

**Internal derangements of the knee-joint : thesis submitted for graduation
as M.D. of Edinburgh University, April 1886 / by W. Scott Lang.**

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Publication/Creation

Edinburgh : Printed by Oliver and Boyd, 1887.

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(4.) Received April 13/86
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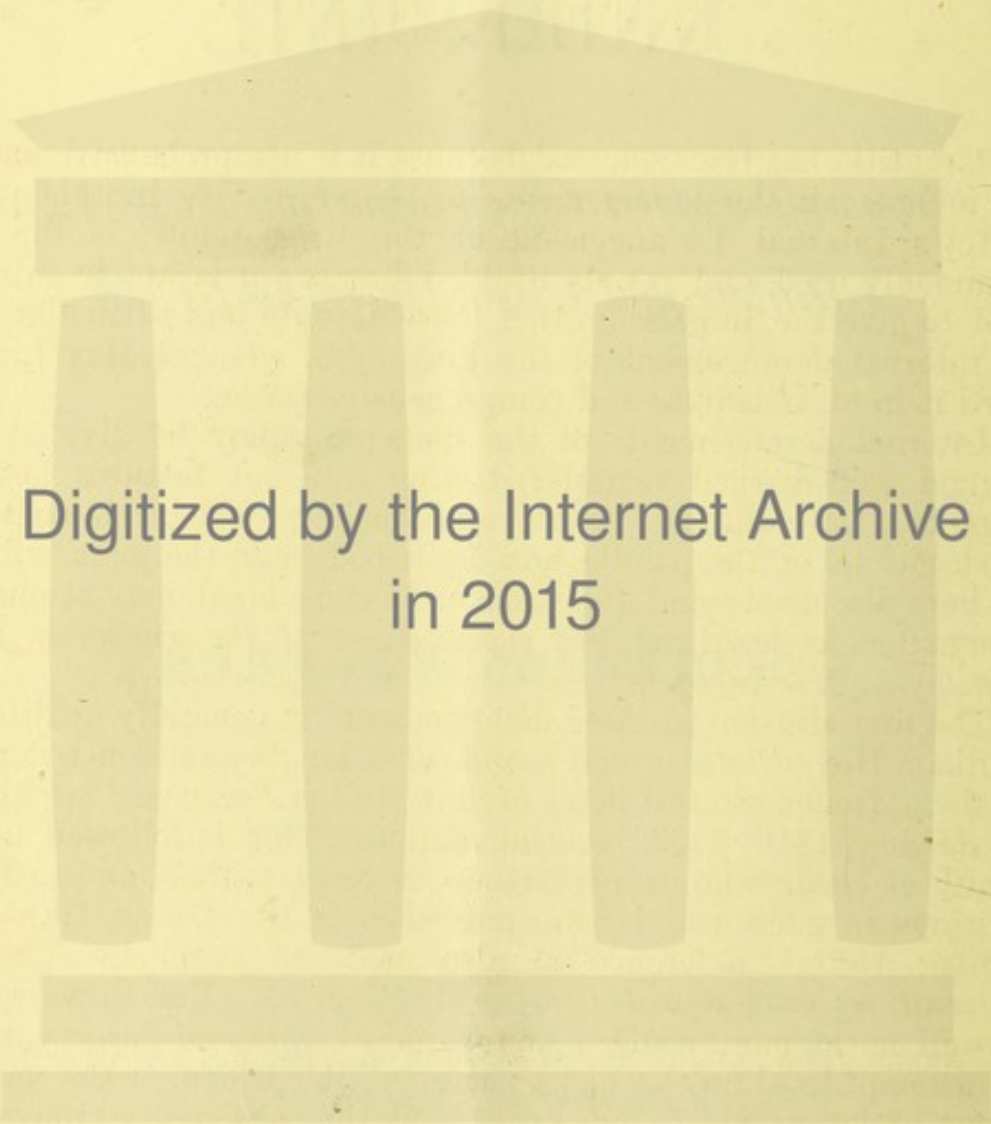
*Thesis submitted for graduation as M.D. of
Edinburgh University, April 1886.*

BY
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*(Reprinted from the Edinburgh Medical Journal for December 1886,
and February and March 1887.)*

PRINTED BY OLIVER AND BOYD, EDINBURGH.

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INTERNAL DERANGEMENTS OF THE KNEE-JOINT.

THIS title has been selected, because it is comprehensive enough to include all the derangements to be referred to in this paper. "Hey's Internal Derangement of the Knee Joint" is the title commonly used, and is only avoided because it is apt to mislead, and to give the impression that there is only one particular form of internal derangement of the knee-joint, whereas Hey himself used it in an indefinite and comprehensive sense.

Internal derangements of the knee-joint may be divided into several well-marked varieties, having different features both as regards their clinical aspect and their pathological anatomy. Dislocations of the patella, and loose bodies in the joint, will not be here discussed; and the cases to be considered may at once be designated as *luxations and subluxations of the semilunar fibro-cartilages of the knee-joint*.

The first allusion to these derangements is generally credited to William Hey of Leeds; and a somewhat lengthy reference is made to them, from a clinical point of view, in his *Practical Observations on Surgery*, 1810, p. 332, second edition. This is followed up by Smith of Leeds, who makes further reference to them and to Hey's writings in a clinical lecture published in the *Lancet*, 16th September 1851. Reference is also made to them by Vincent, *Observations on Surgical Practice*, 1847, p. 75. But these works, as well as the more modern and standard works on Surgery, make no attempt to state the exact nature of the lesion, or the various forms of lesion which may occur, and their differential diagnosis. Consequently their treatment in a rational manner has not been taught, and a field has been left for the notorious "bone-setter" to exert himself in, which he has doubtless done with more or less success, at least from a pecuniary point of view.

