The Harveian Lecture

ON FRACTURES OF THE PATELLA AND THEIR SURGICAL TREATMENT.

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INTRODUCTION.

It is fortunate that the knee-cap is seldom broken.¹ All fractures into joints are especially serious both at the time and afterwards. The joint is sure to become inflamed and cause pain and suffering, and it may in the end be stiff. But a broken knee-cap has a further evil. It is more likely than other fractures to end in bad union and a weak and unreliable limb. In the past this has always been a grave misfortune to the wage-earner, but in the future he will find himself in a sadder plight. Under the Workmen's Compensation Act of 1906 employers are liable to compensate any person under a contract of service—workmen or domestic servants—for personal injury caused by accident arising out of and in course of the employment.² It is obvious that a crippled leg must make its possessor more liable to undergo fresh accidents, to fall again, or get run over. But, in addition, after the knee-cap has once been broken it is more likely than other broken bones to break again. Out of the 38 patients upon whom I have operated, 4 broke the same knee-cap twice—2 broke fibrous union obtained without an operation, and 2 pulled the fragments apart after they had been fastened together by an operation. Both of these will be described hereafter. In each there was an avoidable fault in technique. But not only is a broken knee-cap likely to break again, but when one has been broken the other is not unlikely to follow suit. Four out of the 38 patients upon whom I have operated had broken first one patella and then the other. They were broken at intervals of one and a half, three, eleven, and thirteen years. I question whether my own experience of refracture or of double fractures of the patella is at all unusual.

So employers of labour have good reasons to look askance at those who have broken the knee-cap. The chances of refracture or of double fracture are very considerable; moreover, the strength and security of the limb has to be reckoned with. A weak or crippled limb increases the liability to all kinds of accidents.

Clearly it is of paramount importance that the treatment of fractured patella should give a perfect result. Also that it should give a perfect result in the quickest time. In the past I have treated fractures of the patella either with or without an operation. With the willing help of Mr. A. L. Candler, to whom my warmest thanks are due, a good deal of information has been collected about these cases. I propose to give the results and contrast the two methods of treatment. In addition Mr. Candler has collected some of the other cases treated in my wards, and these too will be used.

In contrasting methods of treatment it is necessary to know clearly what ought to be contrasted. Risks come first, and risk to life first of all. Then the risk to the limb, and last of all the risks to the utility of the limb.

Now, so far as I can learn, no one ever died of a simple fracture of the patella. A patient in my wards died with a fractured patella, but he had grave injuries to his thorax. A compound fracture is another thing altogether. Nor has anyone, so far as I know, ever lost a limb because of a simple fracture of the patella.

So that as far as treatment without operation is concerned, both of these dangers may be put aside, but there remains still that important question, namely, the ultimate value of the limb.

The operative treatment has, on the other hand, dangers which the non-operative does not possess. Although not always recorded, deaths after operation are not unknown, nor can risks to the limb be overlooked. Twice I have seen such severe suppuration after attempts to unite fragments which were far apart that amputation had to

be considered. Should life and limb be saved then, needless to say, the suppuration ends in a stiff and crippled limb.

Although the risks of the operation to life and limb cannot be ignored, yet my own experience—which will be given hereafter—leads me to think that they must be very remote. But however remote they may be, yet they ought not to be incurred if the alternative safe method of treatment without an operation can be relied upon to give sufficiently good results.

THE TREATMENT WITHOUT OPERATION.

At St. Bartholomew's Hospital the treatment without an operation has usually been as follows: For three or four weeks the patient has been kept in bed with the limb extended upon a splint or inclined plane. Sometimes the blood and inflammatory effusion has been removed by aspiration. Some surgeons, including my old master, Mr. Willett, tried to pull down the upper fragment with strapping and elastic traction. About a month after the accident the extended limb is encased in plaster-of-Paris bandages or in a poroplastic splint. These are continued for about a year, during which the patient walks about with a stiff leg. In the end bony union did not take place. The most that could be hoped for was strong fibrous union. We now know that in nearly every instance of fractured patella some of the dorsal aponeurosis is torn off and pulled between the broken ends. This intrusion prevents bony union and retards or prevents fibrous, however close the fractured surfaces can be got together.

These remarks do not apply to those extremely rare instances of fracture without any separation.

CASES ILLUSTRATING THE RESULTS OF TREATMENT.

WITHOUT OPERATION.

