.

Results.—All writers are agreed that a certain amount of deformity almost invariably occurs after this dislocation, but that there is little or no subsequent impairment of the functions of the limb.

DISLOCATION OF THE STERNAL END OF THE CLAVICLE BACKWARDS.

This injury is of very rare occurrence. The following case, which also presented double fracture of the clavicle on the opposite side of the body, and which has already been mentioned in speaking of fractures of the clavicle (Case 103, page 22), came under my notice:—

Case 568.—Partial Dislocation Backwards of Sternal End of Left Clavicle; Double Fracture of Right Clavicle.—The patient, a man, aged 22, was crushed between the buffers of two railway waggons on August 27th, 1895. The inner end of the left clavicle was partially dislocated backwards. The margin of the articular surface on the sternum could be distinctly felt. The displacement was easily reduced by drawing backwards the shoulders. A pad of wool was placed between the scapulæ, and the shoulders were drawn backwards by figure-of-eight bandages. The arms were fixed to the sides by a many-tailed bandage. The bandages were removed at

the end of fourteen days. The bone was in good position, and there had been no tendency to return of the displacement. Three years later, when I examined the patient again, there were no signs whatever of the part having been injured.

Some six years ago a case of complete dislocation backwards of the sternal end of the clavicle came under my notice at the Barnes Convalescent Hospital, Cheadle. The displacement had existed for some time and could not be remedied. There was no interference with respiration or deglutition, nor were there any signs of pressure upon the blood-vessels or nerves of the neck.

Cause.—Direct crushing of the chest in an antero-posterior direction or powerful lateral compression of the shoulders are the usual causes of this accident.

Pathological Anatomy.—The injury is accompanied by more or less tearing of the rhomboid and posterior sterno-clavicular ligaments. The head of the bone, in cases of complete dislocation, lies behind the sterno-hyoid and sterno-thyroid muscles. The displacement is usually backwards and a little downwards; more rarely it is directly backwards, or backwards and slightly upwards.

Complications.—The most frequent complication is pressure upon the trachea, giving rise to dyspnœa. Polaillon[5] found this symptom in 6 out of 16 cases. Dysphagia, from pressure upon the œsophagus, he found in 3 of the same 16 cases, and it is worthy of note that two of the cases which suffered from dysphagia had no interference with respiration. Instances of pressure upon the large arteries and veins at the root of the neck have been recorded.

Treatment.—Reduction is usually effected without much difficulty, and, as a rule, the tendency to redisplacement is not so great as in cases of forward dislocation. In many cases, however, there has been more or less permanent displacement backwards of the bone.

Sir Astley Cooper[6] has recorded a case in which the end of the bone was removed in order to relieve pressure upon the œsophagus. The patient made a good recovery, and was relieved of all symptoms.

DISLOCATION OF THE STERNAL END OF THE CLAVICLE UPWARDS.

The instances of this dislocation which have been placed on record are few in number. Hamilton[7] refers to a number of cases, two of which had come under his own observation. The inner end of the clavicle rests upon the upper border of the sternum lying in the interval between the sternal head of the sterno-mastoid muscle in front and the sterno-hyoid muscle behind. The accident is the result of severe violence acting upon the top of the shoulder, so that the outer end of the clavicle is depressed, whilst the inner end of the bone is levered out of its socket. Hamilton says that in only one recorded case has there been an absolute cure without deformity.

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Chapter III.

DISLOCATIONS AT THE ACROMIO-CLAVICULAR JOINT.

Dislocations in this situation are usually referred to as dislocations of the outer end of the clavicle. Some writers, however, prefer to speak of dislocations of the distal bone of the skeleton, and therefore say that these injuries should be termed dislocations of the scapula. Almost invariably the outer end of the clavicle is raised and lies upon the upper surface of the acromion process. In rare cases the clavicle is displaced downwards, and a third variety, in which the clavicle lies under the coracoid process, has also been described.

Dislocation of the acromial end of the clavicle upwards.

Seven cases of this injury, three of which were treated as in-patients and four as out-patients, are classified in Table XXXI.

Age and Sex.—All the seven patients were males. Their ages varied from 18 to 63 years. It would appear that the injury is much more frequent in the male sex, and that it may occur at almost any age.

Cause.—In all the cases the injury was due to violence applied to the shoulder. It was attributed to falls in four cases, to a blow in one, to the passage of a lurry-wheel over the shoulder in one, and to severe lateral crushing of the shoulders in the remaining case. Polaillon[1] says that it has been caused by a fall upon the elbow. Contraction of the clavicular portion of the trapezius muscle may aid in producing the dislocation, and is an important factor in maintaining or reproducing the displacement subsequently.

Pathological Anatomy.—The injury is accompanied by more or less rupture of the acromio-clavicular and coraco-clavicular ligaments. Polaillon describes two varieties of this dislocation: (1) Complete, with rupture of all the above-mentioned ligaments; (2) Incomplete, with rupture of the acromio-clavicular ligaments only.

TABLE XXXI.—Dislocations at the Acromio-Clavicular Articulation.

No.	Age	Sex.	Date of Injury.	Side.	Nature of Dislocation.	Cause.	Remarks.	Treatment.	How long fixed.	Result.
569	55	M	1895 May 27	?	Clavicle upwards and backwards	Fall on shoulder from a cab	.....	Easily reduced; arm fixed by strapping (Sayre's method) with pad over end of clavicle	18 days	Recovery with very slight displacement upwards of the clavicle; with this exception patient was quite well one month after the injury
570	63	M	June 5	R	Upwards	Fall with shoulder against a wall	The patient was very drunk; he pulled off the dressings, and on the next day it was necessary to administer chloroform to remedy redisplacement	Reduction; Sayre's method of strapping	19 days	Recovery took place with displacement upwards of the clavicle; it was impossible to keep the bone in place
571	18	M	Aug 19	?	Upwards (incomplete)	Blow on shoulder	.....	Reduction; Sayre's method of strapping	15 days	Complete recovery without deformity; no subsequent stiffness of joints
572	24	M	Oct 10	L	Upwards	Fall on shoulder	.....	Reduction; strapping and bandages	22 days	No return of displacement up to time of patient's last visit, 22 days after accident
573	59	M	1896 Feb 14	L	Upwards	Fall on shoulder	Also doubtful fracture of base of skull; treated as in-patient until Feb. 26	Reduction; strapping and bandages	..	Result not known
574	38	M	April 14	R	Upwards	Passage of lurry-wheel over shoulder	Also lacerated wound of forehead; treated as in-patient until April 18	Reduction; arm bandaged to chest	..	Result not known
575	36	M	June 19	L	Upwards	Lateral compression of shoulders between a waggon and a wall	Also fracture of outer end of left clavicle, ½in. from joint, and fracture of right clavicle. (See No. 104.) Treated as in-patient until June 27	Reduction; strapping and bandage	..	Some displacement upwards and thickening of outer end of left clavicle

Complications.—One of my cases was complicated by fracture of the outer end of the clavicle. Sir Astley Cooper[2] recorded a case in which the injury was accompanied by fracture of the acromion process. In a considerable number of published cases the two ends of the clavicle have been dislocated simultaneously.

Treatment.—Reduction of the displacement is generally easily effected by upward pressure upon the elbow, together with downward pressure upon the outer end of the clavicle. The retention of the proper position of the bones is usually extremely difficult. A very large number of special kinds of apparatus have been recommended, but experience has shown that the great majority of them cannot be depended upon. In some cases, however, the use of a Petit's tourniquet placed over the outer end of the clavicle and connected with a strap passing under the elbow, has proved effective in preventing permanent deformity. In my own cases I used an axillary pad to throw outwards the upper end of the humerus and the scapula, together with strapping to raise the elbow, and a pad of wool over the end of the clavicle.

Operation, with the object of producing ankylosis of the acromio-clavicular joint, has been undertaken in a few cases, as in one reported by O'Conor[3]. This procedure cannot be too strongly condemned, since it would abolish the movement of rotation of the scapula and would thus prevent the arm from being raised above the level of the shoulder.

Results.—I was able to record the result in four of my cases. One man made a complete recovery, one had marked displacement, and two had partial displacement of the clavicle upwards. A fifth patient had had no return of the dislocation up to the time he was last seen, 22 days after the injury.

Hamilton[4] says that in only two of his own cases—43 in number—where he was able to record the result, was there complete recovery without displacement. In most cases there was complete restoration of muscular power. Occasionally the patient was unable to lift any object above the head.

DISLOCATION OF THE ACROMIAL END OF THE CLAVICLE DOWNWARDS.

No example of this exceedingly rare accident has come under my notice. Hamilton[5] says that there are only five well-authenticated cases on record. Polaillon[6] mentions three others, but gives no particulars. More recently two examples have been recorded by Fox Edwards[7] and Reynier[8]. The injury is almost invariably produced by direct violence acting upon the upper surface of the outer end of the clavicle. In most of the recorded cases the reduction of the dis-

placement and the maintenance of the position of the bones has been easily accomplished. In two cases only had there been any permanent deformity.

Six examples of dislocation of the outer end of the clavicle under the coracoid process have been recorded; but it would appear that the statements of the observers are open to the greatest doubt.

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Chapter IV.

DISLOCATIONS AT THE SHOULDER-JOINT.

Dislocations at the shoulder-joint are of very common occurrence, about 50 per cent of all dislocations being met with in this situation. Details of 77 cases which came under treatment at the Manchester Royal Infirmary whilst I was recording my cases are given in Table XXXII.

Four of the patients came for treatment with dislocation of the shoulder on more than one occasion, and are therefore included two or more times in the table. The total number of individual patients was 68: 64 came under observation once only, two came twice, one three times, and one six times.

Sex.—Dislocations of the shoulder are more frequent in the male sex. Fifty-six of the patients were males and 21 females.

Age.—The ages of the patients were as follows:—

	Males.	Females.	Total.
Under 10 years	—	—	—
10 to 20 „	—	—	—
20 „ 30 „	11	1	12
30 „ 40 „	22	1	23
40 „ 50 „	5	4	9
50 „ 60 „	7	5	12
60 „ 70 „	8	8	16
Over 70 „	3	2	5
	56	21	77

TABLE XXXII.—Dislocations at the Shoulder-Joint.

