

Ch. M.

NOTES ON CERTAIN OF THE RARER DERANGEMENTS OF THE KNEE JOINT

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Submitted for the Degree of Ch. M.(Edin:)

1911.

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The term derangement of the knee-joint has been in use for many years, but it is within the memory of the younger generation of surgeons that the term had a far narrower limitation than it has at the present day, in fact it was practically synonymous with that of "torn internal semilunar cartilage" or "loose body". It is only within the last twelve or fifteen years that arthrotomy has become a safe procedure and even now the scepticism of the lay public becomes obvious when one suggests the necessity for exploration of a knee-joint, showing that the laity has a long memory where surgical catastrophes are concerned. Nowadays however aseptic technique has reached such a general high-water mark of perfection that the exploration of a knee-joint is undertaken as an every-day occurrence, albeit with a deep sense of responsibility. The natural outcome of operative freedom has been the discovery of several varieties of knee-joint derangements previously unknown and this fact coupled with the tremendous advantage that present-day operators possess in good radiograms, have enabled us to make a differential diagnosis with a very fair amount of accuracy. Despite these advantages it is sometimes discovered on opening the joint that one finds a totally different condition to what one expects. During the last five years the writer has been intimately connected with Mr. Robert Jones in Liverpool and has been

singularly fortunate in seeing the interior of between two hundred and three hundred knee joints. Latterly he has been privileged to examine these clinically and radiographically and so is capable of judging for himself the occasional difficulty of an exact diagnosis, which is such that the most skilled observer sometimes refuses to make anything but a tentative diagnosis, knowing that anything more definite is apt to lead to mistakes. One proposes to deal with certain cases that have been seen which have been somewhat off the beaten track, and to dismiss that large majority of straightforward derangements due to tearing, fracturing, or displacement of the ~~semilunar~~ semilunar cartilages - more especially the internal ones. These have been described recently at length by such authorities as Robert Jones and Whitelocke that one feels constrained to write on those conditions which have received less prominence from such a distinguished quarter. Such conditions as dislocation of the patella and derangements due to exostoses will not be included. It is proposed to deal with the effects produced on the knee joint from such lesions as :-

1. Traumatic arthritis due to strain and its effects.
2. Loose bodies.
3. Rupture of the crucial ligaments and injury to the tibial spine.

It is proposed to deal only with details of anatomy and mechanics which have a definite bearing on the section under discussion.

1. Traumatic Arthritis. This term embraces a variety of changes within the joint which are also grouped under the headings of traumatic hydrops and villous arthritis. For the etiology of this interesting condition it is necessary to go into a few points regarding the anatomy of the joint. The anterior part of the capsule is formed by the patellar tendon as the capsule is deficient in the upper and front part of the joint. The aponeurotic expansions which pass on each side to bridge the defects between the anterior and lateral ligaments, for all intents and purposes, may be regarded as being capsular in origin, though strengthened by fascia lata and surrounding tendons. On the deep surface of the patellar tendon is the infrapatellar pad of fat. This is a large pad of soft fat which fills up the interval between the femur, tibia, and patella and is triangular in form vertically, although it adapts itself to the varied forms which the space takes in the different movements of the joint. The pad is separated from the interior of the joint by a covering of synovial membrane and from its surface a band of this membrane extends backwards and upwards to the intercondyloid notch of the femur where it is attached. This band is called the ligamentum mucosum and it is continuous with this band that there runs the investing layer of synovial membrane to the crucial ligaments. The ligamentum mucosum becomes thinned and threadlike at its femoral attachment, but below this it widens out and towards

the region of the infra patellar pad, to which it is attached below, it is broad and triangular and presents two free margins which run down to the lateral borders of the patella in its lower portion. These lateral folds are termed the ligamenta alaria though of course it is obvious that they are merely folds of synovial membrane and not true ligaments. The synovial membrane is very extensive and lines the deep surfaces of the various ligamentous structures which surround the joint and in addition covers both surfaces of the semilunar cartilages, gives a partial investment to the crucial ligaments and also gives a tube-like prolongation to the tendon of the popliteus. The intimate connection of the synovial membrane to the various ligaments is of great importance as it is due to this fact that ligamentous strain is followed by effusion into the joint. If one studies the course of the superior internal articular artery one finds that it ramifies in and around the internal lateral ligament and in very close proximity to the synovial membrane; if there is a rupture of the superficial fibres of the lateral ligament, haemorrhage into the synovial membrane is bound to follow the tearing of the arterial twigs. Again the fact of the semilunar cartilages being covered on each side with synovial membrane accounts for the effusion which occurs if they are damaged. Repeated synovitis due to any cause which brings an effusion into the joint will produce after-effects which will be detrimental to the synovial membrane

itself, to the ligaments by reason of over-stretching, and to the guardian muscles of the joint owing to changes of disuetude. The changes in the synovial membrane are most marked round the alar ligaments for various reasons,. As Tenney has pointed out the ligamentum mucosum is of service in keeping the synovial covering of the infra-patellar pad tense during extension of the joint, thus obviating any tendency for this delicate structure, in part, getting forced in between the femur and tibia. Tenney states that the fibres of the ligamentum mucosum end in the infra patellar pad whilst Pouzat avers that they end in the anterior horns of the semilunar cartilages. One has examined many knee joints during the last few months in the Anatomical Department of the University of Liverpool and has dissected a suitable one to find a reason for this divergence of opinion. It was found that the main attachment of the synovial fold was to the infra patellar pad but that some few fibres did become continuous with the anterior horns of the semilunar cartilages especially the external one. On pulling the whole mass, however, upwards and backwards in imitation of the action of the quadriceps tendon the main force was exerted on the infra patellar pad, the attachment to the semilunars being so weak as to have a negligible effect on these structures. Tenney holds that in formalin hardened bodies the alar ligaments cannot be found, in the majority of cases this is true but the photograph (Fig. 1) shows the fact of their

occasional presence, the folds being so long as to lie over the anterior half of the semilunar cartilages with the joint in full extension, one tab lying over the internal semilunar cartilage at the junction of the anterior one-third with the posterior two-thirds, the commonest position for cartilage lesions. The interest of this fact in view of differential diagnosis will be referred to later. Let us suppose then that owing to a strain of the knee that there has been an effusion into the joint. There will be stretching of ligaments and as Griffiths has pointed out their return to normal is a matter of months rather than weeks, consequently the synovial membrane will become puckered owing to the close relationship between the two. In addition, owing to the enforced rest atrophic changes will have occurred in the quadriceps muscle and as a result the ligamentum mucosum will not have its compressive action on the infra patellar pad that it so ably fulfils with a firmly contracting quadriceps. The infra patellar pad will now become nipped between the articular surfaces of femur and tibia when the joint is extended and as a result of this nipping fresh exudation is produced. A variety of vicious circle is now in full play and all the necessary ingredients for the production of the villous arthritis described by Goldthwait are at hand. Haemorrhages take place into the pad of fat and these undergo a fibroid change, these are plainly seen in the accompanying radiograph (Fig. 2) and the