These luxations may be classified as follows:—They may be of the *internal* or of the *external* semilunar cartilage, and they may be *complete* or *incomplete*. This method gives us four distinct varieties; and although, no doubt, obscure and complicated cases may arise, such are quite exceptional, and the writer has been unable to find any record of a case in which there was simul-

aneous luxation of *both* cartilages. By complete luxation is meant a total escape of the semilunar fibro-cartilage from under its respective femoral condyle,—the articulating part of the femoral condyle, so to speak, escapes altogether from the socket formed for it by the cartilage.

The clinical cases which the writer has had an opportunity of studying and watching have—with one important exception (perhaps two)—been connected with the internal cartilage, and this is quite in accordance with the usual statement found in writings on the subject, viz., “that the internal cartilage is nearly always the one affected.” In fact, Vincent, in his work alluded to above, states that in *all* the cases he had seen the internal cartilage was the one affected. Sir A. Cooper also states (*Surgical Dictionary*), “It is almost invariably the internal cartilage which is affected.” It cannot be doubted, however, that there are cases in which the external cartilage alone is affected. No reliable figures are obtainable regarding the relatively greater frequency of cases where the internal cartilage is the one concerned.

The *internal cartilage* will be first considered. Complete luxation of this cartilage would appear, from its greater size, to be almost an impossibility without at the same time involving a serious rupture of the internal lateral ligament of the knee-joint, and possibly also a dislocation of bone. The writer has been unable to find any clinical or pathological account of such an occurrence, but there is a doubtful case described by Sir W. Fergusson, *Practical Surgery*, fifth edition, p. 323. It was observed in the dissecting-room, and is described in the following words:—“One of *these* cartilages had been torn from its connexion with the tibia throughout its whole length with the exception of its extremities, so that, during flexion and extension, it must have occasionally slipped behind the articular surfaces.” Unfortunately, Sir W. Fergusson does not state whether it was the internal or the external cartilage which was thus affected, but it was most probably the external one; for the pathological account here given corresponds in a remarkable manner with some clinical cases to be afterwards alluded to.

Partial Luxation of Internal Cartilage.—Of all these internal derangements of the knee-joint this is the most common form, and the reason why it is the lesion most frequently met with will be afterwards considered. It is the lesion which has occurred to the writer in his own person, and several other well-marked cases have come under his observation. Most of these other cases occurred in students of medicine, now practitioners, who could be thoroughly relied on for accurate accounts of their cases.

The lesion occurs at the anterior part of the cartilage, and the diagnosis of the condition is generally easy. There is a history of violence. The violence, however, may be slight. An exact history of the nature of the violence, and the direction in which it was

applied, will not be often obtainable. It may occur from prolonged kneeling and suddenly attempting to straighten the limb, or it may occur by striking the foot against a stone when the toe is turned outwards. The limb must always be more or less flexed. It cannot possibly occur when the limb is extended and rigid.

Symptoms.—The knee is kept in a semi-flexed position, and there is *inability to completely extend it*. There will probably be pain on pressure over the superior margin of the inner tuberosity of the tibia, especially if improper attempts have been made to extend the limb forcibly. On attempting to extend the limb, an irregular prominence will be felt to appear between the internal condyle and the head of the tibia, about $1\frac{1}{2}$ inch internal to the inner border of the ligamentum patellæ. Attempts to extend the limb cause severe pain at this spot, and a painful sensation as if something were being jammed between the opposing bony surfaces. It feels as if a sort of wedge were being put under the internal condyle as it attempts to roll forward on the tibia in extension. Flexion is not interfered with. The rounded margin of the semilunar cartilage can be felt to project unduly on the inner aspect of the joint. (Even in a perfectly sound knee, the rounded margin of the internal semilunar cartilage can be felt on the head of the tibia, and it can be distinctly felt to recede when the knee is flexed, and to come forward on extension on the antero-internal aspect of the joint.)

Although the authors already quoted make no attempt to differentiate these internal derangements of the knee-joint, they had evidently met with cases similar to the one above described, for Hey writes, *op. cit.*, p. 332 *et seq.*,—"The patient himself cannot freely bend, nor perfectly extend the limb in walking." And Smith, in *Lancet*, 20th September 1851, writes still more pointedly,—“In consequence of some slight fall, slip, or sprain, the mechanism of the knee-joint becomes so far deranged that the *full extension* of the limb is rendered impossible.” Sir A. Cooper also writes (*Surgical Dictionary*),—"The patient becomes incapable of perfectly extending the leg. There may be no pain at the instant the accident occurs, so long as no attempt is made at complete extension." Hey refers to luxations of both the internal and external cartilages, and had met with cases of each variety; but the two latter quotations evidently point to a luxation of the anterior part of the internal semilunar cartilage.