No.	Age	Sex.	Date of Injury.	Side.	Nature of Dislocation.	Cause.	Remarks.	Method of Reduction.	How long fixed.	Passive Movement.	Subsequent Stiffness.	Period of Recovery.	Remarks on Result.
			1895.										
576	52	M	May 24	R	Sub-coracoid	Fall for 12ft. on shoulder	No previous dislocation	Manipulation (B)	17 days	Once; 4 weeks after accident	Considerable	..	Patient not seen from day of accident for 24 days; only seen once subsequently
577	45	M	May 26	R	Sub-coracoid	Violent movement of arm outwards	14 or 15 previous dislocations	Manipulation, extension outwards, and heel in axilla failed; extension upwards successful	..	.....	.....	..	Patient not seen again; subsequent dislocation on Feb. 15, 1896 (No. 620)
578	65	M	May 29	?	Sub-coracoid	?	Treated as in-patient; dislocation of 10 days' standing	Chloroform; extension upwards	..	.....	.....	..	Result not known
579	38	M	June 1	L	Sub-coracoid	Fall from bicycle on shoulder	No previous dislocation	Manipulation failed after several attempts; extension upwards succeeded at once	20 days	13 days after accident and many times subsequently	Considerable and prolonged	..	Stiffness slow in disappearing; not much improvement in first 2 months; then gradually improved and almost well when last seen, 5 months after accident
580	25	M	June 4	?	Sub-coracoid	Fall on shoulder	.....	Manipulation (A)	..	.....	.....	..	Not seen again
581	60	F	June 8	L	Subglenoid	Fall on outstretched hand	Also Colles' fracture on same side (No. 468)	Manipulation (A)	13 days	Several times after removal of supports	Moderate	About 2 months	.....
582	74	F	June 13	R	Subglenoid	Fall on elbow	Once dislocated previously — 4 or 5 years before	Manipulation failed; extension upwards succeeded at first attempt	15 days	Once after removal of supports	Slight	2 months	.....
583	72	M	June 14	R	Sub-coracoid	Fall on shoulder	No previous dislocation	Manipulation failed; extension upwards succeeded at first attempt	..	.....	.....	..	Not seen again

584	57	M	June 14	L	Subglenoid	Fall on shoulder?	No previous dislocation of left shoulder, but right shoulder dislocated a year ago	Manipulation failed; extension upwards succeeded at first attempt	..	.....	.....	..	Only seen once afterwards
585	27	M	June 17	L	Subcoracoid	Fall on shoulder	Two previous dislocations; last time 9 months before	Manipulation succeeded at first attempt	..	.....	.....	..	Only seen once afterwards
586	38	M	June 18	R	Subglenoid	Fall on shoulder	Four previous dislocations; last on May 7, 1895; arm was then fixed for three weeks	Manipulation (B)	..	.....	.....	..	Five subsequent dislocations within the next 14 months (see Nos. 588, 589, 593, 618, and 651). On the fifth occasion spontaneous reduction took place
587	37	M	June 23	L	Subglenoid	Fall on shoulder from a lurry	No previous dislocation	Manipulation failed; easily reduced by extension upwards	20 days	Twice; on July 5 and 12	.....	..	Last seen 20 days after injury
588	38	M	July 19	R	Subglenoid	?	Five previous dislocations	Manipulation (A)	..	.....	.....	..	See No. 586
589	38	M	Aug 2	R	Subglenoid	?	Six previous dislocations	Manipulation (A)	..	.....	.....	..	See No. 586
590	31	M	Aug 21	L	Subglenoid	Fall on shoulder	Previous dislocation 15 years before	Manipulation failed; easily reduced by extension upwards	13 days	None	.....	..	Last seen 13 days after injury
591	65	F	Aug 24	R	Subglenoid	Fall on shoulder?	.....	Extension upwards failed; manipulation successful	..	.....	.....	..	Only seen twice subsequently
592	74	M	Sep 5	R	Subglenoid	Fall on shoulder?	.....	Manipulation, extension upwards and extension outwards failed; chloroform, manipulation failed; extension upwards succeeded at first attempt	13 days	After removal of supports	Moderate	3 months	.....
593	38	M	Sep 16	R	Subglenoid	Lifting a plank of wood	Seven previous dislocations	Manipulation (A)	3 weeks	None	None	..	See No. 586

TABLE XXXII.—DISLOCATIONS AT THE SHOULDER-JOINT—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Nature of Dislocation.	Cause.	Remarks.	Method of Reduction.	How long fixed.	Passive Movement.	Subsequent Stiffness.	Period of Recovery.	Remarks on Result.
594	65	M	1895 Sep 21	L	Subglenoid	Fall on shoulder	No previous dislocation	Manipulation and extension upwards failed; extension outwards succeeded	10 days	None	Slight	..	Last seen 10 days after injury
595	54	F	Sep 22	L	Subcoracoid	Fall on shoulder	.....	Manipulation	..	.....	.....	..	Only seen once afterwards
596	26	M	Sep 30	R	Subglenoid	Fall on hand	Two previous dislocations—9 and 6 years before	Manipulation failed; easily reduced by extion outwards	..	.....	.....	..	Sent to own medical man
597	66	M	Oct 12	L	Subcoracoid	Fall	Four previous dislocations	Manipulation	..	.....	.....	..	Twice subsequently dislocated (Nos. 635 and 649)
598	26	M	Oct 12	L	Subcoracoid	Fall on shoulder?	No previous dislocation	Manipulation	14 days	None	Slight	..	Last seen 14 days after injury
599	70	F	Oct 10	R	Subglenoid	Fall	Dislocation of 11 days' standing	Manipulation failed; extension upwards succeeded at first attempt	5 days	None	.....	..	Last seen 5 days after injury
600	65	F	Nov 19	L	Subcoracoid	Fall on shoulder	.....	Manipulation (B)	..	.....	.....	..	Only seen once afterwards
601	51	M	Nov 16	R	Subglenoid	Fall on shoulder	Dislocation of 5 days' standing	Manipulation, extension upwards and extension outwards failed; manipulation then succeeded at second attempt	5 days	None	Slight	..	Slight stiffness when last seen, 19 days after reduction
602	65	F	Nov 22	?	Subcoracoid	Fall	.....	Manipulation failed; extension upwards succeeded	12 days	None	Moderate	..	Last seen 12 days after accident
603	50	M	Nov 23	R	Subglenoid	Direct violence to shoulder	Three or four previous dislocations; last time 10 years before	Manipulation, extension upwards and extension outwards failed; chloroform; manipulation succeeded at first attempt	..	.....	.....	..	Sent to own medical man

604	21	M	Nov 24	R	Sub-coracoid	Fall on shoulder	Previous dislocation 5 weeks before	Not recorded	..	.....	.....	..	Only seen once afterwards
605	36	M	Nov 26	L	Subglenoid	Fall on shoulder	Dislocation of 3 days' standing	Manipulation	..	.....	.. ...	..	Sent to own medical man
606	38	M	Dec 4	R	Sub-coracoid	Fall on shoulder	.....	Manipulation	..	.....	.....	..	Not seen again
607	39	M	Dec 6	?	Sub-coracoid	Fall on shoulder	.....	Manipulation failed; extension upwards succeeded	..	.....	.....	..	Not seen again
608	68	F	Dec 25	R	Sub-coracoid	Blow on shoulder	.....	Manipulation (A)	..	.....	.....	..	Sent to own medical man
609	61	F	Dec 29	R	Sub-coracoid	Fall on shoulder	Dislocation of 5 days' standing; no previous dislocation	Manipulation (A)	12 days	None	Moderate	..	Last seen 16 days after reduction
610	47	F	1896 Jan 3	R	Subglenoid	Fall on shoulder	No previous dislocation	Manipulation (A)	..	.....	.....	..	Last seen 7 days after injury
611	55	F	Jan 4	?	Subglenoid	Twist of arm	One previous dislocation	Manipulation	..	.....	.....	..	Subsequently dislocated, No. 644
612	44	M	Jan 15	L	Sub-coracoid	Fall on hand	.....	Manipulation and extension upwards failed; chloroform; manipulation succeeded at first attempt	..	.....	.....	..	Not seen again
613	37	M	Jan 20	R	Sub-coracoid	Twist of arm	Two previous dislocations — 21 and 6 years before	Manipulation failed; extension upwards succeeded easily	..	.....	.....	..	Not seen again
614	53	M	Jan 25	L	Sub-coracoid	Fall	.....	Manipulation	..	.....	.....	..	Only seen once afterwards
615	38	M	Jan 31	R	Sub-coracoid	Fall on shoulder	.....	Manipulation and extension upwards failed; choloroform, manipulation succeeded easily	..	.....	.....	..	Only seen once afterwards
616	38	M	Feb 1	L	Sub-coracoid	Fall	.....	Manipulation and extension upwards failed; chloroform, manipulation succeeded	10 days	None	Slight	..	Almost well when last seen 30 days after accident

TABLE XXXII.—DISLOCATIONS AT THE SHOULDER-JOINT—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Nature of Dislocation.	Cause.	Remarks.	Method of Reduction.	How long fixed.	Passive Movement.	Subsequent Stiffness.	Period of Recovery.	Remarks on Result.
617	26	F	1896 Feb 12	L	Subglenoid	Fall	.....	Manipulation failed; extension outwards succeeded easily	..	.....	.....	..	Only seen twice subsequently
618	39	M	Feb 13	R	Subglenoid	Putting on coat	Eight previous dislocations	Manipulation	..	.....	.....	..	See No. 586
619	63	M	Feb 14	L	Subglenoid	Fall on shoulder	Fracture of rim of glenoid cavity (?)	Manipulation failed; extension outwards succeeded	..	.....	.....	..	Sent to own medical man
620	46	M	Feb 15	R	Subcoracoid	?	16 or 17 previous dislocations; 3 times within last year (see No. 577). On last occasion, 4 months before, spontaneous reduction took place	Manipulation, extension upwards and extension outwards failed; whilst the patient was waiting for the administration of an anæsthetic, spontaneous reduction took place; he said that he gave a slight jerk of the shoulder-muscles	..	.....	.....	..	Not seen again
621	30	M	Feb 29	?	Subcoracoid	?	.....	Extension upwards	10 days	None	Moderate	..	Last seen 17 days after accident
622	57	M	March 9	R	Subglenoid	Direct violence to shoulder	No previous dislocation	Manipulation and extension outwards failed; extension upwards succeeded at first attempt	11 days	None	.....	..	Last seen 11 days after accident
623	45	F	March 20	L	Subcoracoid	Fall on back of shoulder	.....	Manipulation failed; extension upwards successful	..	.....	.....	..	Only seen twice subsequently
624	56	F	March 25	R	Subglenoid	Fall on shoulder	No previous dislocation	Manipulation failed; extension outwards successful	10 days	None	Slight	..	Last seen 10 days after accident
625	42	F	March 30	L	Subcoracoid	Twist of arm?	.....	Not recorded	11 days	None	.....	..	Last seen 11 days after accident

N														
	626	60	M	April 4	R	Subglenoid	Fall	One previous dislocation, 9 years before	Manipulation	..	.....	.....	..	Sent to own medical man
	627	28	M	April 11	?	Sub-coracoid	Fall on abducted hand	.....	Manipulation	13 days	None	.....	..	Only seen once subsequently, 13 days after accident
	628	31	M	April 16	R	Subglenoid	Fall on shoulder?	No previous dislocation	Manipulation (A)	8 days	None	Very slight	..	Last seen 8 days after accident
	629	27	M	April 27	R	Sub-coracoid	Dragging upon hand	.....	Extension upwards	..	.....	.....	..	Only seen twice afterwards
	630	29	M	May 2	L	Subglenoid	Fall on shoulder from bicycle	No previous dislocation	Manipulation failed; extension upwards succeeded at first attempt	10 days	None	Slight	..	Last seen 17 days after injury; quite well, except slight impairment of power of abduction
	631	22	M	May 13	R	Sub-coracoid	Blow on shoulder	3 previous dislocations; patient wears a shoulder-strap, and was wearing it at time of accident	Manipulation failed; extension upwards successful	9 days	None	None	16 days	.....
	632	42	M	May 17	L	Sub-coracoid	Kick on shoulder	.....	Manipulation failed; extension outwards successful	9 days	None	Slight	..	Last seen 9 days after injury
	633	35	M	May 22	L	Sub-coracoid	Fall	No previous dislocation	Manipulation	7 days	None	Slight	..	Quite well 3 weeks after injury, except some impairment of abduction
	634	46	F	May 22	?	Sub-coracoid	?	Admitted as in-patient for one day	Manipulation, extension outwards and extension upwards failed; chloroform; manipulation successful	..	.....	.....	..	Result not known
	635	67	M	May 24	L	Sub-coracoid	Muscular action in attempting to strike a man	5 previous dislocations; last time on Oct. 12, 1895 (No. 597)	Manipulation	..	.....	.....	..	Subsequently dislocated on July 26, 1896 (No. 649).