difference in size between a hypertrophied infra patellar pad (Fig.3) in a case of traumatic arthritis and a normal one (Fig.4) is seen in the prints taken from cases where the knee-joint had been distended with oxygen. Owing to frequent injury the synovial membrane becomes elongated into long finger-like masses simulating villi, and the investing membrane becomes hyperaemic. Microscopically the synovial tags are found to consist of clumps of connective tissue and are richly endowed with blood-vessels. These vessels show signs of perithelial and endothelial hyperplasia and in some cases show a surrounding mass of small round cells whereas in others they are completely obliterated by endothelial over-growth. The villi increase in number as time goes on and owing to their friction against one another in movements of the joints a creaking sensation is elicited on palpation. The irritation of villi rubbing against each other produces an exudation analagous with that due to direct injury by bony pressure. As time goes on degenerative changes take place and tissues of a higher type are replaced by those of a lower variety. The change most commonly seen is fatty degeneration of the villi so that the ends of the villi are seen to be made up of distinct lipomata. Sometimes a considerable fold may undergo this change and here we have the formation of what is known as 'lipoma arborescens'. These masses are usually found to one or other side of the patellar tendon but occasionally they form in the supra patellar pouch. Sometimes calcareous degeneration takes place and in



Fig. 1.
 Elongated synovial tabs. Lyuigon
 the semilunar cartilages.
 Ligamentum Mucosum and tabs painted white.



Fig. 2



Fig. 3.



Fig. 4.

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the folds of membrane quite apart from articular cartilage and bone small cartilaginous and bony masses develop. It is in this manner that certain types of "joint-mice" are formed. It is necessary to state that the condition is purely the reaction of tissues to injury with consequent retrogressive changes although somewhat of the same condition of things is noticed in some cases of synovial syphilis in children and also in Still's disease. It is a difficult problem to solve as to where the dividing line between this villous change ends and hypertrophic osteoid changes of a rheumatoid nature begin, and the mere fact that many cases show progressive signs of the latter condition superimposing on the former leaves little room for doubt as to the correlation between the two conditions. Viewing the condition from the clinical side, one finds that a divergence of symptoms may manifest themselves according as to whether the tabs are short and numerous or few and elongated. The common train of symptoms is referable to the former condition, two cases illustrative of which are appended, but in the latter instance one is very apt to be misled and to diagnose the lesion in the anterior horns of the semilunar cartilages as one can well imagine from the photograph figured previously (Fig. 1). One has seen several examples of this mistake cleared up on the operating table, where removal of an elongated fatty tab in the vicinity of a cartilage has remedied the condition. As will be seen from the accompanying cases the symptoms in general are not so acute as when a cartilage is damaged;

the onset may be somewhat similar if an internal lateral ligament strain is the principal lesion, but there is no subjective sensation of "something giving in the joint" which is invariably complained of in the other condition.

Locking of the joint occurs in both conditions, but where the trouble is synovial it is of a transitory nature and can be always remedied by the patient himself. Exudation follows subsequent damage in both cases but whereas in the former condition it occurs with exercise and no apparent lesion, as for example a long walk; in a cartilage case there is always a history of some mechanical indiscretion which leaves its imprint upon the patient's memory.

Case 1. To quote an example - a male patient of twenty-eight, strained his knee while driving a golf ball off a slippery tee, synovitis with effusion followed. The limb was rested for a fortnight and after effusion had subsided another game of golf was played with a result that effusion returned. This state of affairs persisted for five ~~or~~ six weeks and so he came to Liverpool for advice. The knee was found to be swollen on each side of the infra patellar tendon and the quadriceps was much wasted. There was pain over the internal lateral ligament but the patient was certain that no slipping had occurred in the joint or that any locking had taken place at the original injury. A diagnosis of thickened infra patellar pad with early villous formation and a generalised oedematous condition of the synovial membrane was made. Energetic massage to the quadriceps was advised

and a cage splint, a modification of that described by Heward Marsh, (Fig 5) ordered so contrived as to allow 20° of movement in the joint but preventing full extension. The nipping of the synovial membrane that had been occurring without much pain during walking exercise was now prevented, and the massage toned up the quadriceps and obviated an ineffective mucosal ligament. Full recovery followed and there has been no recurrence of the symptoms. It is only necessary to barely refer to the differential diagnosis between synovial and cartilaginous lesions of old standing. In the former the circumpatellar thickening becomes more evident and the creaking on palpation becomes the most prominent sign. Where the injury is semilunar in origin recurrent displacements become progressively easier to produce although always caused by some slight slip or twist of the foot ^{which} rotates the femur inwards on the tibia and abducts the leg at the knee-joint. Just as the causation becomes easier so do the after effects proportionately become less marked until effusion is most commonly conspicuous by its absence.

Case 2. is of a lady of 35 years and is of interest in that the two conditions under discussion occurred side by side. The history given was that seven years previously there had been some injury to the knee. Gradual disability came on which was slight in extent and consisted of locking which came on periodically due to no apparent cause while walking. This locking was of a transitory nature but swelling occurred invariably afterwards. Three

years ago after playing golf the joint became painful and swollen, the pain continuing at night. As a result she was kept in bed for seven weeks. Since that time the limb has never been well, periodic exacerbations having occurred which culminated a fortnight ago in a definite slipping of something within the joint owing to a slight fall. On examination a large swollen shapeless knee was found which apparently contained a little free fluid but whose synovial membrane was obviously very thickened and oedematous. The circumference of the knee round the supra patellar pouch was 2 inches in excess of that of the other side. There was inability to fully flex or extend the leg and apparently the knee never resumed its original size but remained somewhat pyriform in shape above the lower end of the femur. The X-ray (Fig. 6) shows masses of thickened synovial tissue especially round the infra patellar tendon. Operation was advised as it was surmised the slipping cartilage was keeping up the irritation. The joint was opened by a vertical incision on the inner side, and it was found that the internal semilunar was detached from its anterior attachment. The joint was absolutely full of old blood-clot and there was much fibrous change in the synovial membrane with an exceptional quantity of villous masses. Tufts of these were floating by pedicles and it was obvious that many of them were constantly lying between the articular surfaces of the femur and tibia. The detached portion of the cartilage was removed, and the incision being enlarged the pendulous masses were clipped

away with scissors. The wound was as usual sutured in three layers. There was a tendency after a few weeks for a slight recurrence of the villous formation but with energetic massage the limb made a good recovery. Where operative treatment is for any reason contraindicated it is of great utility to apply a cage splint (Fig 5) so arranged that the hinge joint locks at 30° from full extension. This splint should be worn day and night and its object is to prevent the nipping of the infra patellar pad previously referred to. Combined with the use of the cage splint firm and energetic massage to the quadriceps should be practiced. In a varying period of time generally a matter of eight to twelve weeks more liberty may be given, that is, the hinge joint can be arranged to lock at 20° or 15° short of full extension and if no tendency to exacerbations of symptoms occurs the splint can be discarded in another month. One has seen very good results follow the use of this mechanical treatment but one cannot too emphatically reiterate the necessity for keeping the quadriceps muscle in good condition.