The following are some instances—taken at random—of cases treated by long-continued extension of the limb, and are probably fair examples of its results. Some of them had broken both patellae and had had one treated by operation and the other without. These are especially useful for comparison. For example:

I.

In 1909 a carman broke his right patella, and had it operated upon at Guy's Hospital. The skiagram shows that this patella has united by bone, and that the wire has been broken and pieces of it scattered amidst the tissues over the outer tuberosity of the tibia. The next year he broke his left patella. The fracture was transversely through the middle of the bone with half an inch of separation. No operation was performed because he had a stricture of the urethra and his urine contained much pus. He was treated in the usual way. The limb was extended on a splint for about three weeks and then put up in plaster-of-Paris for six months. The skiagram, taken two years and two months afterwards, shows that this patella has not united by bone but with about a quarter of an inch of separation.

The patient himself is of opinion that there is nothing to choose between the two results, and that both are equally good. He has perfect movement in both knees, and is able to earn his living as a carman. He says that eight months elapsed before the right leg, which had been operated on, got well. The left, which was not operated upon, took about the same time.

Clearly good results can be got by both methods, but I should have expected the leg which was operated upon to have got well quicker. Clearly the patient took the risks of an operation without reaping one of its great advantages—a speedy recovery.

II.

At the age of 50 years a man broke his right patella, and had it treated in an infirmary by means of a plaster splint. Eleven years afterwards the fragments are 3 in. apart, and the femur can be felt between them, covered with thin tissues. The knee-joint can only be flexed 15 degrees, and is almost powerless for extension.

When 61 years old he broke the left patella. I treated this by operation. Nine months afterwards he said the leg felt strong. Its muscles were firm and well developed. The knee-joint flexed to a right angle, and extension was perfect. The patella was apparently united by bone with the wire in position. Unfortunately we could not get this man to have it photographed.

The superiority of the operation seems incontestable. Perhaps we ought to know more about the way in

which the splint treatment was carried out upon the defective side.

III.

At the age of 37 a man broke his left knee-cap. The treatment without operation resulted in at least 3 in. of separation; but in spite of this the limb seems to have been a useful one, because three years afterwards he broke the right patella, and after it had been treated, and after this double fracture, he said he could run and catch a tram. His right knee-cap was broken by slipping on a greasy road (February 4th, 1904). The fracture was transverse with the fragments close together. The leg was extended upon a back splint until February 17th, when there was so much swelling and cramp that the splint had to be taken away. On February 24th massage was begun. On March 26th a poroplastic splint was fitted and he began to walk with crutches. The splint was worn for eight months. This man's right patella was not wired because he was a glass fascia writer, and it was considered he would get a sufficiently good result without the risks of operation. Clearly this was so, for in spite of 3 in. of separation on the left side, he was able, as I have said, to run after a tramcar. But on October 6th, 1909, he again slipped crossing a road, and tore through the fibrous tissue by which his right patella had united. On this occasion an operation was performed; the lower fragment was so small that it had to be united to the upper by a horizontal circular loop as well as by the usual vertical wire. He now has a useful but far from perfect limb. The skiagram shows that the wiring has torn out of the upper fragment. Possibly torn a piece of it off, because there is an inch of separation with a shadow between, which may indicate the presence of bone. There is no wasting on this side, and the limb can be flexed to a right angle. His progression is very good, but he cannot run.

Here we have a case in which massage was employed at an early date, and in which, although the results seemed to be good, the patella broke again, and then after wiring pulled apart again, indicating, one would suppose, some fault in the patella itself. It is noteworthy that the patient says he could run after breaking both patellae, and with 3 in. of separation on one side.

IV.

A man broke his right patella in May, 1907. The fracture was transverse with an inch of separation. He was kept for a month in bed with limb extended on a splint. Afterwards a leather splint was worn for two years. Three and a half years after the injury there was much wasting of the muscles of the right thigh and leg. The knee-joint can be fully extended, but only flexed 20 degrees. The man walks with a limp, and says the leg occasionally gives way under him. The fragments of the patella, as the skiagram shows, are barely half an inch apart. They are united by strong fibrous tissue. In spite of this excellent repair of the patella the result is most unsatisfactory, because, although the long-continued splinting had united the patella so well, yet it had wasted the muscles. The man was a printer's outter, and could earn his living although his leg was weak and insecure. Many other occupations would have been closed against him.

V.