In *Lancet*, 1855, vol. i. p. 448, Mr Syme describes a case, and confirms Hey's observation, but he does not say whether the internal or external cartilage was the one affected. Again, in *Lancet*, 1856, vol. i. p. 11, Mr W. T. White describes a case which was evidently a subluxation of the internal semilunar cartilage, for it corresponds closely with the description of a typical case already given both as to causation and symptoms. It is unnecessary, therefore, to multiply clinical cases which all

closely resemble each other when the "derangement" is of that particular variety now under consideration. It has been stated that this partial luxation of the internal semilunar cartilage is the most common form of internal derangement of the knee-joint, and it has also been stated incidentally that the lesion occurs at the anterior part of the cartilage. The explanation of these two circumstances is to be found in the anatomy and mechanism of the parts involved, and it will be convenient to consider both the semilunar cartilages at the same time.

In descriptions of the anatomy of the knee-joint it will sometimes be found loosely stated that the semilunar cartilages are fixed on the top of the tibia; but we find in Goodsir, *Anatomical Memoirs*, vol. ii. p. 227, "The external semilunar cartilage must be viewed as an appendage to the external condyle of the femur, with which it moves backwards in flexion, forwards in extension. The internal semilunar fibro-cartilage, again, must be regarded as an appendage to the internal condyle of the tibia. It resembles a curved, yielding, but elastic railway on the upper surface of the inner condyle of the tibia, along which the corresponding condyle of the femur rolls backwards and forwards." Both the cartilages are, however, fixed firmly to the tibia by their cornua, and might be regarded as altering their shapes and positions to receive the condyles of the femur somewhat in the manner in which an ellipse is formed by a piece of cord or an elastic band fixed at two points. The nearer the points of attachment the greater will be the range of movement; and Goodsir states, p. 227, that the movements of the external cartilage "are facilitated by its circular form and the approximation of its horns." The cornua of the internal cartilage are more widely separated, and its range of movement consequently less. Both the semilunar cartilages are maintained in position by the coronary ligaments, and these ligaments are more or less elastic, and also slack to allow greater range of movement. The capsular ligament itself follows these movements to some extent, for the coronary ligaments are neither very long nor very elastic, and the most superficial examination of the knee-joint, in life, shows us that the anterior portion of the capsular ligament falls back in flexion and comes forward in extension of the joint, following the movement of the rim of the semilunar cartilage. The coronary ligament of the external cartilage has a break in it where it is pierced by the tendon of the popliteus muscle. This is a weak spot, and probably accounts for the predisposition to luxation of the external semilunar cartilage to be afterwards described.

When the knee is flexed, the surfaces of the femoral condyles in contact with the tibia are portions of arcs of smaller circles than the anterior portions of the condyles which are in contact with the tibia in extension. In extension, then, the larger bony arcs more completely fill up and fit into the sockets formed

by the semilunar cartilages, and so increase the strength and rigidity of the limb. Both the cornua of the external fibro-cartilage are firmly fixed into the head of the tibia, and the posterior cornu also sends an extra slip of attachment to the posterior crucial ligament. The internal fibro-cartilage has also two horns firmly fixed into the head of the tibia, but its anterior horn is very variable. It is sometimes found that a considerable portion of the substance of the anterior part of the internal cartilage is directly continuous with the transverse ligament, and that the portion of it fixed into the tibia is small.

Works on descriptive anatomy state that the transverse ligament is very variable in size and strength (Gray, Heath), and in proportion as it may vary in size and strength so will the anterior cornu of the internal semilunar cartilage vary inversely. The outer end of the transverse ligament has only a weak and ill-defined attachment to the capsule of the joint and coronary ligament of the opposite side. The so-called alar ligaments are much more important than might be supposed from the usual anatomical descriptions. They are, as is usually stated, in the position of fringes to the ligamentum mucosum, but in many cases they will be found to be distinctly hard and cartilaginous, and, although variable in size and consistency, they will always be found to be introduced between the femoral condyles and the anterior portion of the semilunar fibro-cartilages in complete extension of the joint in a sound knee. This can be readily seen upon opening the joint by cutting along the inferior margin of the patella, throwing forward the capsular ligament, and noting the positions assumed by the alar ligaments when the joint is flexed and extended. It can also be more completely demonstrated by making an oblique vertical section through the internal condyle when the joint is completely extended.

Two opened knee-joints are submitted herewith, one of which shows both the alar pads well marked, but the internal one is the larger. The other preparation shows the internal semilunar cartilage somewhat deficient at its anterior part, and this deficiency is evidently compensated for by a large cartilaginous pad. The word "pad" is here used, as that would seem more correctly to indicate the function of these structures (Goodsir). The internal alar pad is larger than the external (the latter being frequently absent), and in complete extension of the joint is found to be introduced to the extent of about half an inch between the internal condyle of the femur and the corresponding portion of the internal semilunar cartilage. This is a point in the mechanism which seems to have escaped observation, and although apparently trivial, it must add considerably to the complexity and delicacy of the movements necessary to completely extend the limb.

This variability of the size and strength of the transverse ligament, the alar pads, and even the internal fibro-cartilage itself,

will probably account for the fact that a luxation or subluxation at this point is more readily produced in some knees than in others, for it cannot be doubted that although a small amount of violence may produce a permanently recurring subluxation in one knee, the same violence in nature and amount might have no marked effect on another knee. In short, that natural variations regulate predisposition, and such variations must always interfere with the absolute exactness of surgery.