TABLE XXXII.—DISLOCATIONS AT THE SHOULDER-JOINT—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Nature of Dislocation.	Cause.	Remarks.	Method of Reduction.	How long fixed.	Passive Movement.	Subsequent Stiffness.	Period of Recovery	Remarks on Result.
636	21	M	1896 May 26	R	Sub-coracoid	Blow on shoulder	Previous dislocation 3 years before	Extension upwards failed; manipulation successful	10 days	None	Slight	..	Almost well when last seen, 2 weeks after injury
637	55	M	May 27	L	Subglenoid	Fall on shoulder	No previous dislocation	Manipulation	..	.....	.....	..	Not seen again
638	34	F	May 28	L	Sub-coracoid	?	No previous dislocation	Manipulation failed; extension outwards succeeded easily	8 days	None	Slight	..	Last seen 8 days after accident
639	47	M	June 8	L	Sub-coracoid	Fall on elbow	.....	Manipulation (after several attempts)	..	.....	.....	..	Only seen once afterwards
640	69	M	June 4	L	Subglenoid	Fall on shoulder?	Dislocation of 16 days' standing; 3 attempts at reduction before patient came to Infirmary	All methods failed without an anæsthetic: chloroform; manipulation failed; extension outwards (2 assistants pulling on arm) successful	..	... ..	.....	..	Sent back to own medical man
641	25	M	June 10	?	Sub-coracoid	Blow on shoulder	Dislocation of 3 weeks' standing; no previous attempts at reduction; treated as in-patient	Reduction under an anæsthetic	..	.....	.....	..	Result not known
642	33	M	July 3	L	Sub-coracoid	Fall on arm	.....	Manipulation	9 days	None	Slight	..	Last seen 9 days after accident
643	38	M	July 9	R	Sub-coracoid	Fall on shoulder	.....	All methods failed without an anæsthetic; chloroform; manipulation successful	8 days	None	None	2 weeks	.....

644	55	F	July 18	?	Subglenoid	?	Two previous dislocations; last on Jan. 4 (No. 611)	Manipulation	..	.....	.....	..	Not seen again
645	37	M	July 21	R	Subcoracoid	Fall on shoulder	No previous dislocation; attempts at reduction under chloroform before coming to Infirmary had failed	Chloroform; manipulation and extension upwards failed; extension outwards succeeded	10 days	None	Moderate	..	Stiffness gone, but some pain in shoulder when last seen, 2 months after injury
646	69	F	July 21	L	Subcoracoid	Fall on shoulder	.....	Extension upwards	14 days	None	Considerable	..	Much improved when last seen, 2 months after injury
647	59	F	July 22	R	Subcoracoid	Fall on shoulder	.....	Manipulation	6 days	None	Considerable	..	Still much pain and stiffness when last seen, one month after injury
648	70	M	July 23	R	Subcoracoid	Fall on shoulder	No previous dislocation	Manipulation	12 days	None	Considerable	..	Improving when last seen, one month after accident
649	67	M	July 26	L	Subcoracoid	Muscular action in saving himself from falling	6 previous dislocations (see Nos. 597 and 635)	All methods failed without an anæsthetic; chloroform; easily reduced	..	.....	.....	..	Last seen 5 days later
650	64	F	July 30	R	Subglenoid	Fall on shoulder?	.....	Manipulation failed; extension outwards succeeded easily	12 days	None	Slight	5 weeks	.....
651	39	M	Aug 8	R	Subglenoid ?	Putting on a clean shirt	9 previous dislocations (see No. 586)	Spontaneous reduction, as the patient sat down in the Accident Room	..	.....	.....	..	Not seen again
652	38	M	June 26	?	Subcoracoid	?	Dislocation of 8½ weeks' standing; patient admitted to wards	Chloroform; manipulation failed; easily reduced by extension upwards	..	.....	.....	..	Result not known

This injury, therefore, would appear to be of fairly common occurrence at all ages above 20 years. Before 20, that is, before the fusion of the upper epiphysis of the humerus with the diaphysis, dislocation at the shoulder-joint is very unusual, a much more common accident being separation of the epiphysis. The youngest of my patients with dislocated shoulders were two males, aged 21 years; the oldest patients were two, a man and a woman, aged 74 years. Hulke[1] mentions a case in a child aged 14 days, which was due to the arm being violently pulled and twisted, and H. D. Walker[2] has recently recorded a case of subcoracoid dislocation occurring in a man, aged 92.

Side of Body affected.—Information upon this point was recorded in 66 cases. The right humerus was dislocated in 36 and the left in 30.

Varieties of Dislocation.—The classification of dislocations of the shoulder usually adopted in this country is that given by Mr. Hulke in "Holmes' System of Surgery."[3] Five varieties are recognised, (1) subcoracoid, (2) subglenoid, (3) subclavicular, (4) subspinous, and (5) supracoracoid.

(1) *Subcoracoid.*—In this, which is the most common variety of dislocation of the shoulder, the head of the humerus is displaced forwards and slightly downwards, and lies in front of the glenoid cavity, immediately below the coracoid process. Forty-five of my 77 cases were recognised as being of this type.

(2) *Subglenoid.*—The head of the humerus is displaced downwards and slightly forwards, lying below the glenoid cavity and in front of the axillary border of the scapula. Sir Astley Cooper[4] described the subglenoid as the typical variety of shoulder-dislocations, and said that it was the form most commonly met with. His description has been followed by most subsequent writers, including Hamilton.[5]. On the other hand, Mr. Hulke says that the subcoracoid dislocation is the typical form, and that the subglenoid dislocation is of rare and exceptional occurrence. Forty-four out of 50 cases, of which he has particulars, belonged to the subcoracoid variety. My own experience, based upon the clinical examination of a large number of cases, is that, whilst the subcoracoid is the more common form, the subglenoid is not at all infrequent. Of my 77 cases, 45 were diagnosed as subcoracoid and 32 as subglenoid.

A few cases of a very rare variety of subglenoid dislocation, in which the head of the humerus is displaced lower than usual and in which the arm is raised above the level of the shoulder, have been described. From the position of the arm this dislocation is termed *Luxatio Erecta.* The accident has usually resulted from violent

traction upon the arm in an upward direction. Two cases are mentioned by Hulke[6], and others have been reported by Cleland[7] and Judd.[8]

(3) *Subclavicular.*—In this very rare variety of dislocation of the shoulder-joint the head of the humerus lies immediately below the clavicle to the inner side of the coracoid process. Subclavicular dislocation must be regarded as an exaggerated form of subcoracoid dislocation. No example is included amongst my 77 cases, but one case came under my notice before I commenced to keep these records.

(4) *Subspinous.*—The head of the humerus is displaced backwards and lies upon the posterior surface of the scapula, beneath the spine or the inner part of the acromion. Two varieties—subacromial and subspinous—have been described, according to the amount of backward displacement. Diagnosis in these cases is more difficult than in other forms of dislocation of the shoulder-joint, and, hence, in a considerable proportion of the recorded cases, the true nature of the injury has been overlooked for some time, and the dislocation has remained unreduced. The difficulties are well illustrated by a case recorded by my friend, Mr. A. W. Stocks.[9] In his case the head of the humerus lay immediately behind the glenoid cavity, and it was not until the bone was felt to slip into place that all those who had seen the case were satisfied that a dislocation had actually existed. Subspinous dislocation is of very rare occurrence; no example has come under my notice.

(5) *Supracoracoid.*—This is an exceedingly rare variety of dislocation of the shoulder, only a very few undoubted cases having been placed on record. The head of the humerus is displaced upwards and forwards. In some of the recorded cases there has been co-existing fracture of the coracoid process.

Etiology.—Dislocations at the shoulder-joint may be produced either by direct or by indirect violence. Muscular action plays an important part in many cases, the injury being due partly to this cause and partly to external violence. In some cases muscular action is the sole cause of the displacement. An analysis of the exciting causes in my own cases gives the following result:—

Falls upon the shoulder	29
„ „ —probably	8
Direct violence to the shoulder (blows, kicks, etc.)	7
Falls upon the elbow	2
Falls upon the hand	4
Twists of the arm	3
Traction upon the hand	1
Muscular action	6
Doubtful	17
	77

My own experience thus agrees with that of Hamilton that the great majority of the cases are due to falls or blows upon the upper end of the outer surface of the humerus. Falls upon the elbow or upon the out-stretched hand account for a certain number of cases. Muscular action was probably the sole cause of the dislocation in six of my cases, but it is necessary to mention that in all these cases the shoulder had been previously dislocated on several occasions. The particular muscular movements which produced the dislocation in these six patients were as follows: A sudden movement of the arm, an attempt to strike a blow, putting out the hand to save the patient from falling downstairs, lifting a plank of wood, putting on a coat, and putting on a clean shirt.

History of Previous Dislocations.—A history of the shoulder having been previously dislocated can be obtained in a very large proportion of these cases. I have information upon this point in 39 of my cases, and I find that only 16 had not had a previous dislocation of the same joint. Of the other 23 patients the shoulder had been dislocated once previously in 6 patients, twice in 4 patients, 3 times, 4 times, 5 times, and 6 times in two patients each, and 7 times, 8 times, 9 times, 14 or 15 times, and 16 or 17 times in one patient each. No better proof than this could be given of the fact that a shoulder which has once been dislocated is very liable to redislocation.

Pathological Anatomy.—Dislocation of the shoulder, when it occurs for the first time, is necessarily associated with extensive injury to the capsular ligament. There is usually a large rent in the anterior and lower part of the capsule, below or under the subscapularis and in front of the long head of the triceps, through which the head escapes. In the rare subspinous dislocation the capsule is ruptured posteriorly, although it is probable that in some of these cases the head escapes through the lower part of the capsule and is afterwards drawn upwards and backwards by the muscles.

The muscles themselves are more or less injured, especially the subscapularis. In subcoracoid dislocations the subscapularis may be lacerated, thrust upwards, or stretched over the front of the head of the bone. In subglenoid dislocations this muscle usually suffers more or less, and the same occurs with subspinous dislocations. The other muscles which are most liable to laceration are the supraspinatus, infraspinatus, and teres minor. The long head of the biceps is stated by Hamilton to be sometimes ruptured, but Hulke, as the result of an examination of a large number of specimens, says that it is rarely, if ever, injured. Erichsen[10] mentions the pathological appearances in four cases of subclavicular dislocation. In all cases the capsular

muscles were either extensively torn or the greater tuberosity of the humerus was fractured.

Complications.—Very few complications of any serious moment were met with amongst my cases. One patient (No. 581) had also Colles' fracture of the same arm. In another case (No. 619) fracture of the rim of the glenoid cavity was suspected, but the patient was only seen once.

Simultaneous dislocation of both shoulders has been met with in a number of cases, and has recently received a considerable amount of attention. Cases have been reported by Oldacres[11], McDougall[12], Haslip[13], Steele[14], Hartill[15], Anderson[16], and many others.

Co-existing fracture of the upper end of the humerus is chiefly important because of the great difficulties which are presented in the reduction of the deformity. McBurney[17] has collected 117 cases, and has recorded another which came under his own observation. Most frequently the fracture has been situated at the surgical neck of the humerus. McBurney recommends that these cases be treated by open incision, and that the head be replaced by means of traction with a strong steel hook.

Injury to the axillary artery leading to the formation of a diffused traumatic aneurism has been met with, but fortunately is rare. Injury to the neighbouring nerve-cords, more especially the circumflex nerve, has occurred in a few cases.

Compound dislocation is also a rare accident. Unless there be extensive injury to the soft parts, the case will usually do well under antiseptic treatment. In some cases it may be advisable to remove the head of the bone. Amputation should be reserved for cases in which the main blood-vessels and nerve-trunks are seriously damaged.

TREATMENT OF DISLOCATIONS AT THE SHOULDER-JOINT.