SECTION 2.

Loose Bodies.-

Larrey in 1861 collected the reported cases of this condition operated on from the time of Ambrose Paré. In all they numbered 169, and of these 35 died, but in 1803 William Hey reported a successful case. Loose bodies arise from several causes and the classification of Whitelocke

appears to be a satisfactory one. He divides them into those bodies introduced ~~wa~~ from without, those derived from separation of one of the component parts of the joint, and those derived from growth or formation of structures not normally forming part of the joint. Of cases where the body has been introduced from without, the common intruder is a needle which is accidentally or wilfully introduced. Of this type of case one has seen three instances, one where the joint was filled with sewing needles by the patient herself, a neurotic of the worst type. In another case a child of six years old had the misfortune to run a needle accidentally into the joint while playing on the floor, a needle previously dropped onto the carpet being the determining factor. The third case is of a young lady who struck one as being the reverse of neurotic, who came for examination for vague symptoms of knee joint derangement. A radiograph cleared up the mystery for a fair-sized needle was found lying in or around the tendon of the semimembranosus. No reason for the presence of the intruder could be discovered. These instances are of interest on account of their rarity but it is of the more important group of cases where the body is due to some detachment of a portion of articular cartilage with which we next have to deal. Small chips of articular cartilage are sometimes detached from the femoral condyles by an injury, generally a fall or blow. In one instance a kick sustained on the football field wrought the injury. The following case is typical of the condition.

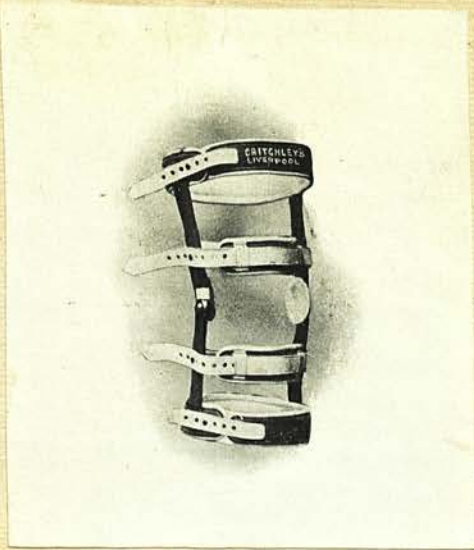


Fig V.



Fig VI.



Fig VII.



Fig VIII.

A = ant: horn of cartilage

Case 3. A youth of 19, an engineer by trade, fell from a platform, a height of 4 feet, on to a tiled floor, striking the right knee which was forcibly bent. The knee was painful, though he found he was able to fully extend the limb immediately after the injury, but it was noticed that the joint quickly filled up with fluid. When the effusion had subsided, a matter of ten days after the injury, the practitioner discovered some hard body lying behind the patella, so the patient was sent to Liverpool for advice. The X-ray (Fig 7) shows a crescentic-shaped piece of cartilage lying in the joint behind the upper portion of the patella, the body evidently having been detached from the external condyle. The loose piece was removed by open operation and full function resulted. A few cases have been seen where a portion of the articular surface of the tibia has been chipped off, giving rise to the same symptoms as described in the above case.

The semilunar cartilages are often the injured part from which a loose body is derived but the body is in this case, as a general rule, attached to its host by a fibrous pedicle. One has seen the anterior portion of the cartilage frayed in part, owing to fracture or rupture to its anterior horn but in addition bearing a cartilaginous body as large as a lentil. This is attached to the torn cartilage by a fine fibrous stalk.

Case 4. A young colliery sub-manager was seen recently complaining of constant locking of the left knee-joint due to a loose body which could be plainly felt extruding between the bones on the antero-internal aspect of the joint.

This mass which feels like a pea can be readily replaced by the patient who by constant practice has learned the necessary manoeuvres of alternate flexion, extension, and tibial rotation necessary to overcome the disability. He states that about 3 years ago while dropping to earth from a scaffolding he alighted with the left foot on an inequality of ground. There was a sickening pain in the left knee and he collapsed in a heap. He rose and found that he could not fully straighten the knee but in spite of pain he continued work. Effusion followed but in the course of a few days the leg gradually became straight. In a week's time a twist of the leg occurred while straining at a heavy weight and a repetition of pain and disability took place. The leg was firmly locked but on placing his hands on the knee and gently kicking out with his foot something went into place with a click. After this occurred effusion lasted for another fortnight. Six months went by without further trouble and then a similar accident to the previous one resulted in like disability, but still no medical advice was requisitioned. In a year's time a sudden twist while turning in bed resulted in locking of the knee and as the patient was manoeuvring the limb, with his hands holding the knee, he felt some lump on its inner side suddenly slip back into the joint and this caused instant cessation of the derangement. From this time on the locking has become more frequent and for the last month or two it has been of almost daily occurrence. Effusion nowadays never follows the derangement and the body when out of place can be plainly felt and its position never varies.

The disability occurs at any time and is not referable to the specific strains involving external rotation of the tibia or abduction of the knee as was the case in the early days of the trouble. An X-ray photograph revealed nothing abnormal. The knee joint was opened by the usual internal incision and at once the body presented into the wound. It was a sausage-shaped body an inch long attached by a thin pedicle to the tibia in front of the spine (Fig 8). It was found to be the anterior half of the internal semi-lunar cartilage, but so changed by an oedematous infiltration as to be quite smooth and cylindrical in shape. The anterior horn formed the pedicle, which was thin and cord-like, this was divided and the body removed. The cartilage was fractured transversely and the posterior half was quite firmly attached and so was left in situ. The case is of interest in that we can trace the change of symptoms from those of injured cartilage to those of loose body. The differential diagnosis between a pedunculated body and a loose cartilage is practically impossible as the symptoms are identical. A radiograph as often as not fails to throw any light on the subject unless as occasionally happens the loose body has a bony basis. One calls to mind at least two cases where the body was plainly felt, the patient in each instance being able to manoeuvre it into the space between the patella and the internal condyle. In each of these cases despite the fact that the bodies were bigger than a pea no sign was manifested by X-ray, but on opening the joint a pedunculated cartilaginous node was removed.

