Diseases of the Knee Joint

I. S. Smillie

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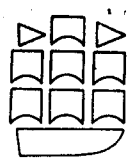

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Preface

The popularity of *Injuries of the Knee Joint*, and particularly of the fourth edition now reprinted for the second time, has been responsible for a considerable increase in my experience of the problems of diagnosis and treatment in fields beyond the concept of single-incident trauma. In this second monograph I have committed to print experience of the disease processes and made good some of the deficiences of *Injuries* for which I have been criticized. The outcome reveals the broad band of overlap between 'injury' and 'disease'. I have kept repetition, which was occasionally unavoidable, to a minimum by reference to the fourth edition of *Injuries*. Where overlap occurs, a difference of approach will be detected and the opportunity taken to record advances in technique, operative and otherwise, and for the correction of errors. In deference to continental practice I have adopted the suffix 'osis', as in osteoarthrosis, in the definition of conditions not primarily of infective origin.

The approach to the problems of the joint is, of necessity, seen through the eyes of an orthopaedic surgeon. This should be advantageous to the reader no matter what his specialty. The orthopaedic surgeon acquires a visual intimacy with the pathological anatomy of the knee not available to any other branch of medicine. He has the added advantage that he commands the widest range of therapy. It is important, for example, that the possibilities of operative intervention should be seen in the role of preventive medicine and not just the last resort for patients broken physically, and mentally, by unfulfilled promises of cure.

I acknowledge the willing help and co-operation of my colleagues. In the Department of Orthopaedic Surgery of the University of Dundee: Mr K. L. G. Mills and Mr J. W. Innes. In the Orthopaedic Service of the Eastern Region of Scotland: Mr J. Hutchison, Mr I. D. Sutherland, Mr G. Murdoch, Mr R. D. Muckart, Mr G. L. Clark, Mr C. S. Campbell, Mr W. Waldie and Mr B. C. Colvin. The frequency with which their initials appear in the text is some indication of the help they have given me.

There are many others who have assisted me and to whom I am grateful. I mention in particular Mrs A. M. McGregor, Secretary to the Orthopaedic Department in the University, who not only typed and re-typed the entire script but corrected the proofs. Miss J. B. Mudie, Secretary in the Department of Orthopaedic Surgery in the Royal Infirmary, Dundee, and Miss M. Russell, Secretary in the Department in Bridge of Earn Hospital, Perthshire, have helped me with statistics. Miss M. Benstead, Medical Artist in the University has been responsible for all the line drawings. The other illustrations are for the most part the work of Mr Adam P. Tilp-Zielinski, Senior Medical Photographer, Bridge of Earn Hospital and Mr R. G. Donovan and Miss M. Sturrock, recently Photographic Technicians in the Department of Orthopaedic Surgery of the University.

I wish to acknowledge too the facilities made available to me by the University of Dundee and the Eastern Regional Hospital Board (Scotland) and, through the latter, the Board of Management for the Dundee General Hospitals and the Board of Management for the County and City of Perth General Hospitals.

Finally I wish to express my gratitude to the anonymous donor of funds which have supported clinical research into the biomechanical basis of osteoarthrosis of the knee, the earliest results of which are incorporated in the text.

My special thanks are due for the assistance I have received from Churchill Livingstone.

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1. Examination and Investigation

Introduction

The knee is the largest of human joints in area of articular cartilage and of synovial membrane. It is the most complicated in terms of internal components. It is the most complicated in terms of mechanics: flexion is successively a combination of rotation, rocking and gliding movements far removed from the concept of a simple hinge. It occupies an exposed position at the junction of the longest and strongest levers in the body. It is, of the weight-bearing joints, the most vulnerable to trauma, incidental or repetitive in the form of wear and tear. There are few disease processes affecting joints to which it is not the most susceptible. It is thought appropriate that the introduction to a subject of such proportions and diversity should be devoted to examination and investigation. There are complexities which apply to no other joint.

The problems of diagnosis in disease, as opposed to injury, are different. If there is a dividing line between the two, which, in many instances is difficult to define, it is that disease involves the joint as a whole while injury involves individual components. In disease, the subtleties of clinical examination are few. In any event the ultimate diagnosis may be determined by the outcome of laboratory tests. In injury, the diagnosis depends on the interpretation of the detailed findings of clinical examination and, with the possible exception of radiography, seldom rests on ancillary investigations. It is a matter of difference of approach, adopted subconsciously by the experienced but to be learnt at considerable cost in other circumstances. Nevertheless, it is important that clinicians undertaking the treatment of diseases of the joint are familiar with every aspect of history-taking and clinical examination and of the possible interpretation of the findings.