Reduction of the Displacement.—In two of my cases the method of reduction was not recorded, and in two others, which I shall refer to later, spontaneous reduction took place. In the remaining 73 cases I have information upon the point, and an analysis of the cases gives the following as the methods which were successful in overcoming the displacement.

Manipulation alone	31	
„ after failure of extension upwards	2	
„ second attempt, after failure of first attempt, extension upwards, and extension outwards	1	
	—	34
Extension upwards	3	
„ „ after failure of manipulation	13	
„ „ „ „ „ and extension outwards	1	
„ „ „ „ „ heel in axilla, and extension outwards	1	
	—	18

Brought forward		52
Extension outwards, after failure of manipulation	7	
„ „ „ „ „ and extension upwards	1	
	—	8
Chloroform (method of reduction not recorded)	2	
„ manipulation	6	
„ extension upwards		
„ „ „ after failure of manipulation		
„ „ outwards „ „ „	1	
„ „ „ „ „ „ and extension upwards	1	
	—	13
		73

Manipulation.—The method adopted in my cases was that which is usually known as Kocher's method. The manipulation consists of three movements—(1) rotation outwards and abduction of the arm, (2) drawing the elbow forwards, inwards, and upwards, and (3) placing the forearm across the chest with the hand on the opposite shoulder. The head may be felt to slip into place in any one of these three movements. In 9 of my cases reduction was effected during the first movement and in 3 during the second movement, whilst in the remaining cases no note was taken upon this point.* I have no mention in the records of these cases of the head having returned to its proper position during the third movement, but I have seen other cases where this has happened. In carrying out the manipulations I think that it is of the greatest importance that the first and second movements should be performed slowly and gradually, so as to overcome muscular resistance. Rapid movements, and especially rough movements, by exciting muscular contraction, tend to defeat their own object. Manipulation was the first method of reduction tried in the great majority of my cases. It succeeded at once in 31 cases; in 3 others it succeeded after the failure of other methods of reduction, whilst in 6 cases the dislocation was reduced by this method whilst the patient was under the influence of an anæsthetic. I am of opinion that in all cases of dislocated shoulders no other method of reduction should be attempted until manipulation has been given a fair trial. In cases of frequently recurring dislocation, reduction can usually be effected with the greatest ease by this means.

Extension of the Arm Upwards.—Extension upwards as a means or reducing dislocated shoulders was first advocated by Charles White, of Manchester, in 1764, and ever since that time has been in great

* In the table of dislocated shoulders those cases in which reduction occurred during the first movement are marked "Manipulation (A)," and those in which it occurred during the second movement "Manipulation (B)."

favour. I have found it very convenient and most effective. It can usually be carried out without the aid of an assistant, and in many cases it has proved successful after other methods have failed. Reduction by extension upwards was attempted in 26 of my cases, and was attended with success in 21. I have not met with any untoward results from its use, although it is possible that further laceration of the capsular muscles may be produced. In old-standing dislocations, however, upward extension should be used with great caution, since it increases the risk of rupture of the axillary vessels. In recent cases I do not think that with this method the risks of injury to the surrounding parts are any greater than in either the method of lateral extension, where the exertion of a very considerable amount of force is often necessary, or in the method of downward extension with the heel in the axilla. The amount of force necessary, when upward extension is used, is usually not great, and in recent cases the whole process, as a rule, can be completed in a few seconds.

Extension Outwards, with the arm at a right angle with the body, was carried out in 13 cases, all of which had previously been subjected to unsuccessful attempts at reduction by other means. In 10 cases it acted successfully, and in 3 it proved unsuccessful. A considerable degree of force has been necessary in some cases, one assistant making extension upon the arm and another making counter-extension by means of a roller-towel around the body, whilst an attempt has been made to lift the head of the humerus into the glenoid cavity by pressure in the axilla. Occasionally the bone can be levered into its proper position by placing the knee in the axilla and by depressing the arm, thus making the knee act as a fulcrum.

Extension Downwards with the Heel in the Axilla is a method of reduction which is very highly spoken of by some writers. I have had very little experience of it, having, in every recent case which has yet come under my notice, been able to effect reduction by means of one of the three methods already mentioned, with or without the use of an anæsthetic. Extension with the heel in the axilla was tried in only one of the above-tabulated cases, and in that case did not prove successful.

The Administration of an Anæsthetic for the reduction of the displacement was necessary in 13 of my cases. Nine were recent dislocations; four were of some days' or weeks' standing. There is a very general impression in the profession that the administration of an anæsthetic in these cases is attended with special risks. The danger is a very real one, I believe, if the manipulations be commenced before the patient is *fully* under the influence of the anæsthetic, since, under such circumstances, reflex impulses are transmitted

through the cords of the brachial plexus and may seriously depress the heart's action. Whenever I have had occasion to reduce a dislocated shoulder under the influence of an anæsthetic, I have always deferred the manipulations until the muscles were thoroughly relaxed. Reduction has then been effected with the greatest ease, and there has never been the slightest appearance of danger.

Treatment after Reduction.—After reduction of the displacement the arm should be fixed to the side by means of bandages, and it is also advisable to place a small pad of wool in the axilla in order to prevent contact of the apposed skin-surfaces. As a rule it is unnecessary to use strapping to fix the arm. In my own cases I have usually kept the arm at rest for a period of 10 to 12 days, and have then allowed the patient to use a sling. Passive movement of the shoulder-joint was adopted in 6 cases, but only after the bandages had been discarded.

Results.—The results in my cases were as follows:—

Patients not seen after day of reduction	17
„ only seen a few times subsequently	36
„ who attended until apparently quite well	6
„ almost well when last seen (12 days to 5 months after the accident)	9
„ who came again at a later date with re-dislocation	9
	77

Only 6 of the patients attended at the Infirmary until they had apparently quite recovered from the accident. The average period of recovery in these cases was about 6½ weeks.

As a rule I have found that patients who had suffered from several previous dislocations of the shoulder, did not come for any subsequent treatment, or, at the most, only attended a few times. When these patients have come under observation again at a later date with re-dislocation, they have usually stated that they only kept the arm bound up for two or three days after the previous accident, and that they then commenced to use the limb freely.

The amount of subsequent stiffness of the shoulder-joint was recorded in 28 cases. In 14 cases it was slight, in 6 it was moderate in amount, in 5 it was considerable, whilst in 3 there appeared to be no stiffness at all.

Sequelæ.—Hamilton[18], in speaking of the prognosis of these cases, remarks: "To whatever cause we may find occasion to attribute the result, it will nevertheless be observed that, in the great majority of cases, the limb is not restored to all its original strength and freedom of motion until after the lapse of some months; and the shoulder does

not resume its perfect form and symmetry until a much later period; occasional pains, especially after exercise of the muscles, and in certain conditions of the weather, are present also at irregular intervals, and for indefinite periods of time. Opposite and more favourable terminations must be regarded as exceptions to the rule." He quotes several examples of partial ankylosis, lasting for some months or years after the injury. Paralysis or wasting of the muscles is sometimes met with, the deltoid being especially liable to suffer, either as a result of direct injury at the time of the accident or as a secondary result of injury to the circumflex nerve. Hamilton also calls attention to the fact that, after reduction, the head of the humerus often remains slightly advanced in its socket for some months or even years. This may be due to rupture of the posterior scapular muscles, or to extensive laceration of the capsule, or possibly in some cases to injury to the biceps tendon. The liability to re-dislocation of the shoulder has already been referred to.

OLD-STANDING DISLOCATIONS OF THE SHOULDER.

Eight patients mentioned in the preceding table did not apply for treatment at the Infirmary until after an interval of some days or weeks from the time of the dislocation. The time which had elapsed was respectively 5 days (2 cases), 10 days, 11 days, 16 days, 3 weeks (2 cases), and 8½ weeks. Reduction was effected in all these cases without any very special trouble; four of the dislocations were reduced without an anæsthetic, and four under the influence of chloroform.

When dislocation has occurred within a fortnight, reduction can usually be effected almost as easily as in recent cases. After the lapse of two or three weeks, however, the difficulties and the dangers are greatly increased, owing to the formation of adhesions between the head of the humerus and the surrounding parts.

Treatment.—The treatment of these cases has received a very large amount of attention in surgical literature. Very different statements have been made as to the time up to which attempts at reduction should be made. Sir Astley Cooper[19] fixed the limit at three months, whilst Malgaigne[20] said that he would not hesitate to attempt reduction in cases of subcoracoid dislocation after the lapse of six months or more. Sédillot[21] effected reduction in a case of subspinous dislocation after an interval of one year and fifteen days. It must not be forgotten that in these old dislocations there are often adhesions between the humerus and the axillary vessels and nerves, and that in some methods of reduction, more particularly in

the method of upward extension, a great strain is put upon these structures.

Kocher (quoted by F. B. Lund[22]) recommends a modification of his ordinary method of reduction by manipulation. The movements are carried out very slowly, the elbow is carried a little backwards during the first movement, the arm is held for some time in the position of complete external rotation, and a pad is placed in the axilla to act as a fulcrum during the third movement. Kocher was successful by this method in 25 out of 28 old dislocations, 3 of which were of over four months' duration. In 3 cases, however, he fractured the humerus during the procedure.

Burrell[23] has advocated what he calls "fractional breaking up of the adhesions." He conducts the manipulations at several sittings at intervals of ten days. He has reduced a dislocation after the lapse of eight months.

Excision of the head of the humerus has been performed in a number of old-standing cases, and has, on the whole, been attended by a fair amount of success. Of 37 cases collected by F. B. Lund[22], the result was good in 16, mediocre in 5, bad in 2, and unknown in 6. Five patients had died as a result of the operation.

Reduction of the displacement through an open incision, after division of the adhesions and some of the muscles attached to the humeral head, has given excellent results, notably in the cases reported by Lord Lister.[24] F. B. Lund[22] has collected 10 cases of this operation published between 1890 and 1896. In 7 cases the result was good, in 2 cases it was poor, and in 1 case death occurred.

Other operative measures, such as osteotomy of the neck of the humerus, with an attempt to establish a new false joint and subcutaneous section of the capsule, have been proposed, but are open to very obvious disadvantages.

It is unnecessary in this place to do more than refer to the numerous accidents which have occurred during attempts at reduction of old-standing dislocations. The most important is rupture of the axillary artery, which has proved fatal in the great majority of reported cases. Other accidents which have happened are rupture of the axillary vein, injury to the brachial nerves, fracture of the humerus, fracture of the ribs, extensive laceration of the soft parts leading to inflammation and sloughing, avulsion of the arm, cerebral complications, and death from syncope.

RECURRENT DISLOCATIONS OF THE SHOULDER.

Of the many cases included in Table XXXII., in which the shoulder has been dislocated on several previous occasions, the following is

worthy of special notice, because of the very peculiar features which it presented:—

J. W. H., male, aged 45, came under observation on May 26th, 1895, with a subcoracoid dislocation of the right shoulder. He stated that the dislocation had been produced by a violent movement of the arm in an outward direction, and that the same humerus had been previously dislocated 14 or 15 times. Kocher's method, extension outwards, and extension with the heel in the axilla failed to effect reduction, but extension upwards was successful. On February 26th, 1896, he again came under observation with redislocation; but in spite of various attempts I could not succeed in replacing the bone. After having tried manipulation, outward extension and upward extension, I decided to attempt reduction under an anæsthetic, and therefore sent the patient upstairs to the operating theatre. When he arrived there he stated that the shoulder had reduced itself whilst he was ascending the stairs. All he could tell me was that he thought he had given a slight jerk of the shoulder-muscles. As a result of further questioning he stated that the shoulder had been "out" four months before, but that spontaneous reduction had occurred whilst he was walking into the Infirmary, and that he therefore went away without being seen. Altogether dislocation had occurred 17 or 18 times, the first occasion being over 12 years before. Four times he had "got the shoulder in" by swinging the arm backwards and forwards. Several times very great difficulty had been experienced in reduction, and on four occasions the administration of an anæsthetic had been necessary (once in Nottingham, once in Blackpool, and twice at the Manchester Royal Infirmary).