From the researches made by himself and several German anatomists into the mechanism of the knee-joint, Goodsir concluded that its movements were like those of a "double-threaded conical screw"—the spine of the tibia, etc., being the cone (the tap), and the lower end of the femur being the hollow receiver (comparable to a candle-extinguisher, but much shallower or flatter), the nut or die. The great rigidity of the limb in complete extension is attained by the conical tap being screwed home into the receiver or nut, with a simultaneous tightening of all the ligaments. In completing extension, the left tibia performs the movement of a right-handed screw, and the right tibia that of a left-handed screw. In order to *initiate flexion*, the opposite rotatory movement is necessary in each case. But, supposing the leg and foot to be held fixed, then, in order to complete extension, a rotatory movement of the femur *inwards* will be observed to take place, and this rotatory movement takes place, in the words of the late Professor Goodsir, "round the oblique curvature or anterior third of the internal femoral condyle."

The passage is as follows (*Anatomical Memoirs*, vol. ii. pp. 221-2):—"In the first third of flexion and in the latter third of extension, the movements of the femur and tibia take place round the oblique curvature or anterior third of the internal femoral condyle, and involve, in addition to the completion of extension and commencement of flexion, a movement of rotation of the tibia, and consequently of the leg and foot, inwards in flexion and outwards in extension. These remarkable movements of rotation inwards and outwards, *inseparable from the commencement of flexion and the completion of extension*, take place round the axis of an ideal cone, which axis is directed at an angle of 45° downwards, outwards, and backwards in front of the spine of the tibia—the oblique axis of the knee-joint."

Besides the anatomical points already referred to, there will be noticed at the anterior extremity of the external femoral condyle a flattening or depression, frequently very distinct, which receives the external cartilaginous surface of the spine of the tibia, and the *external* condyle of the femur partly glides inwards, partly rotates as on a pivot, while the *internal* condyle is passing through the movement of rotation upon an oblique axis, inseparable from complete extension of the joint. This movement is well seen by sawing into the intercondyloid fossa from above the external

condyle, and, after having removed the rest of the femur, observing the movements of the external condyle on completing extension while the leg and foot are held fixed.

The *unlocking* (rotation inwards of the tibia) which is necessary to initiate flexion is arranged for by the peculiar mode of insertion of the semitendinosus, gracilis, and sartorius muscles, as pointed out by Goodsir and other anatomists. It seems probable that the popliteus muscle may act on the external condyle of the femur in a similar manner to produce this unlocking, and initiate flexion in the event of the tibia being held fixed, for the tendon of the popliteus is tense, and ready for action only when the joint is fully extended, and thus is in a position to unlock the joint by pulling upon the external condyle and rotating the femur *outwards*.

Goodsir further points out that a movement, the reverse of this rotation, takes place towards the *completion of flexion*, in which the leg and foot rotate inwards; and further, *op. cit.*, p. 242, "The movements round the anterior combination are more extensive and important than those round the posterior, and, in the ordinary use of the joint, are alone employed."

A remarkable clue is here furnished to explain the great liability of the knee-joint to this particular derangement, *of which the most prominent clinical feature is that there is "inability to completely extend the limb,"* and the surgeons who first pointed this out wrote before the researches of Goodsir were published, and probably without any knowledge of the delicate and complicated mechanism involved in the movement of complete extension.

It was about the year 1855 that Goodsir first made public an account of his investigations, by which he showed that in completing extension the tibia performed a movement of rotation round an oblique axis, and was "screwed home" into the femur, which receives it as a nut or die receives a conical tap.

Besides the well-known oblique portion at the anterior part of the internal condyle of the femur, the other structures concerned in completing extension in relation to it are,—the anterior part of the intercondyloid spine of the tibia, the anterior attachment of the anterior crucial ligament, the internal alar pad, and the anterior portion of the internal semilunar cartilage, held in its place by the coronary ligament and transverse ligament when present.

Here, then, merely from a consideration of the anatomy, the mechanism, and the "ordinary use of the joint," explanation is furnished as to why "internal derangement" occurs most frequently in connexion with the internal cartilage, and also why it occurs at its anterior end.

Before proceeding to investigate the immediate cause and exact pathology of these derangements, exception must be taken to the statement in a popular work upon Surgery, which says, in en-

deavouring to account for them, "that the attachments of the semilunar cartilages must have been previously stretched by inflammation of the joint, and their own substance enlarged so as to increase their prominence" (Holmes). This statement is mere conjecture, quite unsupported by evidence, and numerous cases go to disprove it. There is no reason why the accident should not take place in a perfectly healthy joint, but the natural variations met with in the ligaments, etc., already alluded to, will increase or lessen the liability to the disorder.

In most of the works already quoted it will be found stated that internal derangement of the knee-joint "occurs when the foot is everted," but this is quite incorrect. It ought to be, *that luxation or subluxation of the INTERNAL semilunar cartilage may occur when the leg is ROTATED OUTWARDS*. When luxations of the *external* fibro-cartilage come under consideration, it will be found that they occur only when the leg is *rotated inwards*. The proof of these statements is very strong, in fact complete, and it hence becomes of the greatest importance to distinguish between derangements of the internal and those of the external cartilage when considering either their causation, treatment, or prevention. The erroneous statement above quoted has, doubtless, arisen (1) because derangements of the internal cartilage are by far the most common, and (2) by using the expression "everted" instead of rotated outwards. Of course, before *any* rotation can occur the knee must be somewhat flexed. The rotation here referred to is a rotation of the tibia upon a prolongation of its own axis, and must be carefully distinguished from the rotation upon an oblique axis which takes place when the joint is "screwed home."