In 1897 a woman broke her right patella; it was treated by Sir Thomas Smith, who kept her in bed for a month with strapping on the knee. Afterwards it was in plaster for six months, and when that was taken off a back splint was worn for many months. She says she could not kneel upon it for two years. Thirteen years afterwards the right patella was firmly united by fibrous tissue with the fragments half an inch apart. The muscles of the thigh are strong and well developed; she says she can go quickly upstairs, but cannot run.

In November, 1910, the left patella was broken transversely at the junction of the upper and middle thirds. There was about one inch of separation. This fracture was united by operation. The skiagram shows that bony union is almost completed. The calcification is not yet dense throughout. Clearly the right knee took a long time, although in the end the result was very good. It is rather too soon to say what the left is going to be like, but it promises to give an equally good result in a sixth of the time.

VI.

A porter at a mineral-water works broke his right patella in 1904, and it was treated without an operation. He was in the hospital for three weeks, and wore a splint for eight months. After taking off the splint he began to bend the leg himself, and four months elapsed before he got movement in his knee-joint. In the end the fragments of the patella, which feel of equal size, are slightly movable upon one another; the gap between them is about a quarter of an inch. There is no muscular wasting, and a complete range of movement in the knee joint. He considers that the broken knee is as strong as the other. It never gives way, although he has to carry weights of nearly 2 cwt.

We have here examples of the results of treatment without an operation. (1) Good fibrous union with a good and useful limb. (2) Good fibrous union, with wasting of muscles and defective limb. (3) Wide separation and a useful limb. (4) Wide separation and a wasted defective limb.

None of these cases illustrates (5) the formation of intra-articular adhesions during the expectant treatment. But I have seen such an one operated upon.

VII.

A burly policeman broke his patella in the month of March, and again seven months afterwards, in October. In December the knee was quite stiff, and the fragments of the patella 2 in. apart.

An operation failed to bring them together in spite of much cutting of extensors and retinacula. When the joint was opened, very firm and extensive fibrous adhesions were seen inside it. This is one of the cases which had such severe suppuration after the operation. One would suppose that after the first break the limb became of use again, and that the adhesions formed as the result of inflammation following the second. It is not likely that the man would have broken his knee-cap a second time had the joint ankylosed after the first breakage.

These instances of the results of the treatment of fracture of the patella without an operation are unsatisfactory in two respects. In a large proportion the limb was weakened or permanently lame, and in all the treatment took a long time—perhaps a year on the average.

Some would say that these cases give a far too gloomy impression of the results of the treatment without operation. Unfortunately we have found it difficult to interview many of those who have been treated without an operation. An increasing number of fractured patellae are now operated upon. Last year (1910) 37 cases of fractured patella were admitted into St. Bartholomew's Hospital, and 25 were treated by operation, so that few remain for purposes of comparison. But my own general impression is that the cases I have given are about average samples of the results of treatment without an operation, and by long-continued fixation of the knee. I regret never to have seen any of the results of the treatment of Kraske and Zum Busch,* who "give up the idea of bony union from the onset, allow the patients to go about on the second day, walk upstairs after the eighth day, and report good results." Heroic surgery practised upon heroes.

The question of time is all-important. Wage earners cannot afford the long course of treatment usually thought necessary. The following gives a vivid idea of what time means to the poor. A man writes: "I feel very grateful for the operation which enabled me to start work again after fifteen weeks and this (sic) saved my wife and family from that place we all dread to go—the House." When I place the disadvantages of operative and non-operative treatment before my hospital patients, the saving of time always makes them choose the operative—in spite of a clear statement of the risks.

VIII.

A messenger, aged 52, broke the left patella. It was operated upon in the German Hospital. After a month in that hospital and a further fortnight's rest he says that he was able to work again. Eighteen months afterwards he had bony union with two wires in position—a complete range of movement and a perfect limb. Then he slipped in the street but did not fall. He said he heard something crack in the right knee, but went on wheeling a barrow, and when his work was done walked to the hospital. The right patella was broken across and he elected to have it operated upon. The expectant treatment was declined by this man on the score of time, and also because he thought that he could not mount stairs whilst the knee was being kept stiff.

TREATMENT BY OPERATION.

I now come to the alternative treatment by operation. I have always done the open operation which since 1878 we owe to the genius of Lord Lister; although according to Reichel "three hundred years previously Severino, and later Dieffenbach and Rhea Barton, had performed the same operation."