I am unable to give any very satisfactory explanation of the unusual features presented by this case, but think it probable that a portion of the capsule or other soft structure was in the habit of lodging itself between the head and the glenoid cavity in such a way as to offer a serious bar to the ordinary methods of reduction.

Case 561 was also an example of spontaneous reduction. The patient had frequently been under observation on former occasions, but replacement had always been accomplished with the greatest ease.

The pathological anatomy and treatment of these cases have recently been fully considered by Burrell and Lovett.[25] It would appear that the following conditions may be present: (1) Laxity of the joint-capsule, (2) a large unhealed rent in the capsule, (3) partial fracture of the head of the humerus or of the rim of the glenoid cavity, (4) tearing away of muscular insertions or rupture of tendons, and (5) abnormality in the shape of the head of the humerus, probably the result of chronic non-suppurative inflammation.

With regard to treatment in these cases the use of an apparatus, combined with daily massage and exercises for several months, sometimes does good. In bad cases the question of operative treatment may be considered, and one of the following procedures adopted:—

(1) Excision of the head of the humerus. This has been carried out in a number of cases with excellent results, notably in a very

successful case recorded by Mr. F. A. Southam.[26] In Mr. Southam's case the patient was an epileptic woman, aged 45, whose shoulder had been dislocated about 50 times. The tendency to luxation was completely cured by the operation.

(2) Excision of a portion of the redundant capsule. This was performed by Burrell[25] in two cases. In both patients the movements of the shoulder-joint were fully restored, and there had been no return of the dislocation up to the time the patients were last seen.

(3) "Reefing" of the redundant capsule. This was substituted by Ricard[27] for the last method. He adopted it in two cases, and in both the tendency to dislocation was cured.

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Chapter V.

DISLOCATIONS AT THE ELBOW-JOINT.

Dislocations at the elbow-joint are of more common occurrence than dislocations of any other joint, with the single exception of the shoulder. My notes include 33 cases, details of which are given in the accompanying table (Table XXXIII.).

Sex.—As will be seen from the table, 26 of the patients were males, and 7 females.

Age.—It is an interesting and curious fact that dislocations of the elbow-joint occur mostly in the young, whereas dislocations of almost all other joints are of infrequent occurrence in childhood and youth. The ages of my patients were as follows:—

Under 5 years	0
5 to 10 „	5
10 „ 15 „	13
15 „ 20 „	2
20 „ 30 „	4
30 „ 40 „	4
40 „ 50 „	4
76 years	1
	33

From this analysis it will be seen that the injury may occur at almost any age; it is rare before five years of age, and is most common between ten and fifteen years.

Side of Body.—Of 24 cases in which information with regard to this point was recorded, the dislocation was situated upon the left side in 19 and upon the right side in 5 only.

Cause.—An examination of the records of my cases gives the following as the modes in which the injury was produced:—

Falls upon the elbow	14
„ „ „ „ —probably	3
„ „ „ outstretched hand	8
„ „ „ „ „ —probably	1
„ with the arm under the body	2
Twists of the arm	2
Exact cause doubtful	3
	33

The great majority of the cases were thus caused by falls either upon the elbow or upon the palm of the outstretched hand. My

TABLE XXXIII.—Dislocations at the Elbow-Joint.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Nature of Dislocation.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Subsequent Stiffness.	Period of Recovery.	Remarks on Result.
			1895.										
653	20	F	June 7	R	Fall on hand	Backwards	Also fracture of coronoid process (Case 236). Dislocation easily reduced and reproduced with crepitus	Reduction; internal angular splint	28 days	Commenced 14 days after accident	.....	..	Last seen when splint removed
654	22	M	July 1	L	Fall	Backwards	.....	Ditto	15 days	Twice after removal of splint	Slight	5 weeks	.....
655	33	F	July 8	?	Twist of arm	Backwards	.....	Ditto	..	.....	.....	..	Patient not seen again
656	46	M	July 22	L	Fall on elbow	Backwards and outwards	.....	Ditto	..	.....	.....	..	Patient only seen twice
657	35	F	July 23	L	Fall on elbow	Backwards and outwards	.....	Ditto	..	.....	.....	..	Last seen 13 days after accident
658	45	M	Aug 7	R	Fall on arm which was against the side of the body	Outwards (incomplete)	.....	Ditto	6 days	Several times after removal of splint	Moderate	..	Much subsequent swelling; recovery almost complete when last seen, 7 weeks after injury
659	7	M	Aug 18	?	Fall	Inwards (incomplete)	Also fracture of external condyle (Case 191). Head of radius resting on internal condyle	Reduction; anterior angular splint	2 days	Three times: on Sept 3, 10, and 17	Moderate	4 weeks	Much swelling of soft parts which delayed recovery
660	12	M	Aug 28	L	Fall on extended hand	Backwards	.....	Reduction; internal angular splint	9 days	None	None	..	Apparently quite well—no pain or stiffness — when splint removed; not seen afterwards
661	13	M	Aug 30	L	Fall on hand	Backwards	.....	Ditto	11 days	Once after removal of splint	Slight	6 weeks	.....
662	49	M	Sept 2	L	Fall on elbow	Backwards and outwards	.....	Reduction; external angular splint	7 days	None	Very slight	4 weeks	.....
663	10	M	Sept 20	L	Fall on elbow	Backwards and outwards	.....	Reduction; internal angular splint	8 days	None	Very slight	..	Last seen 11 days after injury

664	7	F	Sept 20	L	Fall on elbow	Backwards	.....	Reduction; evaporating lotion; no splint used	..	None	ight	5 weeks	.....
665	10	F	Sept 24	L	Fall on elbow	Outwards (incomplete)	.....	Reduction; external angular splint	..	.....	.....	..	Last seen 10 days after accident
666	11	M	Oct 27	?	Fall on hand	Backwards	.....	Reduction; internal angular splint	19 days	None	Slight	..	Last seen when splint removed
667	34	M	Nov 24	?	Fall on hand	Backwards	Also fracture of coronoid process (No. 237). Reduction and re-dislocation easy	Reduction; anterior angular splint	8 days	None	Slight	5½ weeks	.....
668	13	M	Dec 9	L	Fall on elbow	Backwards and outwards	.....	Ditto	11 days	None	Slight	6 weeks	.....
669	12	M	Dec 9	L	Fall on elbow(?)	Backwards	Also fracture of coronoid process (No. 238). Reduction and re-dislocation easy	Ditto	32 days	None	Slight	5 weeks	.....
670	43	M	Dec 11	L	Fall on elbow(?)	Backwards	.....	Reduction; internal angular splint	..	.....	.....	..	Patient not seen again
671	25	M	Dec 17	L	Fall on elbow(?)	Outwards (incomplete)	.....	Ditto	10 days	None	Slight	..	Last seen 18 days after accident; quite well except some limitation of extension of elbow
672	11	M	1896 Jan 3	L	Fall on elbow	Backwards and outwards	.....	Ditto	11 days	None	Slight	2 m'nths	.....
673	15	M	Jan 6	?	Fall on elbow	Outwards (incomplete)	.....	Ditto	13 days	Once, 18 days after accident, to correct limitation of extension of elbow	Slight	..	Last seen 18 days after accident: quite well except that power of complete extension was limited
674	25	M	Jan 10	R	Fall on hand (?)	Backwards	.....	Ditto	11 days	None	Considerable	6 weeks	.....
675	17	M	March 3	R	Fall on palm of hand	Backwards and outwards	.....	Reduction; external angular splint	7 days	Once, 3 weeks after accident	Considerable	..	Last seen 24 days after accident
676	76	F	March 19	?	Twist of arm	Ulna outwards; radius forwards	.....	Ditto	..	.....	.....	..	Last seen 5 days after accident

TABLE XXXIII.—Dislocations at the Elbow-Joint—*Continued.*

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Nature of Dislocation.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Subsequent Stiffness.	Period of Recovery.	Remarks on Result.
			1896.										
677	13	M	April 20	L	Fall on hand	Backwards	.....	Reduction; internal angular splint	8 days	.....	....	..	Almost well, when last seen, 15 days after accident
678	12	M	April 22	L	Fall on elbow	Backwards and slightly outwards	Also separation of internal epicondyle of humerus (Case 219)	Ditto	..	.....	....	..	Patient not seen again
679	13	M	May 2	R	Fall backwards, with arm under body	Ulna partially inwards; radius backwards	Also probable fracture of trochlea and capitellum (Case 221)	Radius reduced by pressure; ulna could not be reduced, even under chloroform; anterior angular splint	weeks	After removal of splint	Considerable	..	Stiffness improving when last seen 5½ weeks after accident
680	34	M	May 9	L	Fall on elbow	Outwards and slightly backwards	.....	Reduced with difficulty under chloroform; internal angular splint	13 days	None	Slight	..	Almost well, when last seen, 5 weeks after accident
681	13	M	May 18	L	Fall on palm of outstretched hand	Backwards and outwards	.....	Reduction; internal angular splint	8 days	None	Very slight	1 month	.....
682	13	F	May 26	?	Fall on elbow	Inwards (incomplete)	Did not come for treatment until following day	Ditto	13 days	None	Considerable	7 weeks	.....
683	9	M	June 27	?	Fall on elbow	Inwards (incomplete)	.....	Ditto	13 days	None	Moderate	..	Almost well, when last seen, 2 months after accident
684	7	M	July 31	?	?	Backwards	.....	Reduction; anterior angular splint	11 days	None	Slight	2 m'nths	.....
685	9	M	Aug 4	L	Fall on elbow	Inwards (incomplete)	Also fracture of external condyle (Case 204)	Reduction; internal angular splint	30 days	None	Considerable	..	Still considerable stiffness, when last seen, 7 weeks after accident

cases show a larger proportion due to the former cause, but Hamilton[1] says that the latter is the more usual mode of production. Occasionally the injury is due to violent twists of the forearm, or to force acting upon the lower end of the humerus. Malgaigne[2], from experiments upon the dead body and from statements made by patients who had come under his care, formed the opinion that the luxation is most often produced by torsion of the forearm, either from a fall upon the inner side of the forearm or from a fall upon the elbow.

Hamilton[3], from an examination of cases of outward dislocation, has come to the conclusion that the force causing the displacement in these cases is usually applied to the inner side of the upper part of the forearm or to the outer side of the lower end of the humerus. In cases of inward dislocation the force usually acts on the outer side of the forearm or the inner side of the arm.

The rare cases of complete dislocation forwards of this joint have usually been caused by falls upon the elbow with the forearm in a fully flexed position.

Varieties of Dislocation.—In cases of dislocation at the elbow-joint the radius and ulna may be displaced backwards, outwards, inwards, forwards, or the bones may be luxated in different directions. An analysis of my cases gives the following result:—

Backwards	13
,, and outwards	9
Outwards (partial)	4
,, ,, and slightly backwards	1
Inwards (partial)	4
Diverging dislocations	2
	33

(1) *Dislocation Backwards.*—This is by far the commonest variety of dislocation of the elbow-joint; two-thirds of my cases were of this type. Occasionally there is some lateral displacement in addition to the backward displacement. In 9 of my cases the radius and ulna were dislocated backwards and outwards, but I have no record of a case of backward and inward dislocation. The backward displacement may be complete or incomplete. In the former, the coronoid process, if it is not broken off, lies behind the lower end of the humerus, and may lodge in the olecranon fossa. In incomplete dislocation, which Malgaigne[4] regards as of more common occurrence, the coronoid process lies in contact with the lower surface of the trochlea.