In this first chapter it is proposed to suggest a sequence of events in order of importance which may lead to the establishment of a diagnosis.

History

The importance of the history in any derangement based on a mechanical or disease process cannot be overstressed. The secret of success is thoroughness, and this applies to the history in particular because, in many cases of internal derangement, physical examination reveals no sign upon which a diagnosis can be based. It is hardly an exaggeration to cite the hypothetical situation in which it is required to establish the diagnosis, either from the history or from physical examination; but not on both. There is no orthopaedic surgeon of experience who would not choose to make his diagnosis from the history.

But listening to a patient's description of his complaints is time consuming. It is one reason why this aspect of investigation tends to be neglected. An experienced clinician will recognise the unintelligent and those garrulous with irrelevancies. The former must be questioned following a plan; the latter cut short without offence, with the explanation of the necessity to obtain the history in an orderly manner.

Time spent on purposeful history-taking is seldom wasted. A point, picked up in the course of a detailed history, can direct the way to a particular aspect of clinical examination which can confirm a provisional diagnosis. In routine examination, the sign, or the significance of it, can pass unnoticed.

Method. Time, it is repeated, is valuable in the contemporary scene. It can be expended in limitless quantities on the examination of a knee. If the examination must not be so slow and meticulous as to bore the clinician it is even more important that it is not so slow and meticulous as to bore the patient.

To take a history of maximum assistance in diagnosis the questioner must know his subject and thus know what he is looking for; and without, initially at least, leading questions. The history, unfortunately, cannot be taken by a secretary no matter how experienced; not even

by another doctor. There is no short-cut. The proforma has uses in the field of medical records and in the assessment of the results of treatment in disease processes; but not in diagnosis. The history you must take yourself; and moreover, know how to do it.

What follows is a general guide in the approach to diagnosis. It is not intended to be comprehensive. The detail as it concerns systems or diseases will be found in the related sections.

Name, Age and Sex

The first action in the approach to a knee joint problem is to read the letter of referral, if such exists. The history, taken by somebody else, is of limited value; but it may contain vital background information of which the consultant might otherwise be unaware. Note will have been taken of the age and sex, and whether the condition is the result of trauma, or of a disease process of acute or of insidious origin. These few details will permit a reduction of the probabilities to a minimum; but not the possibilities.

It is not intended and it would be tedious to attempt to cover every eventuality. The list reflects the approach of an experienced clinician to a problem of diagnosis armed with no more information than the age and sex of the patient and the bare facts of background such as might be contained in a letter of referral:

1. IN EARLY CHILDHOOD. The probability is so-called physiological genu valgum and the possibility, one of the rarer forms (Chapter 8).
2. IN ADOLESCENT MALE. With pain at the tibial tubercle, traction epiphysitis (Schlatter's disease) (Chapter 2), in other and more vague circumstances, osteochondritis dissecans.
3. IN ADOLESCENT FEMALE. With giving-way incidents, recurrent subluxation of the patella (Chapter 2) or a congenital discoid lateral meniscus (Chapter 12). If with bilateral intermittent pain and mid-line swelling, the possibility of a fat pad lesion (Chapter 4).
4. IN YOUNG ADULT MALE ATHLETE. With a history of an injury involving rotation, a meniscus tear; with injury involving considerable direct violence, a ligamentous tear.
5. IN YOUNG ADULT FEMALE. Recurrent subluxation of the patella or congenital discoid lateral meniscus are probabilities; the rarity of meniscus lesions on the medial side is a point to be remembered. In the circumstances of persistent synovial swelling the wish to eliminate the possibility of rheumatoid arthritis will be paramount.
6. IN MALE OF MIDDLE AGE. With pain on the medial side of the joint in the absence of trauma will be recognised the probability of a horizontal cleavage lesion of the posterior segment of the meniscus.
7. IN FEMALE OF MIDDLE AGE. An attitude of caution with the probability of patello-femoral osteoarthrosis to be considered and the possibility of rheumatoid arthritis to be eliminated.
8. IN OLDER AGE. Osteoarthrosis in local or general form is the probability.

In general, it is a matter of knowing what to expect but not to be surprised by the unexpected.

It is at this point that particular questions arise:

WHICH KNEE? BOTH KNEES? OTHER JOINTS ALSO? That both knees are affected in relation to age and sex reduces the possibilities. That other joints are affected reduces the probabilities to a minimum.