Rotation *outwards*¹ is performed chiefly by the biceps muscle, consequently, when this movement is taking, or has taken place, the superior surface of the tibia will be found to be held closely apposed to the *external* condyle of the femur, and the external semilunar cartilage is thus held firmly in its place between the two bones. But the gap between the *internal* condyle and the head of the tibia will be found to be increased, and the internal semilunar cartilage is movable, and, consequently, is apt to slip too far in between the internal condyle and the corresponding portion of the head of the tibia. The opposite state of affairs results when the tibia is rotated *inwards*, for then the *internal* semilunar cartilage is held firmly between its respective condyle and the head of the tibia, the parts holding it being the muscles used to rotate inwards, viz.—the semitendinosus, gracilis, and sartorius, and also the *anterior* crucial ligament, which is then

¹ This must be distinguished from the rotation outwards, "inseparable from complete extension of the limb." The latter is effected by the quadriceps extensor, chiefly through the "quadricipital expansion" of fascia, connected chiefly with fibres of the vastus externus.—See Goodsir, *op. cit.*; also Williams, *Journal of Anatomy and Physiology*, vol. xiv. p. 181.

tense, whilst the gap between the external femoral condyle and the head of the tibia is increased in extent.

When the knee is flexed the anterior part of the semilunar cartilage glides backwards on the head of the tibia; if the leg be then rotated *outwards*, the internal semilunar cartilage will be drawn in between the internal condyle and the head of the tibia. A sudden movement of extension will then cause the internal condyle of the femur to roll on to too much of the cartilage; the alar pad will then fail to fit into its place, and complete extension will be impossible. Mr Knott, in *Dublin Medical Journal*, 1882, states that there is then spasmodic action of the quadriceps extensor femoris, but whether this be the case or not, the rotation outwards of the tibia, "inseparable from complete extension" (Goodsir), then comes into play. In this movement the inner tuberosity of the tibia must make a sweeping motion *forwards and outwards*. Thus the semilunar cartilage will be held by the femoral condyle, and as the bone makes its curve forwards and outwards, the coronary ligament will be stretched, or, it may be, torn, and this is doubtless what occurs in aggravated cases, or in cases where the luxation has recurred frequently, and it is well known that this, as well as all the other forms of internal derangement of the knee-joint, is very apt to recur after it has once taken place.

In the milder forms there may be only a stretching and relaxed condition of the coronary and transverse ligaments, and a failure of the alar pad to fit into its place, and hence inability to completely extend the limb; but there is always the risk that sudden extension of the joint, with the parts in faulty position, may result in destruction of the coronary ligament. Prolonged flexion of the knee-joint, as in kneeling, strains the anterior part of the coronary ligaments, and hence the disorder may also be produced in this manner.

In the *Lancet* of 16th September 1851, Mr Smith records the case of a girl who suffered this luxation from a dancing-master roughly turning her toes outwards. After many attempts to produce this luxation on the cadaver, the writer has hardly met with any success, probably owing to the lax condition of parts; but it is on record that Bonnet succeeded in producing it on the dead body. But apart from evidence of this nature, the clinical evidence confirms completely the importance of the anatomical points to which attention has here been called, and which any one can verify in his own person, by examining the gaps between the tuberosities of the tibia and the femoral condyles when the leg is rotated respectively inwards and outwards.

It is unnecessary to multiply clinical cases, for the writer knows that, in his own person, the luxation can be produced *only* when the toe is turned outwards; and on 11th December 1885, a student, who is subject to this form of internal derangement, and whose case is still under observation, informed us that he found

much benefit from the simple advice to keep the toe turned inwards. "The joint was much firmer, felt safer, and not so liable to go out." On the other hand, Mr L., now a general practitioner, writes in answer to the question, "Do you feel it safer or stronger when the toe is pointed inwards or outwards?" "Far safer and stronger when the toe is pointed *outwards*. When the toe is pointed inwards, I always feel as if the accident was going to happen." But this latter is a case of subluxation of the EXTERNAL cartilage, and will be afterwards cited in detail.

The chief clinical features of this variety of internal derangement are thus accounted for. The slight projection at the antero-internal part of the joint is the alar pad pushed forward along with part of the infrapatellar pad. The undue projection of the semilunar cartilage over the inner tuberosity of the tibia results from its failing to assume its proper oval shape, which is requisite in complete extension of the joint. Its anterior part has fallen backwards on the head of the tibia, and its inner part consequently projects inwards. The inability to completely extend the limb is amply accounted for by a consideration of the anatomy and mechanism of the parts concerned in complete extension.

Treatment.—After this accident occurs, there is generally some synovitis and effusion into the joint. This is doubtless Nature's method of attempting to cure, viz., by distending the joint, and so allowing the displaced parts a chance of falling into their places, and at the same time enforcing rest. The value of the treatment recommended by the writers quoted is considerably lessened from the fact that they did not distinguish between luxations of the internal and those of the external cartilage, and the importance of making this distinction has already been conclusively shown.

Most of the authors recommend that the knee be flexed, and then suddenly and forcibly extended. Should this fail, the knee has to be shaken about in all directions in a haphazard manner, and sometimes the cartilage will then resume its normal position. Vincent, however (*Observations on Surgical Practice*, p. 75), deprecates the use of force; and it will be remembered that he referred only to luxations of internal cartilage, and therefore his evidence bears on the point now under consideration. Seeing, however, that the exact pathology of the condition was not made out, little attempt could be made to explain the rationale of any of the various methods of treatment, some of which had occasionally proved successful.