(2) *Dislocation Outwards.*—Complete dislocation outwards is a very rare accident. Hamilton[5] says that there are only 19 cases on record. Another case has recently been reported by Sutcliffe[6]. Incomplete dislocation is of more common occurrence, five of my

cases having been of this nature. In one of the cases there was a slight amount of backward, in addition to the outward, displacement.

(3) *Dislocation Inwards.*—It is stated in most text-books that there is no case on record of complete dislocation inwards. Incomplete displacement in this direction was present in 4 of my cases.

(4) *Dislocation Forwards.*—The possibility of complete dislocation forwards of the elbow-joint, except in cases accompanied by fracture of the olecranon, has been questioned by many writers, but there is now no doubt, owing to a number of cases which have been placed on record, that the accident may occur. To the very few cases hitherto published, I am able to add another, owing to the kindness of my friend, Mr. J. Howson Ray. The case came under Mr. Ray's care whilst he was holding the position of Resident Surgical Officer at the Manchester Royal Infirmary, and I am indebted to him for the following details:—

Complete Dislocation Forwards of Upper Ends of Radius and Ulna without Fracture of the Bones.—The patient, a boy aged 13 or 14 years, attending the Manchester Grammar School, was attempting a "set-off" from the parallel bars in the gymnasium, when he miscalculated his distance and fell to the floor. The palm of the left hand, with the elbow almost fully extended and with the arm behind the body, came in contact with the ground. Afterwards the patient rolled over upon his left side and upon the injured limb. He was removed at once to the Infirmary, and was seen by Mr. Ray within twenty minutes of the occurrence of the accident. The elbow was flexed to a right angle and was fixed firmly in that position. The forearm appeared to be lengthened. Seen from behind, the characteristic outline of the lower end of the humerus was easily recognised, owing to the skin and triceps tendon being tightly stretched over the bone. The tendon was lodged in the groove of the trochlea. On the front of the upper part of the forearm the head of the radius and the upper end of the ulna were made out without difficulty. Pain did not appear to be unusually marked. It was evident that there was a complete anterior dislocation at the elbow-joint. No evidence of fracture was present either before or after reduction. Reduction was performed without the administration of an anæsthetic. After a preliminary flexion of the elbow to free the olecranon, extension was carried out in the line of the humerus and with pressure of the knee against the upper part of the forearm. The radius and ulna then traced in succession and occupied the positions of outward, and backward and outward, dislocation. From the last position reduction was easily accomplished. It appears probable that the bones actually retraced the steps of backward and outward, and outward, dislocation, through which they had been carried at the time and by the nature of the accident. The after-progress of the case was uneventful, and when the patient was last seen, about 3½ weeks after the occurrence of the accident, there was scarcely any impairment of the full movements of the elbow-joint.

Another case of forward dislocation of the radius and ulna, without fracture of the olecranon, has recently been recorded by Fulton[7].

(5) *Diverging Dislocations.*—Dislocations in which the radius and ulna are displaced in different directions are not of common occurrence.

A number of varieties have been described, but two cases, which came under my observation, do not conform to the descriptions given. The varieties of these dislocations are as follows:—

(A) *Ulna backwards and Radius forwards.*—This is the commonest variety of diverging dislocation. Hamilton[8] refers to a number of cases, and others have been recorded more recently by Ferguson[9] and by Rockafellow[10].

(B) *Ulna backwards and Radius outwards.*—Hamilton[8] refers to a case of this injury described by Withe. The injury was due to a fall upon the elbow.

(C) *Ulna forwards and Radius outwards.*—Mahner Mons (quoted by Hamilton[8]) reported a case of this injury, which was due to direct violence to the elbow whilst the joint was in a position of acute flexion.

(D) *Ulna inwards and Radius outwards.*—Hamilton[8] also refers to a case of this accident (reported by Warmont) which was caused by a fall upon the palm of the hand.

(E) *Ulna inwards and Radius backwards.*—Case 679 was an example of this injury. There was also fracture of the lower end of the humerus, probably involving the capitellum and trochlea. The radius was easily replaced, but the ulna could not be reduced even under an anæsthetic. Details of the case have already been given in speaking of fractures of the capitellum and trochlea (page 74).

(F) *Ulna outwards and Radius forwards.*—These displacements occurred in the case of an old woman, aged 76 years, whose injury was due to torsion of the arm. Probably the position of the radius was due to the orbicular ligament having been ruptured by the torsion. The case must be regarded as merely a sub-variety of the ordinary outward dislocation.

Pathological Anatomy.—The internal and external lateral ligaments of the elbow-joint are ruptured in most cases of dislocation, whatever be the direction in which the bones are displaced. The same statement applies to the anterior ligament, but the posterior ligament sometimes escapes, especially in cases of backward displacement. Occasionally the orbicular ligament of the radius is also ruptured. The muscles most liable to injury are the brachialis anticus and the anconeus. The biceps is greatly stretched in cases of backward dislocation, but is rarely ruptured.

In a case of forward dislocation, reported by Canton[11], all the ligaments of the elbow-joint were ruptured, the triceps muscle was torn from its insertion, the two radial extensors and most of the muscles arising from the external epicondyle were lacerated and the ulnar nerve was severed.

Complications.—The following complications may occur in these cases:—

(1) *Fracture of the External Condyle.*—This was met with in Cases 659 and 685.

(2) *Fracture of the Capitellum and Trochlea.*—(Case 679).

(3) *Separation of the Internal Epicondyle of the Humerus.*—(Case 678). It is probable that in some cases separation of the internal epicondyle, to which is attached the internal lateral ligament of the elbow-joint, predisposes to dislocation, and hence it is a good rule always to examine the epicondyle in cases of dislocation.

(4) *Fracture of the Coronoid Process.*—This complication was diagnosed in three patients (Cases 653, 667, and 669). These cases have already been considered (pages 89-91).

(5) *Fracture of the Olecranon Process.*—The olecranon was uninjured in all the dislocations of the elbow-joint detailed in the above table, but one of my patients with fracture of the olecranon (Table XVIII.) was said to have had a dislocation which had been reduced before he came to hospital.

(6) *Injuries to Nerves and Blood-vessels.*—These complications are of rare occurrence in dislocations of the elbow-joint.

(7) *Compound Dislocation* is also a rare accident. It must be treated upon antiseptic principles. In a few cases excision of the joint or amputation will be necessary.

Treatment.—The method of reduction of the displacement adopted in most of my cases was the one which was recommended by Sir Astley Cooper[12], and which is in general use in this country. Sir Astley's description is as follows: "The patient is made to sit down upon a chair, and the surgeon, placing his knee on the inner side of the elbow-joint, in the bend of the arm, and taking hold of the patient's wrist, bends the arm; at the same time he presses on the radius and ulna with his knee, so as to separate them from the os humeri, and thus the coronoid process is thrown from the posterior fossa of the humerus; whilst this pressure is supported by the knee, the arm is to be forcibly, but slowly, bent, and the reduction is soon effected."

In a few of my cases the method employed was extension in the line of the forearm, counter-extension being applied to the upper arm. When the displacement was in a lateral direction, reduction was sometimes facilitated by direct pressure upon the upper ends of the radius and ulna.

No special difficulties were encountered in overcoming the dislocation in any of my cases, with the single exception of the case which was complicated by fracture of the capitellum and trochlea, and in which reduction was impossible.

After the bones have been returned to their proper positions, a rectangular splint—internal, external, or anterior, according to circumstances—should be applied. I think that an internal angular splint is best in most cases, but an external splint is preferable when the injury is complicated by separation of the internal epicondyle, and an anterior splint when there is any other fracture of the lower end of the humerus. As a rule I have discarded the splint at the end of 12 or 13 days (average of 25 cases), and have then allowed the patient to begin to use the arm. Passive movement was carried out during the later stages of the treatment in 8 of the cases.

Results.—The prognosis in dislocation of the elbow-joint is more favourable than in most other dislocations. Generally there is complete recovery, and this takes place in a comparatively short period of time. The results in my cases were as follows:—

Complete recovery	13
Incomplete recovery (case associated with fracture of trochlea and capitellum, in which the dislocation was not fully reduced)	1
Recovery almost complete when patients last seen	6
Subsequent stiffness of elbow improving when patients last seen	2
Patients last seen when splint was removed	3
Patients only seen a few times	8
	33

The average period of recovery in the 13 patients who attended until they were quite well was a little under seven weeks. Complete recovery in many of the patients was delayed by a certain amount of limitation of the movement of full extension of the elbow-joint. This I have frequently noted, but have found that it disappears entirely in the course of a few weeks.

The amount of subsequent stiffness of the joint was recorded in 24 cases, and was as follows:—

None	1
Very slight	4
Slight	11
Moderate	3
Considerable	5

Unlike the shoulder-joint, an elbow, which has once been dislocated, does not appear to be specially predisposed to re-dislocation.

OLD-STANDING DISLOCATIONS AT THE ELBOW-JOINT.

In the case of the shoulder-joint the lapse of a few weeks does not, as a rule, increase very materially the difficulties of reduction, but when we come to the elbow-joint we find that after a few weeks the difficulties are very great, and that replacement of the bones may

be impossible. Reduction is usually impossible, without a resort to operative measures, at the end of eight or ten weeks, although there are cases on record in which it has been effected after three to six months or even longer.

A number of operative measures have been proposed and undertaken for the relief of irreducible dislocations. In some cases reduction has been possible after the olecranon has been broken off, either by forcibly flexing the joint or by means of a chisel or saw. Welsh[13] has recorded a case of six months' standing in which he divided the triceps tendon and removed the olecranon. Reduction was then effected, and the result was good.

Resection of the joint or of the lower end of the humerus alone has been carried out in a number of cases.

Stimson[14], in 6 cases of from three weeks' to three months' duration, reduced the dislocation by open arthrotomy. In all the cases he found a growth of new bone from the back of the external condyle of the humerus, due probably to the periosteum having been stripped up. He opened the joint by two lateral incisions. On the outer side the incision was made over the back of the external condyle and the head of the radius, the mass of new bone was removed, and the sigmoid cavity freed from the humerus. On the inner side a curved incision was made behind the epicondyle, and the trochlea was exposed, care being taken to avoid injury to the ulnar nerve. Reduction was then carried out without much difficulty. In all cases the result was very satisfactory.

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Chapter VI.

DISLOCATIONS OF THE UPPER END OF THE RADIUS.

The upper end of the radius may be dislocated in three directions—forwards, backwards, and outwards. Many writers say that backward displacement is the most frequent, but Hamilton[1] has found forward displacement in the great majority of his cases. Outward dislocation is admittedly the rarest variety. Subluxation downwards of the head of the radius is a very common accident of childhood.

Six cases of complete dislocation, which came under my notice, are included in Table XXXIV.

Five of the patients were males and one a female. Their ages ranged from 9 to 61 years. The right arm was affected in four cases, the left in two.

Cause.—Dislocation at the upper radio-ulnar joint may be produced either by force acting directly upon the upper part of the radius or by indirect force transmitted from the hand. Forward dislocation may also be caused by extreme pronation of the forearm and backward dislocation by extreme supination. Amongst my own cases four were probably caused by force acting directly upon the radius, and two by falls upon the hand.

Varieties.—The displacement was as follows:—

Forwards	1
,, and slightly outwards	1
Backwards	3
Outwards and slightly forwards	1

In other cases of this accident which I have seen there has been a great preponderance of forward dislocations, and my experience thus agrees with that of Hamilton that forward displacement is of most frequent occurrence.