Where a body lies loose in the joint differential diagnosis is not so difficult. Locking of the joint is a frequent occurrence without reference to twist or strain, in fact it often occurs while in bed. The blocking is of an evanescent nature like that due to a synovial fringe but is more acute and painful than the latter. Another similarity between the two conditions is noted in that effusions are very prone to occur in either case. Almost invariably the patient can locate the body and before he appears for advice is generally quite adept in dislodging the offender from one of the inaccessible corners of the joint. The following case is of interest as a loose body was present with a displaced internal semilunar cartilage.

Case 5. A young lady some weeks previous to being seen slipped and fell heavily while leading her horse down a steep rocky hill. The left internal semilunar cartilage was found to be still displaced, there being inability to fully extend the limb although the blocking appeared to be of a fibrous and not of a bony nature. An X-ray (Fig 9) showed a very small body lying near the outer side of the joint and also a minute chip in the region of the internal semilunar cartilage. The cartilage was reduced by manipulation and as it was thought that the small body was fixed and not giving rise to symptoms operation was deferred. After the usual period of rest to the joint followed by massage the wisdom of this step was proved as there has been no return of the symptoms.

The next case is of the same nature as the two preceding ones but exhibits some unique symptoms, -

Case 6.- A youth of 18 was kicked some 15 months ago on the knee by a horse. Synovitis followed which was treated by rest and massage. In three weeks time a radiograph was taken (Fig 10) showing a piece of bone chipped from the region of the external condyle of the femur. Operation was advised but was refused. The boy went about but as soon as full function was obtained sharp pains began to occur, with slight 'giving' of the joint when weight was borne on the flexed knee as in walking upstairs. Consent was obtained for operation and on opening the joint a chip of bone was found fixed to the external condyle by a fibrous union. This was chiselled away and a perfect cure resulted.

In referring to the type of loose body produced by organic change one does not propose to deal with the so-called corpora oryzoidea which are of a fibrinous nature. These are due to degenerative changes of the synovial membrane and occur in tubercular hydrops and in Charcot's disease. They do not produce the classical symptoms referable to bodies composed of organised connective tissues and so do not come within the scope of this paper.

Loose bodies of a type due to organic change in joints with no history of trauma have been the cause of much controversy. As an accompaniment of arthritis deformans it has been long known. However in 1887 Koenig described the formation of these bodies by a process which he considered 'sui generis' and which he named

osteocondritis desiccans, a condition which he held was not due to rheumatoid arthritis and was not the result of trauma. Koenig described the detachment from the underlying joint ends of pieces of cartilage of varying size. These fragments acquire a covering of connective tissue containing some cartilage cells. It is usual to find a defect in the joint segment from which the fragment originated although this rapidly fills in with cartilage. Apart from this separation the joints are otherwise normal except for some effusion and villous hypertrophy and after removal of the foreign bodies they remain well. Koenig admits that in certain cases chondrification or ossification of hypertrophied villi does occur. Koenig's work was disputed in 1896 by Barth who held that arthritis deformans and trauma were the only two modes of formation of loose bodies of chondral and osteochondral nature. Other cases of this condition have been reported by Ludloff in 1908 and Freiberg in 1911 but the presence of the condition as a separate entity still appears to be 'sub-judice' although a radiograph answering to the condition has recently been sent to the writer by Mr. Fairbank of a case seen by him at the Great Ormond Street Hospital for Children. Apart from this one case although many radiograms of foreign bodies have been examined, one has not been able to find any definite cases where there has been no history of trauma or of hypertrophic rheumatoid arthritis present. A body due to organic change in the joint usually proves on section to be composed of fibrous ~~xxxxxx~~ tissue but there is sometimes found to be a



Fig IX.

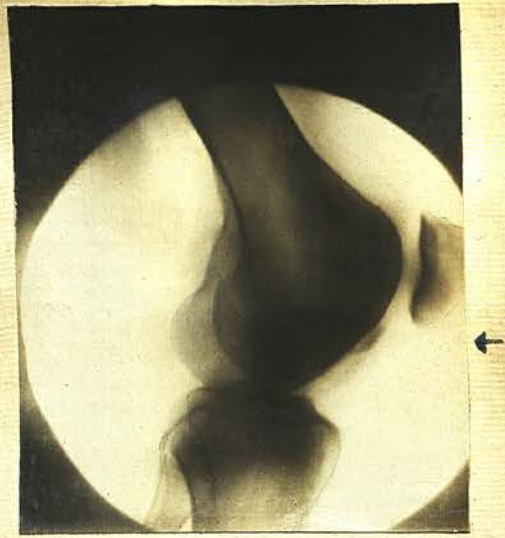


Fig X.



Fig XI.



Fig XII.

central area of a different nature. Lime salts in small quantities may be present with some yellowish material evidently derived from blood pigment, the tissue round this contains groups of cartilage cells. Freiberg assumes that the production of such a pedunculated body was the result of changes in the synovial membrane which were the results of blood vascular proliferation and obliteration. This corresponds with the process suggested by Wollenberg as the foundation for the production of hypertrophic rheumatoid arthritis. Wollenberg's paper is very interesting in that he strives to prove that the changes in cartilage and synovial membrane seen in arthritis deformans and traumatic arthritis are all due to chronic vascular changes. Whether the determining factor is a chronic irritation of toxic or traumatic origin, the result is a congestion and proliferation of blood vessels which cause changes in both cartilage and synovial membrane. As the determining factor increases obliterative vascular changes gradually occur and reduce the blood supply. The result on cartilage is that pieces become detached owing to a rarifying osteitis occurring at the chondro-osteal junction, whereas the connective tissue of the synovial membrane becomes hyaline, then chondrified and finally perhaps calcified. The diagnosis of bodies of this nature is simplified by means of the X-rays.

Case 7 is of a lady of middle age who fell and injured her left knee three months before being seen. A radiogram (fig 11) shows that there has been a detachment ~~and~~ of

a small rheumatoid excrescence. This prevented full extension by 20°. Operation was not permissible so the knee was forcibly extended and kept at rest for two weeks and afterwards a cage splint limiting movement was applied with marked alleviation of symptoms.

(Fig.12) shows most beautifully a supra patellar pouch containing a string of foreign bodies due to hypertrophic rheumatoid arthritis. There was no history of injury in this instance but the patient, a man of 49, complained of recurrent effusions. The bodies were removed by open operation and marked improvement followed, although obviously a rosy prognosis could not be given owing to the bony changes which had occurred.

SECTION 3.

Rupture of the Crucial ligaments and fracture of the tibial spine.