About some of the details of this operation there is still some divergence of opinion, and therefore I propose to say what I have done myself and try to point out the methods which have given the best results. In the first place there can be no question as to the propriety of always performing an open operation. We now know that some of the dorsal aponeurosis is nearly always torn off and intruded between the broken ends. This effectually prevents bony union, although good fibrous union can take place in spite of its presence there. It is, I believe, impossible to ensure an accurate coaptation of the fragments except by an open operation.

Clinically it is not possible to form a precise opinion of the kind of fracture or of the position of the fragments. To the touch they may feel as if the broken surfaces were

facing one another, whilst as a matter of fact the lower one may be so much tilted that its cartilage faces the broken surface of the upper one. X-ray photographs, too, give valuable information, but they cannot be relied upon to reveal the additional breaks which are so often met with in the lower fragment. An open operation also enables one to remove all the clotted blood from the inside of the joint. This could not be done through a puncture or small wound. And, in addition, rents in the capsule can be repaired.

Most of my operations have been done about the fourth or fifth day, but nothing is gained by delay, and now they are done as soon as the operation is properly organized.

Thirty-nine operations were done upon 38 patients—30 males and 8 females. The youngest was a woman aged 22, the oldest a man over 63 years of age. The right patella was wired 16 times and the left 21. Twice the side is not stated in the notes.

Various skin incisions are in use. The patient who had been operated upon so successfully at the German Hospital had a transverse scar, showing that the operator made use of Lord Lister's original incision. But many surgeons now prefer to cover the line of union of the fracture with a flap rather than leave it directly beneath the wound. Another patient who had been operated upon in Guy's Hospital, and who also had an excellent result, had a vertical scar situated over the long axis of the patella.

I have always of late adopted a semilunar incision, carried at the distance of an inch round the inner side of both fragments; beginning on a level with the highest point of the upper one, and ending at the outer side of the ligamentum patellae. When this flap has been turned up it gives, of course, full access to the fracture, to the interior of the joint, and to the rents in the capsule. As soon as the joint is explored all the blood clot is removed from within it, and not infrequently some of the badly bruised tissues are also cut away with scissors. The blood is nearly always situated between the fractures and in the front part of the knee joint, a circumstance which makes it much easier to extract it with some sort of a scoop or spoon. At times the blood is under considerable pressure, and spurts out when the joint is opened. One would have thought that under such circumstances the patient would suffer additional pain, but a man upon whom I operated a few days ago seemed to suffer little inconvenience although the blood spurted out of his joint in quite a considerable jet. This was the man who pushed a barrow for half an hour after he had broken his knee-cap, and who walked to the hospital when his work was ended.

When any difficulty is experienced in dialodging the blood, abundant lotion is poured into the joint, usually a solution of mercuric binioidide 1 in 4 000, sometimes saline solution; but I question whether the latter is quite to be relied upon in the dust laden air of the City of London.

And next all the dorsal aponeurosis is cut away from between the ends of the bone. This structure is nearly always inturned, and covers part of the broken surfaces of both upper and lower fragments. As a rule the upper is the largest flap. When the operation has been delayed the broken surfaces are often covered with firm reparative material. This is removed with a knife, scissors, or a Volckmann's spoon. This removal is very thorough, and occasionally I have sawn off a thin layer of bone. At this stage of the operation the torn capsule is trimmed up with scissors.

At an early stage of the operation a drainage tube, about one-third of an inch in diameter, is placed at the outer side of the joint. A pair of curved pressure forceps is pushed down the inside of the joint over the external condyle, and made to project in front of the external lateral ligament; here it is cut down upon until it can be pushed through, so that when it is withdrawn it carries with it the drainage tube. It is advantageous to introduce a drainage tube at this early stage of the operation, for it serves to carry off any of the blood which escapes whilst the fragments are being trimmed, or the lotion used to wash out the blood.

In some of my earlier cases the drainage tube was lodged through some part of the original skin incision, but that did not seem to afford such satisfactory drainage. The question of drainage will be referred to again.

I have already remarked upon the difficulty of diagnosing the kind of fracture except by looking at it through an open

wound. The following were met with in 38 cases:—In 29 the fracture was transverse, the fragments being about equal in size, but in 6 of them the lower fragments were smallest, sometimes too small to hold a wire, and in 2 the upper fragment was smallest, but I have never seen the upper fragment as small as I have sometimes seen the lower.