Outward displacement is very rare, and is regarded by Hamilton as merely a sub-variety of forward or backward dislocation, since with the latter there is frequently some displacement outwards in addition to the antero-posterior displacement.

Pathological Anatomy.—The orbicular ligament is almost invariably ruptured in cases of complete dislocation. In a few cases, however, it is merely stretched, and slips down upon the neck of the radius. Frequently the anterior and external lateral ligaments of the elbow-joint are also ruptured and sometimes the oblique ligament is torn.

TABLE XXXIV.—Dislocations of Head of Radius.

No.	Age	Sex.	Date of Injury.	Side.	Cause.	Nature of Dislocation.	Remarks.	Treatment.	How long fixed.	Passive Movement.	Subsequent Stiffness.	Period of Recovery.	Remarks on Result.
686	61	F	1895. June 11	R	Fall on elbow	Forwards and slightly outwards	....	Reduction; internal angular splint	7 days	None	Slight	2 weeks	....
687	9	M	July 14	R	Fall on outer side of elbow and forearm	Outwards and slightly forwards	Also fracture of ulna at junction of upper and middle thirds of shaft (Case 407).	Ditto	33 days	None	None	..	Ulna thickened by callus, when last seen, 5 weeks after accident
688	38	M	Sept. 13	R	Arm caught in belt of a machine	Forwards	Also comminuted fracture of shaft of ulna at junction of upper and middle thirds (Case 410).	Reduction; anterior angular splint; redisplacement reduced under chloroform on Oct. 1	29 days	None	Considerable	..	Stiffness much improved when last seen, 2½ months after accident
689	19	M	1896. May 26	L	Fall on outstretched hand	Backwards	....	Reduction; straight splint with elbow extended at first; afterwards anterior angular splint	14 days	None	Slight	..	Almost well when last seen, 4 weeks after accident
690	9	M	June 9	L	Fall on palm of hand	Backwards	....	Reduct on; internal angular splint	7 days	None	Slight	weeks	....
691	14	M	July 10	R	Fall on elbow	Backwards	....	Ditto	11 days	None	Slight	4 weeks	....

Complications.—The most important complication is undoubtedly fracture of the shaft of the ulna, which was present in two of my cases. The important bearings of this complication upon the questions of prognosis and treatment have already been considered (pages 120-124), and it may be well to always make a point of examining the shaft of the ulna in cases of dislocation of the radial head. Hulke' says that the backward and outward varieties of this dislocation are often accompanied by fracture of the external condyle.

Treatment.—Reduction is usually easily accomplished by extension upon the forearm, combined with pressure upon the radial head. Difficulty, however, is sometimes met with, and it may be altogether impossible in some cases to return the bone to its proper position. Under the latter circumstances the best treatment undoubtedly would be an incision with antiseptic precautions, and liberation of the resisting structures.

After reduction I have, as a rule, kept the limb at rest upon a splint for 7 to 14 days. In cases associated with fracture of the ulna the splint has been retained for a longer period.

In one case there was subsequent trouble from redisplacement of the bone, but this was remedied under an anæsthetic.

Results.—Of the four patients who had simple dislocations three made complete recoveries, and the fourth was almost well when I last saw him. The average period of recovery was about four weeks.

The two patients who had also fracture of the ulna were lost sight of before recovery was complete, but the progress in both cases was satisfactory up to the time they were last seen.

Except in one case there was never much subsequent stiffness in the movements of pronation and supination.

Old-standing Dislocations.—Old-standing cases are not of uncommon occurrence, being due in some cases to the accident having been overlooked and in others to impossibility of reduction. Removal of the head of the radius has given excellent results in these cases.

SUBLUXATION OF THE HEAD OF THE RADIUS.

I have seen a large number of cases of this accident, but the mode of production of the injury, the signs presented, and the results are so constant that it is unnecessary to give details. The accident is peculiar to childhood, and is almost invariably due to traction upon the hand. As a result of this, the lower part of the orbicular ligament is stretched and the head of the radius partially escapes from beneath it. On rotating the radius a slight grating is usually felt in the upper radio-ulnar joint, and the child experiences pain in this

situation. Complete recovery almost invariably follows after a few days' rest upon a splint.

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CHAPTER VII.

DISLOCATIONS OF THE ULNA.

DISLOCATION OF THE UPPER END OF THE ULNA.

Dislocation of the upper end of the ulna, without dislocation of the radius, has occurred in a few cases, several examples of backward displacement, and one of inward displacement, having been reported. In most of the cases the radius has been fractured, whilst in the remaining cases the forearm has been markedly deflected to the ulnar side. The injury is necessarily accompanied by rupture of the orbicular ligament.

DISLOCATION OF THE LOWER END OF THE ULNA.

Hamilton[1], from whose book most of my information with regard to this injury has been derived, says that dislocation of the lower end of the ulna is not very infrequently associated with fractures of the lower end of the radius. Without fracture of the radius it is a rare accident.

The dislocation may be either forwards or backwards, more frequently in the former direction. Malgaigne[2] refers to a number of cases, but states that only one—a case of forward dislocation—had come under his own observation. Hamilton has seen four cases, three of backward and one of forward displacement.

Dislocation backwards has been caused most frequently by excessive pronation of the hand; dislocation forwards by forced supination. More rarely the cause has been traction upon the hand or direct violence to the wrist. Kirkby-Thomas[3] has recently reported a case of forward luxation which was caused by the application of severe direct violence to the back of the ulnar side of the wrist.

The injury may be accompanied by rupture of the triangular fibro-cartilage, and of the internal lateral ligament of the wrist-joint.

Reduction is generally easily accomplished in recent cases by traction upon the hand and by pressure upon the lower end of the ulna.

About three years ago an old-standing case of subluxation of the lower end of the ulna, in a man aged 54 years, came under my notice. The displacement was in a backward direction, and was of 20 years' duration. Some months before I saw him the patient had received a blow upon the back of his hand, which had ruptured the extensor tendons of the ring and little fingers. There was no evidence of any old fracture of the radius.

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CHAPTER VIII.

DISLOCATIONS AT THE WRIST-JOINT.

Dislocations at the wrist-joint were regarded as not uncommon accidents by some of the older writers, but their frequency was called in question by Pouteau, and their occurrence was almost absolutely denied by Dupuytren. At the present time, owing to a number of cases which have been examined by dissection, no doubt can be entertained as to their occasional occurrence. In most of the recorded cases the injury has been complicated by fracture of one of the neighbouring bones, or the dislocation has been compound. Simple uncomplicated dislocation is one of the rarest of all accidents. The infrequency of these cases is largely due to the way in which the joint is closely surrounded and supported by tendons. The carpal bones, however, may be dislocated either backwards or forwards; in either case the dislocation may be complete or incomplete.

Three cases of subluxation of the wrist, all of which were associated with fracture of the lower end of the radius, are included amongst my cases. In two cases the luxation was in a forward direction, and in one backwards. The cases have already been referred to in the description of fractures of the lower end of the radius.

DISLOCATION OF THE WRIST BACKWARDS.

Backward dislocation of the wrist-joint would appear to be of more frequent occurrence than forward dislocation. Malgaigne[1] collected eight cases, five of which were compound, and the remaining three cases accompanied by other injuries. Hamilton[2] describes an uncomplicated case which came under his own observation, and other

cases have been reported more recently by Hossack[3], Morton[4], Sell[5], and Körte[6]. In Körte's case the dislocation was compound, and the semilunar bone had not followed the rest of the carpus, but was displaced forwards. My own case was as follows:—

Case 692.—Fracture of Styloid Process and of Posterior Border of Articular Surface of Radius, with Subluxation Backwards of the Carpus.—This case has already been described as a case of Barton's fracture (p. 156). The patient was a man, aged 39, whose wrist was injured, on February 15th, 1896, by a fall upon the back of the hand, with the fingers flexed. The styloid process of the radius was detached, and there was also a fracture of the posterior border of the articular surface. The carpal bones were luxated backwards and slightly upwards; the dislocation could be reduced and reproduced without much difficulty, owing to the presence of the fracture. The limb was placed in anterior and posterior splints, and when the patient was last seen, two months after the occurrence of the accident, there was no deformity of the wrist, and he had recovered almost complete movements in the joint.

Cause.—Backward dislocation of the wrist-joint, apart from cases due to severe crushing forces, has usually resulted from falls upon the palm of the hand. In Hamilton's case it was due to a fall upon the back of the hand and wrist, the hand being forced into a position of extreme flexion.

Pathological Anatomy.—In cases of compound or complicated dislocations the posterior and lateral ligaments, and frequently also the anterior ligament, have been extensively torn (Hamilton).

Complications.—As already stated, complications are usually present in these cases. The dislocation was compound in five out of the eight cases collected by Malgaigne. Many cases have been accompanied by fracture of the lower end of the radius. Pick[7] figures a case in which there was a transverse fracture of the scaphoid bone. Chauvel and Nimier[8] refer to a case in which fracture of the ulnar styloid process was present, and to another case in which the inferior radio-ulnar joint was luxated. When the injury has been compound, there has usually been extensive injury to the neighbouring vessels, nerves, and tendons.

Treatment.—Reduction is usually easily effected by extension upon the hand with direct pressure upon the displaced bones. When the injury is uncomplicated, there is little tendency to redisplacement, and complete recovery usually takes place.

DISLOCATION OF THE WRIST FORWARDS.

This is of rarer occurrence than backward dislocation. Malgaigne[9] collected five cases, three of which had been verified by dissection, and records another which came under his own observation. Erichsen[10] figures a cast of a case which was under the care of Mr.

Cadge, of Norwich. Hamilton[11] quotes a case which was reported by Haydon, of London.

In two patients who came under my notice I diagnosed subluxation forwards of the carpus with fracture of the anterior border of the articular surface of the radius. These cases have already been referred to, and a skiagram of one of them has been reproduced (pages 156-157).

Case 693.—Fracture of Styloid Process and of Anterior Border of Articular Surface of Radius, with Subluxation Forwards of the Wrist.—The patient was a youth, aged 18, whose wrist was crushed by a packing-case, on October 26th, 1895. An examination under an anæsthetic showed a fracture of the styloid process of the radius, and also a fracture of the anterior border of the articular surface. The loose fragments, together with the carpus, were displaced somewhat upwards and forwards. Reduction was effected by extension and pressure, but a certain amount of re-displacement subsequently took place, and the carpus remained permanently partially luxated. A skiagram of the case, taken about 3¼ years after the accident, shows the subluxation clearly (Fig. 25, p. 156).

Case 694.—Fracture of Anterior Border of Lower End of Radius, with Subluxation Forwards of the Wrist.—The patient, a woman, aged 51 years, came to the Infirmary on October 8th, 1895, with an injury to the wrist, caused by a fall upon the hand. There was some doubt as to whether she had fallen upon the palm or the dorsum of the hand. The carpus, which was in place when I first saw her, could be dislocated partially forwards, and returned to place with the application of very little force. I regard the case as very similar to the last-mentioned case, with the exception that the styloid process of the radius was intact. The patient was not seen again.

The causes of the injury, the pathological anatomy, the complications, and the treatment in cases of forward dislocation of the wrist are very similar to those in cases of backward dislocation, and do not require special notice.

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Chapter IX.

DISLOCATION OF THE CARPAL, METACARPAL, AND PHALANGEAL BONES.

DISLOCATIONS OF THE CARPAL BONES.

Dislocations of the carpal bones are of very rare occurrence. In a large proportion of the recorded cases the injury has been of a compound nature, and has been due to very severe violence. The bones which are most subject to displacement are the os magnum and the semilunar. Cases have also been recorded of dislocation of the second row of carpal bones at the medio-carpal joint.