It is proposed to deal with these injuries in one section but it must be understood that although the two lesions bear a distinct correlation, it is relatively common for a crucial ligament to be ruptured without injuring the tibial spine and also that fracture of the spine occurs without damage to the crucials. However the anatomical connection between the above-mentioned structures is such that combined damage in certain forms of injury is to be expected. With reference to the crucial ligaments the subject is one which has received little prominence in literature for although rupture of one or other of the

crucial ligaments must ~~af~~ be of frequent occurrence in lateral dislocation or other such injuries to the knee joint, one can only find reference to operative treatment by Battle, Mayo Robson, Pagenstecher, Hogarth Pringle and Robert Jones. Hogarth Pringle in 1907 published a most enlightening paper on the connection of rupture of the anterior crucial ligament with avulsion of the tibial spine with the report of a case operated upon by stitching the spine into position. This is the first time apparently that the operation had been performed though in 1888 Rickman Godlee described the lesion in a leg he had dissected some years previously which had been amputated by Erichson in 1873. He states that there was much destruction of soft parts by the passage of a cartwheel over the leg, there being a wound from the external malleolus to the middle of the thigh. Fourteen days after the injury amputation was performed and on opening the joint it was found that the piece of bone on the top of the tibia to which the anterior crucial and external semilunar are attached was separated. In the illustration (Fig. 13) (kindly lent by Mr. Rickman Godlee) it is seen that the external semilunar cartilage has been displaced upwards with the torn fragment which is lying free at the inferior extremity of the anterior crucial. These cases apparently form the basis for Pringle's deduction that the injury to the tibial spine was due to excessive traction by the anterior crucial ligament and as such he called the injury 'Avulsion of the tibial spine'. During the last two years one has seen ten cases of tibial

spine injury in Mr. Jones's clinic and although one agrees with Pringle that some cases are undoubtedly traction fractures there are others in which the chip of bone detached does not involve the area to which the anterior crucial is attached so that some other injury is the determining factor in these instances. From the anatomical side it is seen that the superior tibial articular facets extend upwards towards each other at the middle of the joint to form the tubercles of the spine. The summit of this spine is grooved in an antero-posterior direction and is capped on either side by tubercles which spring from, and are formed by, the upward extension of the neighbouring condylic surfaces. The lateral aspects of these tubercles are covered by the same articular cartilage as covers the condylic surfaces. The inner tubercle is higher and also longer in an anter-posterior direction than is the outer one, but the latter is more pointed. These tubercles are by no means constant in size and shape as the accompanying radiograms (figs 14 & 15) picked out from a stock of normal knee joints will plainly show. In view of the mechanics of a variety of tibial spine fracture this is what one would expect and further reference to the subject will be made later. The spines may not be quite vertical but be deflected to the inner side in apparently healthy knees, at the same time however retaining their usual contour. In certain forms of rheumatoid arthritis, more especially the hypertrophic type, the tubercles become changed in shape being more pointed than is usual. One has also seen exostoses growing in front of the spine which if detached for any reason would cause the formation

of a type of loose body. In front and behind the spine the articular areas are separated by V-shaped surfaces which are called the inter-condylic fossae. The anterior fossa is larger and wider than the posterior one and furnishes attachment for the anterior horns of the semilunar cartilages and for the anterior crucial in front of the inner tubercle of the spine. The posterior inter-condylic fossa slopes downwards and backwards and is concave from side to side. The external semilunar is attached by its posterior horn to a surface which rises on to the back of the spine. The internal semilunar is fixed to its inner edge ^{while} ~~by~~ the posterior crucial is attached to its smooth posterior rounded surface. The tibial attachment of the anterior crucial ligament is deserving of note. It is found to be attached to the anterior intercondylic fossa slightly to the inner side of the middle line and lying just anterior to the inner tubercle of the spine, to the base of which some few of its hindermost fibres are attached. The ligament then passes upwards, backwards, and outwards to the posterior portion of the intercondylar fossa. Here it is attached somewhat less strongly than at its tibial extremity to the posterior part of the inner surface of the external condyle. The posterior crucial ligament passes upwards, forwards and slightly inwards and crossing the anterior crucial, is attached in the front part of the intercondyloid fossa to the outer surface of the anterior oblique portion of the internal condyle. From the study of these attachments it is obvious that the anterior crucial becomes tense with the limb in full extension, the posterior crucial meanwhile being slack. With the limb in extreme flexion

the converse does not hold as while the posterior crucial is now tense, under certain conditions of femoral rotation the anterior crucial is likewise tightened. Pringle worked out the mechanism of his two cases on the lines taken by Pagenstecher and others showing that tension on the anterior crucial wrought the damage to the tibial spine. As before stated this lesion does not account for the injury in all the cases one has seen so the following classification is submitted -

1. Avulsion of the tibial spine or its internal tubercle.
2. Fracture of the external tubercle.
3. Injury to the spine combined with fracture of one or other of the tibial tuberosities.

1. Avulsion of the Tibial Spine or its internal Tubercle.

This is the only type of case which has previously been described and as the mechanism of its production appears to be that causing rupture of the crucial ligaments, more especially the anterior one, it is proposed to discuss^{rupture} of these ligaments in this section.

To cause rupture of both crucials extreme violence is necessary, such indeed as to produce complete dislocation of the knee joint. Battle described such a case where he sutured both crucials which were torn from their femoral attachments. Mayo Robson's case was a similar one and the dislocation was due to a fall of coal onto the patient's knee while working in a mine. Pringle has seen two cases of a like nature, in both there was severe laceration of soft parts with rupture of the lateral and posterior ligaments. Robert Jones has seen the lesion occur in forward displacement of



Fig XIII.



Fig XIV.



Fig XV



Fig XVI.