DURATION OF COMPLAINT? The time the condition has existed distinguishes the acute from the chronic and is thus important both in diagnosis and prognosis.

INITIAL INJURY? The tendency to attribute human ills to an incident of trauma is well-known. It is important, therefore, that the nature and particularly the degree of the violence be assessed, i.e. indirect in the form of rotation or direct in the form of a blow. On the other hand, horizontal cleavage of the posterior segment of the medial meniscus can be initiated by a simple twist or, indeed, occur with no injury at all.

INSIDIOUS ORIGIN? If so, what was the presenting symptom, pain, swelling or loss of function in form of stiffness, block or obstruction to movement, or what?

INTERPRETATION OF PRESENTING SYMPTOM OR COMBINATION OF SYMPTOMS

Pain

It is well-known that pain, the most variable, unreliable and unassessable of symptoms is yet

the commonest and most important single reason for seeking advice.

If it is the presenting symptom the nature and site must be determined. Was it acute, as in an incident of locking, or a constant ache? Is it general throughout the joint or can it be located? The patient's opinion on the site of the pain is of diagnostic importance as, for example, medial joint line posteriorly, infrapatellar fat pad, patello-femoral joint, etc. Is it constant, related to movement after rest, or at a particular time, for example, in bed at night? A positive answer to any of these questions would point to a possible diagnosis to be confirmed or refuted by clinical examination. Pain in bed at night, for example, in a male of middle age, located to the joint line posterior to the medial ligament, would indicate a degenerative lesion of the meniscus.

A classical trap for the unwary, recorded in every text-book and taught to generations of students, whereby pain complained of in a knee originates in the hip joint, still accounts for misdiagnosis. The error occurs in the earliest degree of tuberculosis in childhood or of osteoarthrosis in later life at a stage revealed only by careful clinical examination; not when the diagnosis is obvious. The patient indicates the anterior aspect of the thigh and the inner side of the knee as the site of the pain. The exact mechanism is debatable. But the knee and hip joints share a common nerve supply through the obturator nerve, the anterior branch of which supplies the hip joint; the posterior branch terminates in the knee.

Swelling

Is it general or local? Was it of sudden or of insidious origin? Does the swelling involve the entire joint? Is it fluid, filling the synovial cavity, or is it the membrane lining the cavity?

A sudden swelling of the entire joint, within, say, half an hour, is a haemarthrosis. If it is superficial and located in the mid-line anteriorly, it is a haemobursitis; elsewhere it is probably a haematoma.

The insidious swellings of the entire joint are likely to have a more serious pathological background and often provide considerable problems of diagnosis. The most common local swelling of insidious origin is located on the lateral joint line in the form of cystic degeneration of the meniscus. In spite of the small size, its existence is likely to be known to the patient on account of pain associated with physical activity.

Loss of Function

This description of disability, from the patient's viewpoint, covers a variety of complaints.

Stiffness. Stiffness may be defined as resistance to mobility. There are normal physiological variations in the sensation. It is greatest at the beginning and at the end of the day. In addition the phenomenon is closely related to atmospheric conditions increasing as the temperature decreases. In general this symptom, the inability to move freely after rest, is indicative of ageing articular cartilage and the breakdown of the lubrication system. It covers a multiplicity of circumstances, the most common of which are the various forms of arthritis and arthrosis. It is a symptom, but not the major complaint, in the commonest of all internal derangements of degenerative origin, horizontal cleavage of the posterior segment of the medial meniscus. In such circumstances it is explained by contact between the rough surface of the meniscus with the damaged opposing articular cartilage. In other circumstances the underlying gross pathology will be recognised as the source of the symptom. On the other hand it is unlikely in the early stages of a disease process, in view of what is known of the low coefficient of friction between articular surfaces, that stiffness is so related. It is probably located within the soft tissue elements from stretching of abnormal synovial membrane and/or friction between opposing synovial layers.

Insecurity: giving-way. This common symptom arises as a result of the interposition of some small object (as opposed to a large one as in locking, see below) in the form of a fragment of meniscus, articular cartilage or loose body between opposing articular surfaces under circumstances of stress. It can thus relate to a wide variety of pathological processes. Interposed in the hinge action of tibia on femur, or rotatory action of the screw-home movement, the most common underlying lesion is a tear of degenerative or traumatic origin of the posterior segment of the medial meniscus. In the patello-femoral

joint, particularly in the presence of a flexion deformity, a tag of articular cartilage from chondromalacia is the most likely obstructive object. In gross osteoarthrosis the sensation can be produced by contact between irregular surfaces in some unguarded action. There is, finally, to be considered, in the absence of obvious explanation, the possibility that the symptom is related to no more than the existence of a minor flexion deformity and the related quadriceps wasting.