In order to reduce this special form of internal derangement, force ought not to be necessary; for, as the luxation may be caused by a very slight amount of violence, it ought to be reducible without the application of any great force. With the symptoms formerly detailed, the treatment ought to be—to flex the knee fully, keep it flexed for a little time, then rotate the leg firmly *inwards*, and extend somewhat suddenly while maintaining rota-

tion inwards, at the same time pressing the rim of the cartilage inwards with the thumb should it protrude (as it generally does) over the inner tuberosity of the tibia.

Flexion removes the anterior portion of the head of the tibia from the femur, and so releases any portion of the cartilage which may have been jammed between the two bones. "In extreme extension it is the anterior portion of the tibia which is in contact with the femur, in the semiflexed position its middle, and in complete flexion its *posterior* edge" (Humphrey on *The Skeleton*). Flexion will also straighten out the alar pads should they be displaced or doubled upon themselves.

Rotation of the leg inwards is most important, as it brings the inner condyle of the femur more closely in apposition with its corresponding articular surface of the tibia, as already explained. Then, by extending the knee while maintaining rotation inwards, the internal condyle is kept moving truly in its socket, and does not ride upon too much of the semilunar cartilage.

Hey states, in a general manner, that the disorder may arise from "anything which prevents a condyle of the femur from moving truly in the socket formed for it by the semilunar cartilage." And although that is nearly all he says regarding the pathology, it accords, as far as it goes, with the theory here propounded. The rotation inwards makes tense the external (anterior) crucial ligament; and Goodsir states, *op. cit.*, that this ligament "guides rotation of the tibia outwards" in order to bring about complete extension. Hence by keeping this ligament tense, the rotatory movement necessary in order to completely extend the joint may be brought about. This same point is referred to by Morris (*Anatomy of the Joints*, p. 371), where he says, "'Pronation' is limited by external crucial ligament." Further references to treatment in general will be made after other forms of internal derangement have been described.

The External Semilunar Fibro-Cartilage.—The anatomical and physiological peculiarities of this body have already been referred to, viz., its smaller size and more nearly circular form, also its greater range of movement; and, keeping these facts in view as well as "the ordinary use of the joint," we can readily understand how its complete luxation is possible, and also why its partial or incomplete luxation is more rare than that of the internal cartilage. Luxation of this cartilage may be complete or incomplete.

Complete Luxation.—Several cases of this variety of internal derangement of the knee-joint are on record, and a drawing of a dissected specimen shown by Mr Godlee, *Transactions of the Pathological Society of London*, vol. xxxi., may be seen. In the words of Mr Godlee, "The circumference of the fibro-cartilage has been torn away from its attachment to the capsule of the joint, and it—the external semilunar cartilage—now occupies a vertical position in the intercondyloid fossa." This case appears to be

quite unique, and nothing short of opening the joint would have sufficed to completely diagnose or treat the condition. There is no clinical history of the case; but it is conceivable that, by opening the joint and completely flexing the knee, it might have been possible to replace the cartilage between its proper bony surfaces and to fasten it there. This case might be designated one of complete and *persistent* luxation of the external fibro-cartilage; but several other cases are on record where such luxation was apparently complete although not persistent. The cartilage slipped from its place only when the knee was flexed, returning into its place when the joint was extended. Of such nature was the case reported by Mr Clement Lucas (*British Medical Journal*, 15th November 1879). It is described in the following words:—“On flexing the knee the leg and foot jerked inwards with a sudden shock, and, at the same time, a projection appeared on the outer side of the patella, which could be seen and felt. On extension the leg and foot jerked suddenly outwards, and the semilunar cartilage went back into its place.”

Other cases corresponding exactly with this are referred to by Mr J. F. Knott in the *Dublin Medical Journal*, 1882. One is that of M. Le Fort, the eminent French surgeon, whose symptoms were exactly similar to those detailed above, and in whose case the lesion subsequently appeared on almost every occasion when the knee was forcibly *flexed*. The case recorded by Mr Clement Lucas was cured by rest and retention in a plaster of Paris case, so that it could not have been a pedunculated tumour attached to the synovial membrane. These pedunculated tumours, although rare, give rise to symptoms closely resembling luxations or subluxations of the semilunar cartilages, but are only mentioned here incidentally.

The movements so carefully detailed by Mr Clement Lucas deserve attention, as they seem to be explained by the mechanism involved in completing flexion. As already indicated, in order to attain complete *extension* of the knee-joint, a rotation of the leg and foot outwards takes place, the surfaces chiefly implicated being the spine of the tibia, alar pads, etc., and the peculiar oblique surface on the anterior portion of the internal condyle of the femur, as already fully detailed. Similarly, in completing *flexion* a rotatory movement in the *opposite direction* takes place,—the leg and foot rotate *inwards*, and the portion of the femur chiefly implicated is an oblique portion at the posterior extremity of the external condyle (Goodsir). Here, then, this luxation takes place; for in flexion the rotatory movement of Goodsir will carry the external tuberosity of the tibia forwards and inwards in a curve, carrying with it the external semilunar cartilage; and this cartilage is the more readily able to escape from under the external condyle of the femur, because the coronary ligament, which assists in maintaining the cartilage in position, is broken and weakened by the passage

through it of the tendon of the popliteus muscle. This break in the coronary ligament exists at the point where its fibres are put into requisition, viz., the postero-external part.