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the tibia due to forcible hyperextension and also in cases where the tibia has been forcibly dislocated backwards and upwards. One has seen the injury follow lateral dislocation of the knee due to the leg being caught in the spokes of a revolving wheel, the damage to the crucials being accompanied by complete popliteal paralysis due to pressure. In these cases the knee is very flail and on manipulation it is possible to bring the head of the tibia forward with the leg extended, showing the involvement of the anterior crucial. On full flexion of the joint the head of the tibia can be pushed backwards into the ham which is proof positive that the posterior crucial is torn. As a rule firm union of the torn crucials follows a prolonged period of rest so that generally speaking if a case is not seen for 5 or 6 weeks after the injury the undue mobility of the tibia is not obvious, though Pringle states that under an anaesthetic the mobility again becomes apparent. This one has not seen although it has been looked for. Rupture of the posterior crucial alone rarely occurs, though Pagenstecher has had one such case which he sutured successfully. Experimentally Honigschmied found it was most easily produced by forcible hyperextension but Pagenstecher obtained the same result by direct backward force applied to the upper end of the tibia with the knee fully flexed. In some cases he tore out the 'intercondyloid eminence' a fact which one has not been able to verify. It was found however that the rupture usually occurred at the tibial extremity of the ligament. The anterior crucial ligament is more

prone to injury than the posterior one and many experiments have been made to throw light on the manner of its production. Dittel ruptured the ligament by acutely flexing the knee joint and at the same time separating the tibia from the femur. On one occasion he managed to tear the spine away, instead of the ligament rupturing at its femoral extremity. Pagenstecher forcibly flexed the knee over a wooden bolster and then struck the upper part of the tibia from behind. After several attempts one has corroborated this experiment, but like Pagenstecher one could never make the ligament tear at its tibial attachment. Pringle ruptured the anterior crucial experimentally by fixing the pelvis and then forcibly flexing the knee joint at the same time abducting and rotating the leg inward. He considers the internal rotation the most important feature but thinks that when the fibres have once begun to tear the abduction plays its part as the crucial is drawn ~~xxx~~ across the sharp internal margin of the external condyle which acts as a lever. In both his cases marked abduction at the knee in extension was displayed but no increase of internal rotation as one would expect. The presence of this one symptom led him to think the injury was to the internal lateral ligament only but in both cases the superficial fibres of this ligament were found to be intact at the operation. Experimentally however the deep fibres of the internal lateral ligament were found to be ruptured with the anterior crucial in all cases. On the cadaver there is no experiment to account

for this wide degree of abduction, unless both anterior crucial and the whole of the internal lateral ligaments are divided, which obviously did not occur. Pringle accounts for the abduction by the fact that as the anterior crucial is torn, the inversion of the femur, round the axis of this ligament, in locking the knee in full extension, does not occur. This being so, in both cases the leg was not tightened up and so the amount of abduction possible in semi-extension with the anterior crucial torn was substituted. In addition, the fact that a greater amount of internal rotation would be possible and so the swell of the calf on the outer side would give the impression of a greater amount of valgoid deformity than really existed. One case of the present series displayed analagous symptoms but another case recently seen where apparently the anterior crucial was partly torn from its femoral aspect is quoted in addition.

Case 8. - is that of a man of 40 who came for advice regarding a slipping knee. He stated that 6 years ago he slipped badly whilst turning quickly with the leg bent inwards. The internal semilunar cartilage was supposed to have been dislocated and since then there have been constant recurrences which are getting worse in nature and frequency. At the time of the original injury his knee never struck the ~~ground~~ ground, but the leg was rotated outwards with the foot fixed while the thigh ^{was} rotated inwards at the knee. At the present time the leg can be fully extended but there is great laxity of the joint both on rotation inwards of the

tibia, which is permitted with the leg fully extended and also on forcible antero posterior movements. An anterior displacement of the head of the tibia is permitted, slightly marked with the limb in extension more so when it is flexed at 30°. The posterior crucial is evidently not involved, as there is no sliding back of the tibia when the joint is fully flexed. An interesting point is elicited on placing the hands on the joint while the patient extends the limb. Just before full extension is reached the femur appears to suddenly become displaced inwards and this constitutes the slipping the patient complains of. The radiograph (Fig.16) shows that there is a chip from the inner side of the spine. In this case apparently the ligament has torn away a small spicule of bone and this accounts for the fact that there was no impediment to full extension of the joint which was the most marked symptom in all the other cases. Unfortunately operation was refused. A cage splint to prevent rotation of the tibia was fitted but scant alleviation of the trouble resulted. It is doubtful whether the internal semilunar cartilage was ever displaced at all. Another case seen lately is apparently of the same nature but with less marked symptoms.

Case 9 A professional footballer came with the history of having been severely tackled in one of the last matches played last season. He fell as far as he remembers with the leg doubled under him. No marked effusion followed and he felt little or no ill effects after a



Fig XVII.



Fig XVIII. (A-Views)



Fig XVIII. (Side view)



Fig XIX.

few weeks. This season he has been playing off and on but he now complains of a 'giving' in the left knee joint. There is no history of anything slipping within the joint and the knee has never locked. The disability only occurs during a hard match. On examination there is found to be no laxity of, or pain over, the internal lateral ligament but there is some pain on deep palpation on each side of the infra patellar tendon. The limb is extremely muscular and no definite abnormality in internal tibial rotation or antero posterior mobility is to be elicited. At will however the patient can on full extension slide the femur forwards on the tibia, the condyles moving forwards and inwards. This is somewhat painful and constitutes the disability complained of. The X-ray (Fig. 17) shows the least suspicion of roughening at the inner margin of the external condyle and at the tibial spine as if some fibres had been torn away and bony overgrowth had occurred. Operation was refused although an exploratory arthrotomy was strongly advised. It is suggested in this case that the anterior crucial has been weakened or elongated by injury but only to a slight extent. Three other cases come within the same category but the symptoms and mode of production of the injury though analagous to eachother bear no resemblance to Pringle's cases. In all the predominant feature was inability to fully extend the limb by about 20°, the nature of the blocking being felt to be bony and not fibrous when forcibly endeavouring to extend the limb. In no instance were there any signs of the crucial ligaments being torn,

no abnormal mobility being present, even when the patient was anaesthetised. Operation was performed in one of the cases and the reason of this was apparent as it was found that the anterior crucial was only partly torn. As far as one can gather the mechanism in these cases was that described by Pringle - i.e. - flexion, abduction, and rotation either inwards or outwards of the tibia. A short history of each case is appended.

Case 10 A man of 38 was thrown from his bicycle about 14 weeks ago, he fell on his knees and then pitched forward. The knee filled with effusion and he has never been able to straighten the limb since. On examination the thigh muscles were found to be wasted and there was pain over the external lateral ligament. A diagnosis of displaced semilunar was made and so an anaesthetic was administered to reduce it. On relaxation of the muscles the bony nature of the block was made manifest so an X-ray was taken (Fig. 18) which showed the true nature of the injury. It will be seen that the external tubercle is intact but that the internal tubercle is much blurred through formation of new bone. The fracture which extends into the base of the spine on the inner side is seen to be a traction fracture, the force apparently having expended itself before the fracture was complete. Open operation in due course was performed in the flexed knee position and a large collection of infra patellar fat had to be removed before a view of the spine could be obtained. The external semilunar was normal. New bone had formed an attachment to the tibia and this was chiselled away,

some fibres of the anterior crucial which were involved in the mass being sacrificed. A good portion of the ligament remained however unaffected. After removal of the mass the leg could be almost brought straight and much improvement resulted but complete extension was not possible when the patient was last seen, new bone having apparently been thrown out so the result is only classed as a partial recovery.