Locking. This is a symptom associated with the young male athlete rather than the patient suffering from a disease process. It is defined as a sudden and complete painful block to extension sustained by the mechanism of rotation in flexion usually in some contact game, commonly football. In such circumstances the block to extension, and to the screw-home movement, is due to the classical internal derangement, the displaced complete longitudinal or bucket-handle tear of the medial meniscus. In the realm of disease process, as opposed to trauma, locking occurs totally unexpectedly, out of the blue as it were, in the course of some simple domestic action from the interposition of a loose body between femur and tibia.

If these are the classical situations in which locking occurs exceptions are almost the rule: A displaced longitudinal tear may lock the joint at the age of 70; and a loose body separate from an osteochondritis dissecans lesion without previous warning in an adolescent.

In taking the history the statement that the knee 'locked' should not be accepted in terms of the definition and implications outlined above. The patient must be asked to explain what he means by 'locking' and demonstrate the angle at which the block to extension occurred. The sensation experienced at unlocking, if such occurred, is also important. In general, knees lock at 45 to 10 degrees short of extension; and unlock dramatically. The description of 'locking' in full flexion, or full extension, or with a gradual return of movement should be accepted with reserve.

Limitation of movement. The complaint of loss of range of movement as such is unusual. But it depends on the circumstances of the case; and this varies widely. It is seldom, for example, that loss of those important last few degrees of extension which constitute the screw-home movement is recognised other than by the young athlete seeking perfection of function. In circumstances of the ageing knee a flexion deformity of considerable degree may pass unnoticed. It will be recognised, in circumstances of gross pathology, that right-angled flexion is an acceptable range of motion for most social and domestic purposes; but anything less constitutes a disability.

PHYSICAL EXAMINATION

Prerequisites

If the history can be taken anywhere certain prerequisites are necessary for physical examination.

Lighting. It will be shown that observation is the most important act of physical examination. It is important that the lighting of the room is even and the same on one side as on the other. In this respect the walls of a room used for such examinations must be white; never one of one colour and one of another. Inspection is useless carried out on a couch against a wall from which there is no reflected light.

Examination couch. To examine the knee the couch must be free-standing and of suitable height so that the clinician can stand not only at the foot-end to observe both joints at once but at either side to undertake the necessary observations and manipulations. Furthermore, it is desirable that sufficient space exist on either side so that the profile of the joints can be observed from a distance in flexion (Fig. 1,6) or in extension (Fig. 1,7), held by an assistant.

Adequate exposure. Patients are normally resistant to removing clothes. They are prepared for limited exposure of the affected knee; but not the other one. When the normal is examined first, as it should be, how often is it exclaimed: 'But it's the other knee, Doctor'.

It is essential to have the other knee visible for comparison, even if it too is abnormal. To pull up the trouser leg above the knee, if such is possible, is not enough. Both knees and both thighs must be exposed if embarrassing mistakes are to be avoided.

Relaxation. A patient, required to lie on his back while his knee is examined, will almost invariably

raise his head to see what is going on in what for him is a new experience. It is understandable; after all, it is his knee. In such circumstances it should be explained why relaxation is important and why the head should remain on the pillow.

Induction of pain. In this respect also, and with the purpose of achieving and maintaining confidence, pain should never be induced without warning. If it is essential to invoke such reaction, the provocative movement should be purposefully relegated to the termination of the examination; and the possibility indicated. To induce pain precipitatively and unnecessarily at an early stage is to create a situation in which co-operation is lost in the atmosphere of apprehension. In such circumstances an erroneous conclusion may be achieved.

Privacy. When confronted with 'a difficult patient' with 'a difficult knee' it may be important to take the history and examine the patient alone; not in the presence of nurse, secretary, students or other patients as in an open hospital ward. The assessment of such patients is easier when they are deprived of an audience. In this regard too, and in circumstances in which exaggeration is evident, a second examination a week or so later may be conducted in a calmer atmosphere in which a more accurate evaluation of symptoms is possible.

Approach

It is unrealistic to pretend that a complete examination is undertaken in every case. Examination of the joint, no matter how complete, leads in no particular direction without background knowledge. In any age group of either sex, there is a minimum of possibilities; and these are known to the experienced. In other words, the clinician, having heard the history, and confined the patient to the relevant details, examines the knee only in regard to the possible diagnoses to which his experience directs him: complete examination is irrelevant.