Treatment.—Seeing that this luxation occurs only when the knee is completely flexed, the best treatment will be to avoid this movement, or the joint may be put up in plaster of Paris, as was done by Mr Lucas, in order to give the coronary ligament a chance of healing.

Incomplete Luxation of External Cartilage.—In this form of derangement the symptoms are more obscure than they are when luxation occurs to the internal cartilage, for the external cartilage does not approach so near the surface, and consequently less can be made out by palpation. Without having discussed the nature of any of the varieties of internal derangement of the knee-joint, and although he did not distinguish between luxations of the internal and those of the external cartilage, Hey, in his work already quoted, alludes to a case which was evidently of the nature indicated in this heading. It occurred in 1782 “to a gentleman as he was turning himself in bed.” It was evidently the external cartilage which was affected, for Hey states “that there was some pain at the insertion of the tendon of the biceps femoris into the head of the fibula.” A sudden and accidental cure took place as the patient was standing or moving about and talking to Hey.

In Cooper's *Surgical Dictionary* a case is recorded as having been treated at the London Hospital. It was diagnosed “as a dislocation of external semilunar cartilage, and all efforts to reduce it were ineffectual, and the patient left hospital in a month unable to bring the heel to the ground or to extend the knee beyond a certain point.”

Sir W. Fergusson, *Practical Surgery*, 5th edition, p. 323, records a case of a gentleman about 40 years of age who, from an accident which had happened to him twenty years previously, “sprain of knee,” suffered dislocation of external semilunar cartilage. Like Mr Hey's case, it went in at first suddenly and accidentally (by a fluke, if the term may be allowed), after having caused lameness for a considerable time, but afterwards it frequently suffered displacement. “The limb during the displacement could never be fully straightened until, by pointing the toes outward as much as possible, and then lifting the foot forward, which the patient usually did with the other foot behind the tendo Achillis, a sudden slip at the knee was felt, when all was at once right again.” He adds,—“I have seen two other instances within the last twelve months where there was every reason to suspect such displacement of a semilunar cartilage, and in both of them there appears every likelihood of permanent lameness.”

A case of this description has been under the notice of the writer for some years. It occurred in the person of a fellow-student, now a graduate in Medicine and Surgery, and the following

is the history of the case:—Mr L——, aged 19, was playing football. He was just in the act of “dropping” when he was charged over. He could not say exactly how the violence was applied to his knee, but *when* it was applied the knee was semiflexed. The pain at the time of the accident was very severe, localized, and almost exactly over the biceps tendon and external semilunar cartilage. He could not completely flex nor extend the limb. There was no effusion, and in three days he was allowed to get out of bed. A fortnight later he started playing football again, and from this it may be concluded that there could have been no serious rupture of ligaments, for healing of such could not have taken place in a fortnight. The rest of the case may be given in the patient’s own words: “After playing for a time I slipped and fell. The pain on the second occasion was very severe, as I rolled on the grass for about ten minutes. The limb at this time was fixed in the semiflexed position. After some hours there was a great deal of effusion in the joint. I was in bed for a fortnight, and lame for about three months after this accident. . . . On three subsequent occasions, and at intervals of about six months from each, the same accident happened, the pain on each occasion being severe, and followed by synovitis with copious effusion. It has also happened while I was in bed, and I have since done it while sitting at table. The pain is now nothing to speak of, but always distinctly localized on the external aspect of the joint, exactly opposite the external semilunar cartilage. I think I could always displace it by crossing my left leg (the injured one) over the right. I have never succeeded in replacing what has gone wrong. No abnormal projection was ever seen or felt.” This is the case to which brief allusion has already been made in order to bring out the fact, as stated by the patient, that the limb is “far safer and stronger when the toe is pointed *outwards*.”

From these cases it will be seen that reliance has to be placed mainly upon subjective symptoms in order to diagnose this condition.

Another case recently came under the observation of the writer where there was reason to suspect this variety of derangement. The patient was seated on a low chair with the right leg considerably flexed, thrown under the chair and resting upon the outer edge of the foot—that is, flexed and rotated inwards. On attempting to extend the limb it was found that the knee-joint was fixed, and there was great pain. The disorder was at once reduced by flexing the limb still further and rotating the leg outwards, and then extending the joint.

In discussing the mechanism involved in this luxation or subluxation three different movements require to be kept in view. 1st, There is the rotation of the tibia inwards, described by Goodsir as inseparable from complete flexion of the joint. This, however, will not explain the condition, for after the accident has

happened there is not only inability to flex the joint completely, but there is also inability to extend it. The joint is more or less completely locked. (In the subluxation at anterior part of internal semilunar cartilage, already described, there is only *inability to completely extend the limb*, as asserted by Smith, Sir A. Cooper, etc., and verified by the writer in his own person.) 2nd, There is a sort of pendulum movement without any rotation which may take place between the tibia and femur when the ligaments are relaxed in flexion. 3rd, There is the movement of rotation of which the tibia is capable in flexion round a prolongation of its own axis. This rotation may extend through about 36° in the horizontal plane of the joint, and to it must be referred the derangement now under consideration.

In experimenting on the cadaver, this is the displacement (subluxation) which can be produced with greater ease and certainty than any other. The knee requires to be well flexed (it will then be found that the external femoral condyle almost entirely leaves the external semilunar cartilage), the foot and leg are then rotated strongly inwards, and the leg gently extended while maintaining rotation inwards—a little pressure on the outer rim of the external semilunar cartilage may be required to assist, but the external condyle of the femur can be readily made to ride upon the postero-external part of the rim of the external semilunar cartilage,¹ and the “locking of the joint” more or less completely effected, even on the dead body. Of course, in the living, the so-called locking is more complete, by reason of the great pain when attempting to move the joint.