Case 11 A drill sergeant while doing gymnastics fell from the horizontal bar and dropped on to the inner side of the right foot, the leg slipping outwards. He felt a sharp pain in the knee and fell in a heap. The knee was very painful but he walked on it for about 5 hours when the pain increased so much that he had to lie up. The knee was now found to be very swollen and felt very tight and sore. The pain and swelling lasted for a week, he remained in bed for another fortnight and then resumed duty but found he could not fully extend the leg when springing to attention. On examination it is found impossible to fully straighten the leg, locking taking place about 25° from straight. There is a grinding pain when one attempts to force the knee. The X-ray (Fig. 20) shows that the internal tubercle and possibly the external one are involved. Operation was not performed in this case and full extension despite rest and attempts to straighten is not yet possible.

Case 12 An old gentleman of 65 while walking in his park three weeks ago was unfortunate enough to be tossed over some railings into an adjoining field by one of

his own stags. He fell on soft grass onto the front of the fully flexed knees after having described a somersault. Naturally he was much shaken but he got up the next day and thought that the injury he had received was a strained back. He has walked freely since then, up and down stairs and in his grounds, which are hilly, without pain but finding himself unable to fully straighten the right leg. However three days ago he felt a sudden sharp ^{pain} in the knee which has since become worse. The pain is marked while lying on his back in bed and to ease it he crosses the right leg over the left in order to relax the knee. There is pain on palpation over the insertion of the biceps and the anterior horn of the ~~interior~~ internal semilunar cartilage. The X-ray (Fig. 19) shows a fracture of the inner tubercle of the spine. The limb was forcibly extended and kept thus in a back splint for a fortnight. A cage support was fitted and the limb energetically massaged for some weeks and a nearly normal range of movement resulted. In the absence of all signs of anterior crucial rupture it was presumed that the ligament had suffered but little as in the previous two cases. Feeling that perhaps the damage in this instance differed from that of case 10, there being no evidence of avulsion in the nature of the fracture, one is led to think that the mechanism may be similar to that which one believes takes place when the external tubercle is fractured. In this case the lesion was probably of the nature of ~~the~~ a shearing off of the tip of the spine from behind forwards by means of the outer edge of the internal condyle of the femur. It is well known that there is a rotation inwards of the femur



Fig XX. (A-P view)



Fig XX. (Side view)



Fig XXI



Fig XXII.

on the tibia, the so-called 'screw home' action which completes full extension. If a person then falls on the fully flexed knees with the toes turned inwards, a force acting in the axes of the femora from behind forwards would act momentarily, gravity would then bring forward to the body, up to the present bent at the waist. The knees would thus be extended without the line of pressure being removed from them, and owing to the extreme rotation inwards of the tibia the 'screw home' action would not be allowed to come into play. The sharp outer margin of the internal condyle instead of circling round the internal tubercle as it normally does, through the axis of the anterior crucial, would impinge on the back of the internal tubercle, would fracture it, and carry it forwards.

2. Fracture of the external tubercle.-

This fracture has not been described before, but it has been the cause of disability of three of the cases seen within the last two years. It is thought that this fracture has no connection with the anterior crucial ligament, as the spicule of bone removed is generally so small and does not involve the region of the attachment of this ligament. For the same reason the posterior crucial has no part in its production as was seen at the operation on the one case of this type whose joint has been opened. It is considered that the injury is due to the shearing action of the inner sharp margin of the external condyle by a force which acts from behind forwards, though conversely the same result obtains through

the head of the tibia being forced backwards. As previously stated much variation in the height of the spine appears in apparently normal knees, examples of a high and low type being figured (Figs. 14 and 15). It is obvious that for the possibility of fracture of this tubercle to occur, its height must be such as to make it feasible. The difficulty of finding high spines in dissecting room parts was not overcome until a good number had been examined. A suitable one was obtained and the idea was to partially chip off the external tubercle with a small chisel and to finish the fracture by manipulation. Judge of one's surprise when the outer tubercle was found to be fractured and fixed to the base of the spine by means of fibrous tissue (Fig. 25). A radiograph was also taken of the specimen (Fig. 25) which showed the bony nature of the loose body. The reproduction in miniature however hardly does the original plate justice. In every instance the fragment has been displaced forwards no matter what the type of case may be. Here the fragment lies behind the anterior crucial, very little if any forward displacement being present. In view of this fact and also that the joint exhibits the changes due to the hypertrophic type of rheumatoid arthritis one wondered if it were a rheumatoid change purely and simply. The opinion of several well-known experts was obtained, including that of Goldthwait of Boston, who on seeing the specimen stated that he had never observed such a change in rheumatoid cases. The bony fragment was easily moveable but firmly anchored by fibrous tissue

to the subjacent spine. Experimenting on this joint by rupturing the internal lateral ligament, rotating the tibia outwards, and then abducting the knee it was found that by carrying the femur forward and slightly rotating it inwards there was produced a jamming of the sharp inner margin of the external condyle, which with a high tubercle would cause the partial dislodgement forwards of the latter. It is assumed that the spicule is not wholly separated or that it impinges against the anterior crucial. Whatever happens, one has not seen a loose body attributable to this accident. Probably the inflammatory exudate organises and so fixes the broken portion to the spot where it is subsequently found. One finds that on the cadaver, with the internal lateral ligament divided, the posterior crucial will permit the shearing edge of the condyle to impinge on the spine, there being no necessity to cut it to allow this range of sliding movement. This mechanism is of interest as it appears to be similar in a measure to that producing dislocation of the internal semilunar cartilage, but the force is apparently of a more sustained character.

Case 13 A young colonist injured his left knee fifteen months ago through a fall (unfortunately the precise details are wanting) which was followed by synovitis. The knee joint is now normal except that its range of movement is restricted by 15° from full extension. On attempting to force this blocking, which is very firm there is much pain. The radiograph (Fig. 21) shows the injury to the external tubercle of the spine. Operation was advised and this was acceded to. The knee was opened by a long straight

incision on the outer side and the small piece of bone was removed which was ragged in texture and was bound tightly by fibrous tissue to the front of the anterior crucial ligament. No chiselling was required as in Case 10 but the mass was cut away with a scalpel. The patient made a perfect recovery and returned to South America, hence the inability to obtain the necessary details of the onset of the trouble.