He looks at the patient's quadriceps 'perfect quadriceps seldom control imperfect knees'. If there is wasting, it is observed but not measured (Chapter 2). He looks then for points to which he has been directed by the history, the common degenerative lesion of the medial meniscus, patello-femoral osteoarthrosis, etc. In short, he confirms or refutes the diagnosis to which he has been directed; **or he begins again.**

The ability to diagnose internal derangements of the knee, and the massive related pathology, cannot be acquired from a book; not even this one. If the art of clinical diagnosis is to be mastered there is no alternative to acquaintance with the attitude and techniques of the expert: More can be learnt in minutes than in hours of reading.

Inspection

The human eye is the most sensitive of the instruments of clinical examination. It can detect what cannot be palpated, measured or otherwise recorded. It is the facility to be exploited. It is important at all stages of the investigation of a knee complaint.

The patient should give his history in answer to relevant questions; and not otherwise. While doing so the clinician should be observing the uncovered knees in general and the one complained of in particular. By the end of the history he will have noted any abnormality of conformation, and if swelling is present, whether it is general or local, and if the latter, the precise site. In many instances the history combined with such observations, and essential academic background knowledge, make further examination almost superfluous. But it is indicated to confirm the provisional diagnosis; and that other possibilities are eliminated.

But observation, of course, is not and must not be, limited to what is seen as the patient sits before the examiner while the history is taken. It is a continuous process while the patient lies on the couch with the knees initially extended or later, flexed.

EXTENSOR APPARATUS

The importance of observation as a method of examination has been stressed. The first action is to compare, standing at the foot-end of the couch, the development of the quadriceps on the two sides. The muscle should be observed first in relaxation and then in contraction, the patient asked to brace his knees against the couch. If a

difference is noted it is pertinent, in a youth, to inquire if he is naturally right- or left-footed.

Observe thereafter whether wasting is uniform or whether certain elements are picked out, for example, vastus medialis. Differential wasting involving vastus medialis alone could be the clue to the diagnosis of recurrent subluxation of the patella.

It is at this stage that the existence of a minimal degree of flexion deformity, that is, loss of complete extension, may be evident. If so, the quadriceps will be wasted in some degree by comparison with the other side. If there is no wasting of the quadriceps there is not likely to be very much wrong with the knee.

Inspection of the muscle, particularly in relation to detecting minor degrees of wasting, is more important than measurement. Measurement is applicable to extremes; but not otherwise. A degree of wasting which cannot be measured can be appreciated by the eye. In any event measurement is dependent on the point at which the tape surrounds the limb and the tightness with which it is applied. In general it is useless in the female thigh with its frequent clothing of subcutaneous fat: the muscle may be wasted, the thickness of the fat is constant. Nevertheless, circumferential measurement is necessary if it is only for the maintenance of records.

In assessing wasting related to chronic disability care must be taken in using the muscle of the normal leg as the basis of comparison. The 'normal' leg is not normal. It has undertaken the function of the other leg in such simple everyday activities as rising from a chair, ascending or descending stairs. The muscles are in consequence hypertrophied. The experienced clinician makes a deliberate adjustment in his appraisal of the situation.

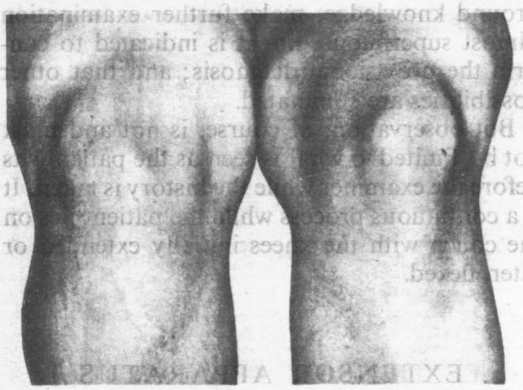


FIG. 1,1. **Examination: inspection. Patello-femoral joint: patellar posture.** The patient is examined with the knees hanging over the side of the couch. On the patient's left the patella will be seen to be located at a high level and pointing laterally. On the right side, which has been subjected to operation, the patella is seen to be at a lower level and the posture corrected in that it faces directly forward.

In the gross disease processes the condition of the quadriceps should be recorded as:

1. Strong.
2. Weak to resistance.
3. Able to extend against gravity.
4. Able to extend if gravity eliminated.
5. Flail.

See also Chapter 2, Lesions of the Extensor Apparatus.