In 2 the fracture was T-shaped, the main fracture crossing the middle of the patella transversely with a vertical fracture through the centre of the lower fragment. In 3 the fracture was transversely through about the centre of the patella, with a small triangular piece broken off the outer angle of the lower fragment. Once the fracture was transverse, with a small triangular piece broken off the inner angle of the lower fragment. Two were Y-shaped, the fractured end of the upper fragment forming an angle which fitted by its apex into a vertical fracture through the centre of the lower fragment. Once the fracture was comminuted, with a transverse fracture through the middle of the patella with the lower fragment broken into three by two vertical fractures, so that there was a large central fragment and a small outer and inner one.

One of the Y-shaped fractures was diagnosed clinically as being a star-shaped fracture. There is a tradition that these fractures unite by bone and therefore do not require an operation.* A woman with what was diagnosed to be a star fracture was treated in the usual way and went to Swanley with a plaster splint on. On her return she broke her knee-cap as she was ascending the surgery steps. On this occasion an operation was performed, and, as I have said, a Y-shaped fracture was found.

I am afraid that I cannot agree with my friend Mr. Burghard that *x*-ray photographs "readily differentiate" the kind of fracture. For the fissures in the lower fragment are hidden by the shadow of the femur.

We have found it hard to learn from the patients how they broke their knee-caps. As a rule those with a transverse break did not hit the knee against the ground, although they may have fallen down. An intelligent man said he was wheeling his barrow in the street when he felt a crack in the knee. He never fell nor touched the ground with his knee, but went on wheeling his barrow, and afterwards walked to the hospital. So his right patella was broken across by muscular action. This case also shows that muscular action may do more than break the bone clean across, because he had a small piece, which was not to be seen in the *x*-ray photograph, broken off the outer angle of the lower fragment, leading one to think that the T- and Y-shaped fractures may also be caused by muscular action, and also those in which the fracture is transverse with a piece broken off the outer or inner angle of the lower one.

Another fairly well educated and intelligent man with the patella broken into four fragments was positive that he fell so that the bone came in violent contact with the ground.

Mr. Blakeway has most kindly obtained for me knee-joints divided vertically. These have been photographed at various degrees of flexion. They confirm what we already know about the movements of the patella. When the knee is bent to half a right angle, a very small area at middle of the patella is in contact with the convex condyle and the bone is most advantageously placed for being broken across the condyle, like—as the books say—a stick across the knee. When the knee-joint is bent at a right angle only the upper third of the patella is supported on the condyles, the lower two-thirds being unsupported, and, as can also be felt, projecting in front. Thus the lower end is most favourably placed for being broken off or comminuted by direct violence—or for being pulled off by the leverage of the tibia acting through the ligamentum patellae. The lower end of the patella is thin and pointed, and, we may assume, unable to offer as much resistance as the rest. We have here some reasons to explain why the lower fragment is usually the smallest. I have not yet met with a vertical fracture in the upper fragment; it has invariably been single. As Mr. Blakeway

* In a recent work on surgery it is said: "The stellate or longitudinal fractures, which are readily differentiated by the *x* rays and which are not accompanied by any marked separation of the fragments, are excluded from this category; in them excellent bony union usually results without operation."—*A System of Operative Surgery*, by F. F. Burghard vol. i p. 611.

suggests, the upper fragment is not likely to be broken again by the quadriceps extensor because it is easily pulled up and can offer no further resistance.

But vertical fractures are quite common in the lower fragment, and are usually central. The outer angle of the lower fragment was broken off in three instances, and the inner is one; I should expect the thin outer angle to be more easily broken off than the thick inner angle, which is supported during flexion upon its crescentic facet.

I suspect, moreover, that during violent muscular action the thin outer edge of the patella may be pulled against the external condyle. I have seen a case of genu valgum in which both patellae were pulled outwards over the external condyle of the femur by the contractions of the extensors of the thigh.

THE OPERATION.

I have always used annealed silver wire to bring fractures of the patella together, and consider it by far the best and most reliable material. One of my patients had previously had his patella united with fishing gut, but it came apart again six months afterwards. When I operated the second time, bony union had not taken place. The fishing gut had come undone at the knot. Every salmon fisherman knows what treacherous material gut is to knot. On these grounds alone it is to be condemned.

Kangaroo tendon was used once last year at St. Bartholomew's Hospital.⁵ Once my colleague, Mr. Rawling, tried chromic gut, but found it difficult to pull upon it enough to bring the fragments firmly together. My colleague, Mr. Bruce Clarke, uses catgut to unite the dorsal aponeurosis and rents in the capsule and puts no other retaining sutures in. He is very contented with the results. I is, he considers, harmful to drill the patella.