DISLOCATION OF SINGLE CARPAL BONES.

Os magnum.—The os magnum is stated by Erichsen[1] to be more frequently displaced than any of the other carpal bones, but I have only been able to find references to a few cases. The usual causes of the displacement would appear to be falls or blows upon the back of the hand whilst the wrist is in a flexed position, by which the head of the bone is made to start backwards from its socket. Hamilton[2] quotes two cases which have been reported by other writers. Sir Astley Cooper[3] relates two cases in which the os magnum and the cuneiform were displaced somewhat backwards, apparently from simple relaxation of the ligaments.

Semilunar.—Many more cases of dislocation of this bone would appear to have been placed on record than cases of dislocation of the os magnum. The displacement may be either backwards or forwards, more frequently in the latter direction. In most of the cases there has been a wound on the front of the wrist, in which the bone has presented. Examples of forward dislocation have been recorded by Mougeot (quoted by Malgaigne[4]), Taaffe (quoted by Erichsen[1]), Hulke[5], Körte[6], and Stimson[7]. In Hulke's case there was compound dislocation of both semilunar bones, due to a fall upon the hands from a great height.

Pisiform.—Erichsen[1] and Polaillon[8] refer to cases in which the pisiform bone was displaced upwards, owing to rupture of the prolongation of the flexor carpi ulnaris tendon to the unciform and fifth metacarpal bones.

DISLOCATIONS AT THE MEDIO-CARPAL JOINT.

Malgaigne[9] quotes a case of this accident, recorded by Maisonneuve, which was confirmed by dissection after the death of the patient.

The injury was due to a fall for a distance of forty feet. The second row of carpal bones, together with a small fragment of the scaphoid, a part of the cuneiform, and the pisiform bone, was displaced backwards and formed a marked prominence upon the back of the hand.

Mr. C. E. Richmond[10] has recorded a case of this dislocation, in which the diagnosis rested upon an external examination only. The displacement was in a backward direction, and the os magnum and the trapezoid bone were rather more prominent than the other bones of the second row.

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DISLOCATIONS OF THE METACARPAL BONES.

Dislocations of the metacarpal bones are of uncommon occurrence. The first metacarpal bone is the one which most frequently suffers. The four inner metacarpals are so firmly bound down by ligaments that they can only be displaced by very severe violence.

DISLOCATIONS OF THE FIRST METACARPAL BONE.

Dislocation Backwards.—Three cases of this injury, details of which are as follows, are included in my records:—

Case 695.—H. L., male, aged 15 years, came to the Manchester Royal Infirmary on August 28th, 1895, with an injury to the right thumb caused by a fall from a lurry. The exact way in which the hand had come in contact with the ground could not be ascertained. The first metacarpal bone was completely luxated backwards and rested upon the trapezium. There had been no previous dislocation of the same joint. Reduction was easily effected by extension upon the thumb, and a palmar splint was applied. The patient was last seen on Sept. 8th, on which day the splint was removed, the metacarpal bone being in good position.

Case 696.—P.S., male, aged 53 years, met with an injury to the right thumb on December 25th, 1895, but did not apply for treatment at the Infirmary until two days later. The injury had been caused by a fall down some steps, and the end of the thumb had come in contact with the ground. The first metacarpal bone was dislocated partially backwards. The displacement was easily reduced by putting the

thumb in a position of full extension. A pad was placed over the end of the bone, and a splint was applied to the dorsum of the hand. During the after-treatment there was a tendency to re-displacement. When the patient was last seen, about seven weeks after the accident, the proximal end of the first metacarpal bone was somewhat displaced backwards, and there was some thickening of the bone in this situation. He also complained of "weakness" in the thumb.

Case 697.—J. W., male, aged 23, came to the Infirmary on March 30th, 1896. The injury had been caused by a bag of flour falling upon the end of the right thumb. The metacarpal bone was dislocated backwards. Reduction was effected, and a palmar splint was applied. The splint was discarded at the end of twenty days; the metacarpal bone was then in good position, and the movements of the joint were free.

Dislocation of the metacarpal bone of the thumb may be complete or incomplete. The cause is usually either forced flexion or forced extension of the thumb. Dislocation has also been caused by striking a blow with the closed fist. In two of my cases the force which caused the injury was received upon the end of the thumb.

Mr. E. H. Bennett[1] says that a not uncommon injury is fracture of the anterior part of the proximal end of the first metacarpal, accompanied by dislocation at the carpo-metacarpal joint. I think that it is not improbable that such a fracture was present in the second of the above-mentioned cases, since it would explain the subsequent thickening of the bone and the tendency to re-dislocation. A similar tendency has been met with in several other recorded cases.

Reduction of the displacement is usually easily effected by traction upon the thumb and by pressure upon the dislocated bone.

Dislocation Forwards.—The statements made in text-books with reference to the occurrence of this injury depend chiefly upon the remarks of Sir Astley Cooper[2], who says that he has seen cases in which the proximal end of the first metacarpal has been thrown inwards between the trapezium and the second metacarpal bone, but of which he gives no particulars. The only other case on record would appear to be a case of incomplete dislocation forwards, reported by Vidal (de Cassis)[3].

DISLOCATION OF THE FOUR INNER METACARPAL BONES.

The following case of complete dislocation backwards of the second and third metacarpal bones came under my care:—

Case 698.—J. W. R., male, aged 35, came to the Infirmary on August 24th, 1895, with an injury to the left hand, caused by a fall down stairs. There was a very marked projection upon the dorsum of the hand caused by the proximal ends of the second and third metacarpal bones, which were completely dislocated backwards. Reduction could not be effected, even when the patient was under the influence of chloroform. Two days later I first saw the man, and advised him to submit to replacement of the bones through an open incision. An anæsthetic was again administered, and a vertical incision, about 1½in. long, was made over the pominence. The second and third metacarpals were found to be resting upon the back of

the carpus. A very small fragment of the second metacarpal had been torn off with the ligaments. Reduction was easily effected by passing the blade of a raspatory between the carpus and metacarpus and by levering the latter bones downwards. The wound was closed, dressings were applied in such a way as to keep up a little pressure upon the metacarpals, and a dorsal splint was placed along the hand and forearm. The wound healed rapidly and the patient recovered with a slight projection backwards of the proximal ends of the two metacarpal bones.

Complete dislocation backwards of one or more of the four inner metacarpals is an exceedingly rare accident. The only cases on record with which I am acquainted are four mentioned by Polaillon[4] and one by Erichsen[5]. Incomplete dislocation has been seen by Hamilton[6] on several occasions.

Dislocation forwards has only twice been met with. Malgaigne[7] and Hamilton[6] each quote a case reported by others. In both cases the index finger was involved, and in both the injury was due to severe direct violence.

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DISLOCATIONS OF THE PHALANGEAL BONES.

DISLOCATIONS OF THE FIRST PHALANX OF THE THUMB.

The following cases of this injury came under my notice:—

Case 699.—Male, aged 22, accident on June 15th, 1895, caused by a fall upon the thumb (exact position uncertain). The first phalanx was subluxated backwards. Reduction was easily effected. The patient was not seen again.

Case 700.—Male, aged 6, injury due to a fall upon the end of the thumb, on January 10th, 1896. Dislocation backwards; easily reduced by drawing the first phalanx away from the metacarpal bone, and then flexing the joint. Complete recovery took place in from two to three weeks.

Case 701.—Male, aged 17, came to the Infirmary on February 14th, 1896. Injury caused by the end of the thumb coming in contact with a small projecting knob, whilst the patient was sliding down some banisters. The dislocation, which was complete, was easily reduced, as in the last-mentioned case. The patient was only seen once subsequently.

The only case in which I have met with any difficulty in reducing this dislocation is the following:—

Case 702. Male, aged 30, came to the Infirmary on August 31st, 1896, with a complete backward dislocation of 2 days' standing. Chloroform had twice been

administered, with the object of attempting reduction, before the patient came to the Infirmary. After renewed attempts had failed, an incision was made on the palmar aspect. The head of the metacarpal bone protruded through the muscles. Reduction was effected by passing the blade of a raspatory over the metacarpal head and under the base of the first phalanx, and levering the bone into place. The chief obstacle to reduction seemed to be the outer sesamoid bone, although I think it probable that the glenoid ligament also contributed. About three weeks later, when the patient was last seen, he was quite well, with the exception that the joint-movements were not fully restored.

Dislocation of the first phalanx of the thumb may take place either forwards or backwards, the latter being much more frequently met with. Either the forward or the backward dislocation may be complete or incomplete. Vitrac[1] describes two varieties of complete dorsal dislocation. He says that in almost all cases the phalanx is turned slightly inwards as well as drawn backwards, but that there is a rare variety in which it is turned somewhat outwards, and which may result from violence when the thumb is in an extended and abducted position.

Dislocation backwards is usually caused by a fall or blow upon the palmar surface of the thumb. The rarer forward dislocation is due to violence received upon the dorsal surface.

Reduction of the displacement frequently offers no special difficulties. In other cases, however, the difficulties are great, and may be quite insuperable without a resort to operative measures.

Very many explanations have been given of the cause of the difficulty. The locking of the head of the metacarpal bone between the lateral ligaments of the joint or between the two parts of the flexor brevis pollicis, the interposition of a sesamoid bone or a portion of the capsule between the joint-surfaces, and displacement of the flexor longus pollicis tendon have been given as the true causes. There can, however, be little doubt that the correct explanation is the way in which the metacarpal head is driven through the anterior ligament of the joint. Mr. J. Hutchinson, junr.[2], says that this ligament is very strong at its attachment to the phalanx, but near its attachment to the metacarpal bone it is much weaker, and consequently offers little resistance to the escape of the head of the latter bone, when the joint is forcibly extended. It is probable that in some cases the long flexor tendon also aids in preventing reduction.

The various methods of attempting reduction in these cases need not be described, but a few remarks may be made about the mode of procedure in difficult cases. The giving of an anæsthetic alone is useless, since the obstacle to reduction is not muscular action. Moreover, in these days of antiseptic surgery, the dislocation should never be allowed to remain unreduced. The choice of an operation lies

between open arthrotomy and subcutaneous section of the resisting bands. The latter is better if it can be made effective, but it has failed in many cases. Hutchinson, however, recommends that a narrow-bladed knife be passed from the dorsal surface between the metacarpal bone and the phalanx, and that the anterior ligament be divided. He has adopted this method with success in three cases. In all the cases reduction was effected with ease after the ligament had been cut.

DISLOCATIONS OF THE SECOND PHALANX OF THE THUMB.

The second phalanx of the thumb may be dislocated backwards, forwards, or laterally. The dislocation may be complete or incomplete. Backward displacement is by far the most common. In a very considerable proportion of recorded cases, as well as in most of those which I have seen myself, the injury has been of a compound nature.

DISLOCATIONS OF THE PHALANGES OF THE FINGERS.

The first phalanges may be luxated backwards or more rarely forwards. From their more exposed situations the index and little fingers are the ones which usually suffer. Reduction is usually easily accomplished, but Mr. Marmaduke Sheild[3] says that he has found as much difficulty in some cases as in dislocations of the first phalanx of the thumb.

The second and third phalanges may be dislocated backwards, forwards, or laterally. In very many cases the dislocation is incomplete. Until quite recently dislocations of the third phalanx were stated in some text-books to be of very rare occurrence. The statement, however, is incorrect. In the latter part of the year 1897 a case was reported in the *British Medical Journal* by Bays[4]. This was followed by reports of no less than 19 other cases, excluding five cases in which the terminal phalanx of the thumb was dislocated. The injury in a large proportion of these cases was due to blows from cricket-balls upon the end of the finger. In about two-thirds of the cases the dislocation was dorsal, and in one-third palmar.

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