PATELLO-FEMORAL JOINT

Inspection

The derangements of the mechanism, and of many of the disease processes, of the patello-femoral joint are so closely associated with the relationship of the patella to the femoral condyles that the approach to diagnosis is observation first in the erect position and then supine to determine that relationship. The existence of a large flat fat pad, and a discrepancy in form and development of the quadriceps by comparison with the calf muscles, are common clues as to the existence of patella alta.

Lateral posture of patella. When the history suggests subluxation of the patella as the possible diagnosis, observation of the joint in flexion in the dependent position may be helpful. The patient sits on the examination couch with the legs dangling relaxed at a right angle over the side. The joints are observed from in front and the direction in which each patella faces noted. Lateral posture of the patella at this angle, if in marked degree, may indicate instability (Fig. 1,1). In any event the cause must be determined. Is it due, for example, to lateral torsion of the femur? In observing the patient in this position due note will be taken of the position adopted by the foot. It is the means of locating the site of medial torsion. Observation of the knees in this position is important because inspection in extension, standing or supine, does

not reveal the abnormal relationship of patella to the femoral condyles nor the site of rotational deformity.

Location of symptoms. If in the course of taking the history it is established that the symptoms arise within the extensor apparatus, rather than in a component concerned with rotation, the exact site has to be determined.

1. ATTACHMENT OF QUADRICEPS. This location is rarely the site of pathology other than of gross degree, namely, total rupture; but such a possibility must be kept in mind in the middle-aged and the elderly.

2. PATELLO-FEMORAL JOINT. In youth, an abnormal relationship of patella to femoral condyles, in particular, patella alta with the related possibilities, must be considered. In adult life, chondromalacia patellae, and later, patello-femoral osteoarthrosis are the probabilities. In localising pain, as opposed to some mechanical obstruction to movement, it has to be remembered that articular cartilage has no nerve supply. Pain produced by manual pressure on the patella in extension or in hyperextension is likely to be due to compression of synovial membrane; not of articular cartilage (Chapter 2).

3. SUPERIOR ATTACHMENT OF PATELLAR TENDON. In early youth the Sinding Larsen-Johannson disease is a possibility. In later youth the traction lesion of the inferior pole without radiological findings and which lacks a precise pathological description (Jumper's knee) is a possibility.

4. PATELLAR TENDON. Pain located to the tendon may indicate a peritendonitis or teno-synovitis. In the differential diagnosis will require to be considered the possibility of a fat pad lesion or, uncommonly, a retrotendon bursitis.

5. INFERIOR ATTACHMENT OF PATELLAR TENDON. In the adolescent male the traction epiphysitis well-known as Osgood-Schlatter's disease is the probability. In adult life pain and swelling at the site is usually the residue of traction epiphysitis in youth.

LOSS OF EXTENSION: FLEXION DEFORMITY

The earliest stage of flexion deformity is nothing more than absence of complete extension. Impairment of function implied by flexion is not assessed in degrees but the point in the range of movement at which loss occurs. It is the small flexion deformity which is important. Loss of 5 to 10° at the extension-end of the range eliminates the essential screw-home movement with consequent loss of function out of all proportion to the range of motion involved. But it will be accepted, in a volume which purports to deal with disease as opposed to injury, that perfection of function is frequently unattainable. It is important to appreciate, however, that complete extension is essential to perfection; and that anything less accepts a lower standard. In examination, therefore, whether in injury or disease, the estimation of extension is mandatory.

At the completion of the screw-home or back-lock position it is possible to stand, even on one leg, without external support with the quadriceps relaxed and the patella mobile to passive movement in every direction. Once the screw-home position is reversed, however, and there is slight flexion, the body-weight can be supported only by contraction of the quadriceps and thus with the patella pressed hard against the femoral condyles. This is a situation of considerable practical importance. In osteoarthrosis in general, and patello-femoral osteoarthrosis in particular, symptoms are precipitated not so much by advance in the degenerative process as by an increase in flexion to the point where, in maintaining the erect position, the worn articular cartilage of the patella is pressed hard against the worn articular cartilage of the femoral condyles. The result is pain; and often in considerable degree.

In the course of taking the history a patient should be asked if he has appreciated loss of the ability to extend. Reactions vary in relation to background, intelligence and education. In some, the absence of those few degrees which constitute the screw-home movement is immediately obvious. In others, 15 degrees of flexion passes unnoticed. Such is the variety of attitudes to which the clinician must adjust. The ultimate decision as to loss of extension, if there is any doubt, depends on examination in the supine position.