Case 14 The patient, a farm labourer, had the misfortune to be run over by a waggon three months ago. The wheel passed over both knees but the man was unable to state in what position his legs were at the time. The right knee is now quite well, but the left one still swells and it is not possible to fully straighten it. On examination one finds that full flexion is possible without pain but that extension is limited by 15° . There is pain over both external and internal lateral ligaments. The radiograph (Fig. 24) shows that the external tubercle is injured and displaced to the inner side. The knee also shows slight hypertrophis rheumatoid changes. The knee was forcibly extended under an anaesthetic and kept at rest for two weeks, after that time massage and movement were persevered with and a marked improvement accrued. Cases 15 and 16 both gave a history of internal lateral ligament strain due to injury and in both, as will be seen from the photographs, injury to the external tubercle has occurred. Case 15 (Fig. 22) was a middle-aged man whose X-rays shows only the suspicion of crushing of the external tubercle. Case 16 was seen several years ago and is the outcome of



Fig. XXIII



Fig. XXIV.



Fig. XXV
X-ray of specimen.



Fig. XXV.
Detached portion of bone lies in front of the anterior cruciate ligament (which is cut short) and between the horns of the external semilunar cartilage.

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the search through many X-ray negatives to find, if possible, any such injuries which might have remained undiagnosed in years gone by. The only instance of suspicious injury (Fig. 23) appears to be similar to the last three cases but on account of not being able to trace the patient it is only quoted as a possible example.

3. Injury to the spine combined with fracture of one of the tibial tuberosities. -

Two cases come under this heading, in one the external tubercle was fractured with the internal tuberosity, and in the other exactly the reverse occurred. The injury in each case seems to have been more severe and the nature of the violence applied more direct than in the cases discussed in the previous section as will be seen from the history of each.

Case 17.- A workman in an iron foundry injured his right knee four months ago. He was sitting down working at some machinery on the ground and his left leg was curled beneath the right one. The right foot rested flat on the ground with the ankle extended, and the leg was bent about at a right angle with the thigh. While in this position an iron bar weighing nearly a cwt. fell directly downwards onto the region of the condyles of the femur. As far as the patient remembers the knee was forced inwards but of this he is not certain. Most of the force however was expended on the knee and caused severe contusion in its neighbourhood and in addition there was a jagged wound in the region of the supra patellar tendon. There was much effusion in the knee

joint which lasted for three weeks, during which time he was confined to bed. It was not possible for the patient to straighten his knee after the accident and this disability has remained ever since. He has since gone about with crutches.

On examination one finds that the range of movement in the knee joint while normal as regards flexion is wanting by 30° towards full extension. On palpation one finds marked thickening of the infra patellar pad. There is involvement of the internal lateral ligament as is evinced by the amount of abduction at the knee that is permitted. With this however there is no abnormal rotation of the tibia nor undue antero posterior mobility of the joint. The X-ray (Fig 26) shows a fracture of the external tubercle of the spine combined with a crush fracture of the internal tuberosity of the tibia. Operation was advised and is to be performed in the near future.

Case 18 A man of 38 while cycling three months ago was thrown headlong over the handles of his machine as the result of a collision. The left knee was badly damaged. As far as he could recollect he fell on the flexed knees. He was picked up, and conveyed home to bed where he remained for a fortnight. There was much effusion in the knee and extensive bruising around its neighbourhood. He has since walked with the knee stiff but bent to an angle of 120° , that is to say - 60° from full extension. On ~~xxxx~~ examination the knee is found to be quite stiff and there is some lateral displacement of the leg to the outer side with rotation inwards of the tibia on the thigh.

There is much pain on palpation over the internal lateral ligament and synovial effusion is still present especially noticeable in the upper pouch. The radiogram (Fig 27) shows a fracture of the spine mainly involving the inner tubercle together with a crush fracture of the external tuberosity of the tibia, which is somewhat displaced and renders the head of the tibia wider than normal in consequence. Stereoscopic radiographs show the detached piece of bone lying in the middle of the joint. It was decided to try the effect of manual correction of the deformity before resorting to a resection of the knee, although no amount of joint mobility was prognosed. Under an anaesthetic the limb was with difficulty extended, but the lateral displacement of the tibia still remains. After three week's rest, massage and graduated movement were practised with the most gratifying results. A good range of movement, about 60°, was obtained within a few weeks and complete extension of the joint with 90° of flexion is now possible. The patient is now back at his original work.

In the main the mechanism of these cases appears to be the same with the difference that probably in the latter the integrity of the anterior crucial ligament was involved whereas in the former instance it was untouched. The force in case 17 apparently was directly applied to the head of the tibia, through the intermediation of the condyles of the femur. The blow one would imagine fell in a downward and inward direction so that the outer tubercle was first struck by the outer condyle,



Fig XXVI. (Side view)



Fig XXVI. (A.P. view)



Fig XXVII.

and the internal lateral ligament giving way at this moment, the rest of the force was expended on the internal tuberosity. The reason of this is that the antero posterior dimension of the femur at the upper end of its trochlear surface is greater on the inner than on the outer side. The force probably ceased to act when the knee was bent inwards, if as the patient asserted, this took place. In the latter case no doubt the reverse occurred, the force falling in a downward and outward direction, though from the patient's history there is no definite evidence that this was so. One can very well imagine that as the accident appears to have been similar in nature to that occurring in case 12, more damage would have occurred in the latter instance had the patient fallen onto a hard ~~XXXX~~ surface instead of onto turf. From the history of the cases grouped under the different headings much has been gained in the attempt to elucidate the manner of production of the injury, and though one may be at fault w in the various ideas above enumerated, the story of the patient in each case seems to have been in accord with the theories expounded.

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C O N C L U S I O N S

It cannot be too strongly urged that a radiograph is necessary before proceeding to arthrotomy in cases of knee joint derangement of long standing especially ~~where~~ where the initial injury was severe.

Mechanical treatment to prevent full extension of the joint and thus tending to obviate nipping of the infra patellar pad in cases of traumatic arthritis, should be tried before operative procedure is resorted to.

Loose bodies unless of the nature of bony detachments are rarely discernable by the X-rays. If a definite shadow is cast in a case where there is little history of injury it is advisable to be on the look-out for signs of hypertrophic rheumatoid arthritis.

In view of the number of cases of tibial spine injury seen in the last few years, ~~while~~ it is suggested that the injury is not of such extreme rarity as previous writers have assumed. The traction type of fracture (avulsion) either complete or partial, probably accounts for 60 per cent of all cases of this nature, the remainder being caused by the shearing action of the femoral condyles. This variety of the injury can only occur where the tibial spine is fully developed. It has been noticed that in many cases of hypertrophic rheumatoid arthritis the spine is conspicuous by its small size, although this is by no means the rule.

Good results have followed forcible extension of the joint in these fractures, but in one of the two cases that

underwent operation, full function followed, although the symptoms in this particular instance were not so severe as in several others where forcible correction was practised.

The writer's best thanks are due to Mr. Robert Jones~~f~~ for the use of his cases and radiographs which have been quoted in this paper.

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