Although silver has been used for subcutaneous sutures for many years, we do not know much about its behaviour in the tissues. In the year 1900 I used silver wire ten times for the radical cure of hernia, after the method of Bloodgood. At the beginning of this year I had to remove some of the wire which had been buried in the tissues for about ten years. It had turned black, and all the tissues about it were deeply pigmented.

The photograph of the knee of a patient who had had his right patella united by wire at Guy's Hospital in 1899, shows the front half of the wire, including the twisted part, in position. But the hinder part of the loop has been shattered into three pieces. Two of these, each about one-third of an inch long, are close to the outer side of the tubercle of the tibia, whilst one bent piece three-quarters of an inch long lies over the outer tuberosity of the tibia. This state of things was not suspected until the photograph was taken. Another man, whose patella was wired on January 13th, 1906, and who was photographed in January, 1911, had bony union and a perfect result, but the skiagram shows that the wire has come undone at the twisted part, and that its loose end gradually tapers off, as if it had undergone corrosion.

For simple transverse fracture of the patella I have used a single stout wire. This is applied with the intention of keeping the fragments in accurate contact until they have undergone bony union. Nothing short of bony union is able to withstand the enormous strain of the great extensor muscles. I have never seen it stated, but infer that some surgeons do not attach the same importance to bony union, but expect sutures alone to withstand the action of the extensor muscles. I know an instance in which the patient was allowed to work within six weeks of the operation. The surgeon could not have expected bony union in that time and must have relied upon the wire. The photographs lead me to think that about three months is required for good bony union. Two photographs of uncomplicated transverse fractures show that ossification was not quite complete towards the end of the third month, although the position of the fragments was good. One of my cases illustrates the dangers of using a double strand of wire.

IX.

On February 25th, 1910, I wired the transverse fracture of the left knee-cap for a man aged 27. The wire supplied for the operation was so thin that it had to be used double, both strands being threaded through the same drill holes in the patella and then twisted together in front of it. On August 29th, 1910, the man, whilst carrying a weight, broke the bone again. At the second operation I found that the wires had come undone

at the knot. There had been no attempt at bony union. I suspect that the wire came apart long before the accident, allowing the fragments to separate with failure of bony union. On the second occasion the wires themselves were not taken out; they seemed in perfect position, and by merely twisting them together separately the surfaces came into accurate apposition. In January, 1911, the photograph shows both knots intact and that bony union has taken place. He was seen at the end of February, 1911. He is a fish porter, and says he can carry 2 cwt. of fish—that his left leg feels as strong as the other, and that he can run upstairs. He has complete flexion and extension, but slight wasting of the muscles of the left leg.

This man's case illustrates another point. I usually drill the fragments obliquely, so that the drill hole emerges through the broken surface exactly in front of the articular cartilage. When the wire is tightened up none of it is exposed within the joint. But in this case, as in some of the others, the cartilage was drilled, and the skiagram shows at least half an inch of the loop within the joint. So far no harm has resulted, and I question whether it matters at all. Indeed, I have not hesitated whenever the lower fragment has been particularly small to encircle it, cartilage and all, by piercing the ligamentum patellae.

The fractures were found to be so variable that they had to be wired in a number of different ways, such as:

A. A single verticle loop at the middle of transverse fractures.

B. Two slanting sutures for Y-shaped fractures. The upper fragments drilled once.

C. Four slanting sutures. The fractures being obliquely across the patella with the lower fragments broken into two unequal parts.

D. A single horizontal loop to enclose a piece broken off the inner or outer angles of the lower fragment. Transverse drill-holes. The same used for T fracture with small lower fragments. Mattress sutures not practicable.

E. A horizontal circular suture the same as D, through the upper and both lower fragments of a Y-shaped fracture, combined with two slanting sutures the same as B, but intertwined with the horizontal loop.

F. A horizontal circular suture through the upper fragments and surrounding a very small lower fragment by passing through the ligamentum patellae. Reinforced by a vertical loop through the upper and lower fragments above and below the circular loop. Sixteen months afterwards the fragments were nearly an inch apart, the wires having torn out of the upper fragment. The man had a useful limb because of the presence of fibrous union, and the skiagram shows some bone in it. This man had broken the left patella once and the right twice, the right being the one operated upon.