Examination supine. At this stage the patient is lying on a couch in a state of relaxation as

indicated to be necessary. The clinician stands first at the foot-end of the couch to observe the comparable development of the quadriceps and then compares extension of the two knees in turn from the side, standing well away from the couch. A flexion deformity of more than a few degrees should be evident; and the reason is to be determined.

The subtleties of the situation are less in evidence in disease than in injury. If, for example, the complete longitudinal (bucket-handle) tear of the medial meniscus is the classical internal derangement of youth it is by no means exclusively so. It occurs at all ages and must be considered as a possibility even with minimal trauma. The tear, extending far into the anterior segment, is a block to the screw-home movement but obstructs extension only in minimal degree.

The initial approach, as it should be, is one of observation: the comparison of the two knees in extension on the couch. If it is not obvious that there is a difference between the two the effect of gentle manual pressure should be compared. A hand is laid first on the normal knee (assuming that it is normal) to effect a standard of extension, and only then upon the joint in question. If the slightest difference is noted, it becomes a matter of explaining the reason for the difference. It is at this stage that general background knowledge of the possibilities in relation to age, sex and circumstances becomes important.

The last few degrees of extension or, as is so often present in the female knee, hyperextension, can hardly be expressed in exact terms. In the more obvious flexion deformities of rheumatoid or other form of arthritis it is important that exact measurements are made and recorded. Such measurements are of value in assessing reaction to treatment whether of increasing the range of movement or of securing a reduction of deformity. The method, generally accepted as standard practice, is illustrated in Figure 1.2.

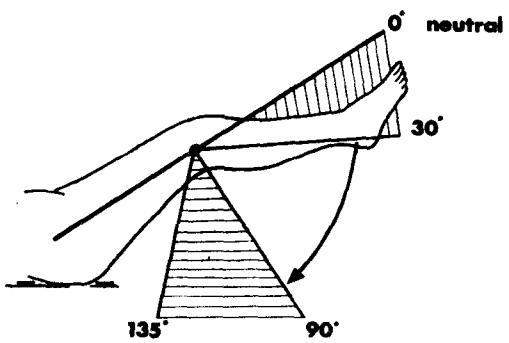


FIG. 1.2. **Examination.** Standard method of measuring range of motion and/or flexion deformity.

LIGAMENTS

Medial

The medial ligament is the most important single soft tissue component concerned with the stability of the joint. In a volume concerned with diseases the relevance of such a structure may be questioned. But it is not so. The ability to assess the state of this ligament is at all times important. It is overlengthened, for example, and thus inactive in control of stability, in old

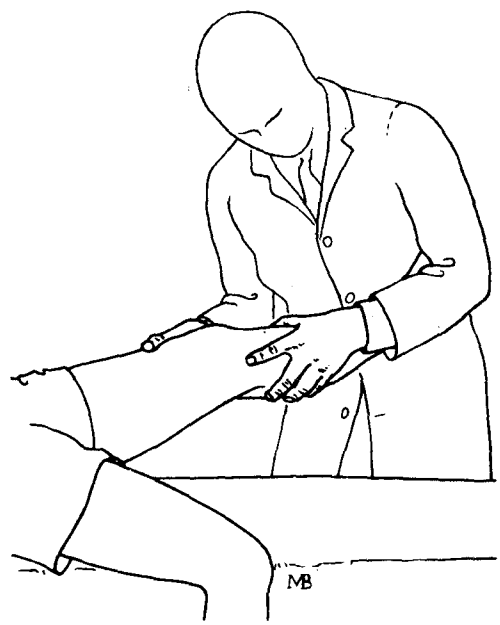


FIG. 1.3. **Examination: ligaments: medial.** To examine the medial ligament one hand fixes the femur above the joint, the other grips the tibia below the joint with the forefinger on the joint line where the ligament is located. By exerting pressure with the elbow on the foot the normal ligament should be palpable under tension; in other circumstances absence, attenuation or overlengthening can be estimated.

fractures of the medial condyle of the tibia (Chapter 9). More common, in the concept of disease, is the influence of overlengthening in the symptomatology in angular deformity of degenerative origin (Chapter 10) and, of course, instability in rheumatoid arthritis.