When the leg is rotated inwards the crucial ligaments are rendered tense, and it must be borne in mind that the posterior cornu of the external semilunar cartilage has an attachment to the posterior crucial ligament. This fibrous attachment is then rendered tense when the leg is rotated inwards, and tends to draw the semilunar cartilage more under the external condyle, and, it will be remembered, that during this rotation of the leg inwards the gap between the external femoral condyle and the head of the tibia is increased, and the external cartilage more movable. In aggravated cases of this lesion, the coronary ligament will probably be torn where it is pierced by the tendon of the popliteus muscle, and thus there might be produced a complete and persistent luxation, such as that shown by Mr Godlee.

It has been asserted that this lesion is in reality a rotatory dislocation of the tibia upon the femoral condyles, and not without show of reason, for the rotatory movement, of which the tibia is normally capable when the ligaments are relaxed in flexion, might be looked upon as a dislocation of bone, and it is simply by preventing the readjusting movement from taking place when the limb is being extended that the luxation in question is produced. The import-

¹ The part must be dissected to some extent in order to show this.

ance of recognising this condition and treating it properly is very great, for it is somewhat distressing to read of the result of the case treated at the London Hospital (Cooper's *Surgical Dictionary*); also of the two cases mentioned by Sir William Fergusson, already quoted, in which there was every reason to suspect the existence of this condition, and in which permanent lameness was the result. Another case has been brought under the writer's notice recently, where the lesion was, in all probability, one of this nature, and the patient, a gentleman of active habits, after getting no relief from his own medical attendants, finally had recourse to a notorious "bonesetter." He made a sudden and complete recovery, and the "bonesetter" got the credit.

This condition, then, having been recognised, the treatment ought to be to flex the leg fully, endeavour to free the cartilage by moving the leg from side to side like a pendulum, rotate the foot and leg firmly *outwards*, and then extend suddenly while endeavouring to maintain rotation outwards. This treatment slightly resembles that adopted in a case mentioned by Sir A. Cooper, "in which the patient used to accomplish the reduction by sitting upon the ground, and then bending the thigh inwards and pulling the foot outwards" (*Surgical Dictionary*). There is also a resemblance to it in the treatment adopted successfully by Sir W. Fergusson's patient, viz., "pointing the toe *outwards*, and then lifting the leg forwards with the other foot behind the tendo Achillis."

Regarding treatment in general, it may be stated that before attempting the cure of any of these internal derangements of the knee-joint, the exact nature of the lesion ought to be made out as fully as possible. No rational treatment can be adopted except that which is founded upon an accurate diagnosis.

In adopting the treatments herein advocated, it will generally be advisable to administer chloroform to the patient, especially should there be much pain and locking of the joint, for spasm of the muscles may require to be overcome. Should the methods of treatment recommended fail after several attempts, the question of opening the joint will be raised, and, as far as can be gathered from all the authors who have written on this subject, the luxations most likely to lead to permanent lameness are those of the external cartilage. Luxations of the internal cartilage, according to Vincent, do not leave permanent lameness. They probably get reduced either by accident or after distension of the joint from synovial effusion. Now-a-days, rather than accept the "permanent lameness" which seems to have resulted in several cases of luxation of the *external* cartilage, it would be advisable to open the joint, and, as a transverse incision would destroy the insertion of the biceps and also the external lateral ligament before a good view of the external cartilage could be obtained, a vertical incision might be advisable.

The only recorded case, however, where the knee-joint was opened on account of "internal derangement" was on account of a troublesome recurring partial luxation of the internal semilunar cartilage. It is recorded by Professor Annandale, in the *British Medical Journal*, April 18, 1885,—“On opening the joint the semilunar cartilage (internal) was seen to be completely separated from its anterior attachment, and was displaced backwards about half an inch.” Stitches were introduced to keep the cartilage in position, and the result was a complete success, for the patient was seen again some months later, and was found to have a sound and useful knee, whereas he had been unable to work for ten months previous to the operation. This might be termed heroic treatment, and the question as to whether or not it ought to be applied must be decided by the usefulness or uselessness of the limb, and the occupation of the patient must here come into consideration. Still, it must be admitted in favour of operation, that these constantly recurring luxations are very unpleasant and often painful, although they may not prevent a patient following his ordinary occupation; and, as with each recurrence a slight amount of tenderness and synovitis is almost invariably present, extensive disease of the knee-joint might be brought on, especially where there happened to be a rheumatic or strumous tendency to general disease of the joint.

Patients will often apply for advice in order to prevent the recurrence of some internal derangement of the joint. The first point to settle will be to exclude the possibility of a “loose body in the joint,” or a pedunculated tumour (the two conditions which most closely simulate luxation or subluxation of a semilunar cartilage). Should operative interference not be considered justifiable, the best palliative treatment (it may be also curative) will be to recommend the wearing of some apparatus to restrain the movements of the knee—either an elastic bandage or a leather knee-cap, probably the latter is the best. Should the luxation be of the internal cartilage, it is most important that the patient should be instructed to keep the toe pointed *inwards*; and should the external cartilage be affected, the toe should be turned *outwards*, to obviate recurrence of the derangement.