G. An attempt was made to fix another small lower fragment by using the wire horizontally through the ligamentum patellae, but it tore out sideways. A horizontal loop was carried through the centre of the lower fragment and through the ligamentum patellae near its tibial attachment. This served to reinforce the ligamentum patellae and support a vertical medium suture which held the upper and lower fragments together; and two thin lateral sutures which closed large rents in the capsule and helped to hold the fragments together. The ultimate result was good; four months afterwards the patient had good union, and could kick hard with the leg. Ten years afterwards he writes to say that he is cured and working in a warehouse.

Whilst inserting the wire I have taken care to keep the twisted ends as high as possible so as to be out of the way in kneeling. But when kneeling is painful, as it was in two instances, the pain is not always due to the wire.

X.

I am indebted to Mr. Cyril Thatcher for a very clear photograph of a wired patella. At the operation the lower fragment was very small and consequently the twisted end of the wire was rather low down. Six years afterwards the result is all that could be desired, except that kneeling is painful. Mr. Thatcher's photograph shows the wire in position, and the patella united by bone. But just below the patella there is a small bony nodule in the ligamentum patellae. There is no reason for thinking that this was part of the lower fragment—which, although small, was single—it seems to be a new formation.

XI.

A butcher whose left patella was wired in 1908 said in 1911 that the leg was as strong as the other and that he "could do anything but kneel, because something seemed to pierce the

skin." Here again the lower fragment was very small. The twist in the wire is high up, but the lower end of the loop projects in front at the attachment of the ligamentum patellae.

The wire had to be taken out of 2 of the 39 cases.

XII.

A woman aged 28 had a transverse fracture of the left patella wired on February 10th, 1906, five days after the accident. Large rents in the capsule were closed with silkworm gut. A week later a subacute abscess formed beneath the flap; drains were placed beneath the flap, and one at the outer side of the joint. At this time an offensive vaginal discharge was discovered. The infection was mild and ran a favourable course. Two months after the operation the patella was movable, and nine months later I saw the patient, and she also had a good and movable knee. The wire was removed from a sinus three months after it had been put in; also one of the pieces of fishing gut ultimately came out.

This was before the days of x rays, so that I do not know for certain whether bony union took place, but I think it did. It is the only case out of thirty-nine in which there was suppuration. The operation would not have been done had I known about the infection.

XIII.

The second case was also that of a woman, who was admitted intoxicated with a compound fracture of the right patella. The fracture was supposed to be of the star kind, and should therefore according to tradition, have united by bone. After a projecting piece of bone had been removed there was slight suppuration caused by *Staphylococcus albus* infection. The wound healed and the woman went to our convalescent home wearing a plaster splint. On her return she slipped on the hospital steps and broke her right patella again. When this was operated upon the main fracture ran across the middle of the patella obliquely from above downwards and outwards. The middle of the lower fragment was broken in two vertically. The upper fragment had adhered to the femur but the fibrous tissue was easily broken through. The fractured surfaces were covered with fibrous tissue and had to be refreshed with a saw. Four slanting sutures were inserted. The wound healed by first intention, but later a haematoma was found under the flap and with the wire in view through a minute ulcer in the skin. Gas was given and one of the four wires was removed. Healing quickly followed, but three months after the operation the movements of the knee were limited—although she was walking about quite well. We have been unable to see this woman again.

I do not propose to dwell upon the remaining stages of the operation. The wound is closed and the limb adjusted upon a comfortable splint such as Neville's or Mackintyre's. The drainage tube inserted at an early stage at the outside of the joint is left in position and taken out in forty-eight hours or more. The dressings are put on with a many-tailed bandage, so that it is easy to get at the tube without any movement whatever.

The drain always allows much blood and synovial fluid to escape. I have tried to do without the drain, but the patients usually suffered from far more pain than those who were drained. When the tube was removed, on the third day, from the knee of a man who is said to have had no pain, a gush of synovial fluid ensued. The drain was kept in another knee for several days because some synovial fluid continued to run from it. In another instance bright arterial haemorrhage followed the removal of the tube on the second day. This was at once stopped with a strip of gauze. One man had much reactionary haemorrhage from the tube the night of the operation, and the sheets were soaked with blood. It ceased spontaneously, but the tube was left in for five days. His recovery afterwards was uneventful. Another man had a small haematoma under the flap, but it caused no delay in the repair.

The only complication occurred in an aged working man, who before the operation looked ill and anaemic.

XIV.

He gave his age as 63. The operation was undertaken with reluctance, although he was very anxious to have it done. A week afterwards his leg swelled, and it was clear that he had thrombosis of the popliteal and superficial femoral veins. Three and a half years afterwards he had a very good and useful limb, but said the knee ached a good deal at night. He has chronic rheumatic arthritis in both knees. The skiagram shows good bony union.

I declined to operate upon a man with stricture of the urethra and septic urine and upon another with albuminuria.

To learn the ultimate result we have been able to obtain skiagrams of 12 out of the 37 patients. In 11 there is good bony union with a thoroughly good limb. The case in which bony union failed has already been mentioned. It is that of the man whose left patella had been broken, and as a result of treatment by splint the fragments were 3 in. apart, with wasting of the thigh. He afterwards

broke the right patella, which was also treated with splints, but the bone broke again and was then wired. The lower fragment was so small that it could only be surrounded by horizontal and vertical wires. The skiagram shows that these have come out of the upper fragment leaving a gap of nearly one inch, but with what appears to be a bony nodule in it. The man is well able to do his work, but says that he cannot run or go quickly upstairs. Although he has not got bony union, the leg which was operated upon is certainly the best.

Another patient whose patella was wired for me by Mr. Jameson also has good bony union, and the limb is as good as the other.

A small proportion of the patients had some slight diminution in the degree of flexion, but as this never prevented kneeling it was scarcely noticed.

In spite of excessive wasting of the left leg, owing to bygone infantile paralysis, a man aged 43 recovered with a leg as good as it was before. Two and a half years after the operation he has good bony union, but cannot flex the knee quite so far as he could before the operation.

Considerable differences of opinion prevail as to the best treatment after the wound is healed. Some begin to bend the joint during the third week—massage it—and by the sixth week allow it to be freely used. But, as I have said, bony union cannot be relied on so soon; and therefore, although making use of gentle movements and of massage, I apply a restraining apparatus until the end of the third month, lest the repair be torn through by a sudden bending of the joint. A plaster-of-Paris or poroplastic splint is usually employed, but those who can afford it have a jointed steel apparatus—made with a ratchet—to allow of gradually increasing flexion.

I only find one note to say that nitrous oxide had to be given six weeks after the wiring to break down "many firm adhesions." The formation of adhesions seems to be exceedingly rare.

It has been found desirable to begin massage and movements early when there has been much bruising of the tissues. This is commonest when the fracture is comminuted.

In conclusion, I venture to say that the facts which I have laid before you are most strongly in favour of treating all fractures of the patella by an open operation. That gives a far better result in a far shorter time. The advantages gained far outweigh the risks.

REFERENCES.

1. 14 per cent. of all bone fractures according to Reichel, quoting v. Bruns and Rossi, *A System of Practical Surgery*, E. von Bergmann, vol. iii, p. 573; translated by Bull and Tolley. 2 See that useful little book, *Workmen's Compensation Act, 1906*, seventh edition, by T. Henry Baylis, 1907, p. 73. 3 Loc. cit., p. 578. 4 Loc. cit., p. 578. 5 Surgical Registrar's Report.

THE Belgian Medical Federation, which has recently been recognized by the Belgian Government, includes twenty-five societies, with a total membership of more than 2,500 members. The federation is organizing a professional congress to be held at Charleroi in September next (16th, 17th, and 18th).

H. SCHMIDT, in an article contributed to the *Zeitschrift für Augenheilkunde* (January, 1911), entitled "Cataract Section in One Movement," bears rather grudging witness to the excellence of the cataract knives made by Messrs. Weiss, of London. We cannot do better than translate the author's exact words: "Unfortunately, the extraordinary superiority of the English manufacture, both in material and in workmanship, is seen at a glance. The cutting edge in places approaches a mathematically straight line, whereas the German article shows an unevenness. That part which lies near the edge, and which I will call the stropping zone, forms on the English blade an even band with parallel borders and relatively shallow furrows, whereas the lower edge on the German knife forms an entirely irregular line with deep furrows." Schmidt took one of Weiss's Graefe knives, and two of the very best German knives, and had them photographed under a high magnification; in the above sentences he expresses his opinion of the two photographs. Schmidt found that a Graefe knife could be placed in cold water containing 1 per cent. of sodium bicarbonate and boiled for fifteen minutes without the slightest alteration of its edge when examined microscopically, but if the cold knife be plunged into boiling water and then examined its edge shows minute serrations. He recommends that every knife be annealed by boiling up from cold before being sterilized for use.