In the normal knee, if subcutaneous fat is not excessive, the medial ligament is readily palpable. It stands out as a strong band beneath the forefinger in the circumstances of the method of examination to be described:

The patient lies on a firm couch, head resting on a pillow, relaxed with hands resting on the chest and fingers interlocked. The surgeon stands on the outer side of the leg. One hand grips and fixes the femur above the knee. The other grips the tibia below the knee with the forefinger placed on the joint line where the ligament is located. The inner side of the elbow is in contact with the medial malleolus. By exerting pressure on the inner aspect of the foot, with the femur fixed, a valgus strain is produced. In the normal knee the ligament is palpable under tension. In other circumstances the ability to open up the joint in varying degree is evident and the absence of a palpable band appreciated (Fig. 1,3).

The condition of the ligament should be determined at zero degrees extension, as opposed to hyperextension (genu recurvatum) if this is possible, and at 30° flexion.

Record observations of laxity as:

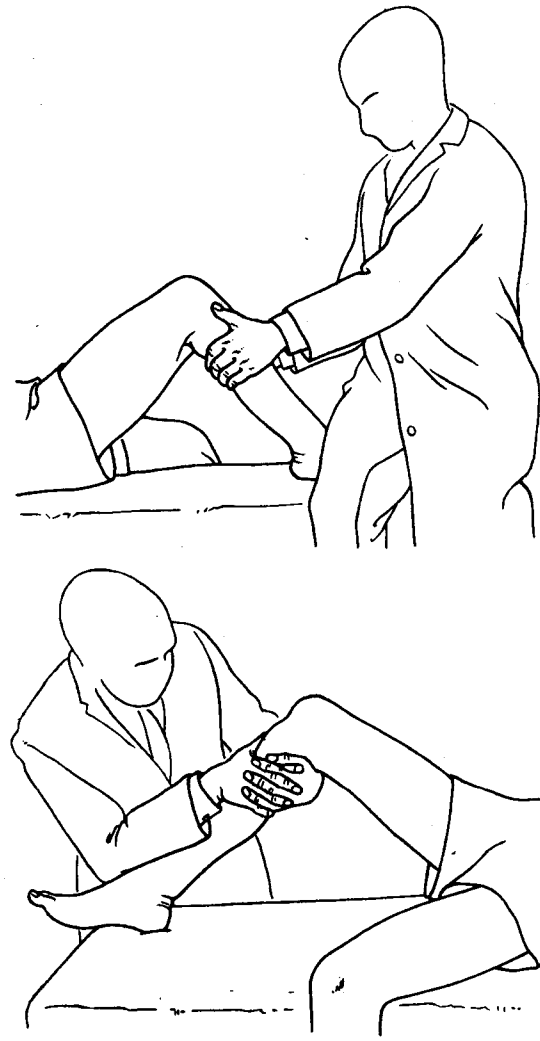
In extension:

1. None.
2. Slight.
3. Moderate.
4. Marked.

At 30° flexion:

1. None.
2. Slight.
3. Moderate.
4. Marked.

EXAMINATION UNDER ANAESTHESIA. The administration of a general anaesthetic has little to offer in the diagnosis of internal derangements or diseases of the knee joint. Under anaesthesia the muscles are relaxed so that the torn meniscus in particular is not subject to compression: meniscus 'clicks' can be produced without anaesthesia which cannot be produced with. Furthermore, the patient does not experience the pain which may be of such importance in localising the lesion. There are however important exceptions. The first, in the concept of injury, concerns the diagnosis of recent total ligamentous tears. In circumstances of doubt, and in the presence of pain and muscle spasm making complete examination impossible, an



FIGS 1,4–5. **Examination: ligaments. Anterior cruciate.** Two methods of eliciting the drawer-sign (see text). The degree of mobility is influenced by the condition of the medial ligament. The ability to pull the tibia forward is minimal in isolated rupture; maximal in combination with rupture of medial ligament.

There is a common error of interpretation (see text and Fig. 1,6).

anaesthetic may be necessary to distinguish total rupture, necessitating immediate operative repair, from a partial tear. The second, in the concept of both injury and disease, concerns the necessity to distinguish an apparent fixed flexion deformity due to a mechanical obstruction from that due to muscle contracture, as in hysteria, and which will resolve completely under anaesthesia (Chapter 12).

Anterior Cruciate

The patient lies on a firm couch, head resting on a pillow, relaxed with arms across the chest and fingers interlocked. In the initial stages *both* knees are drawn up to a right-angle for purposes of comparing the profile of the joint in question with the normal (see below, Posterior Cruciate Ligament and Fig. 1,6).

Drawer-sign. The diagnosis of rupture or laxity of the anterior cruciate ligament is based on the ability to demonstrate an abnormal degree of antero-posterior mobility of the tibia on the femur with the knee about right-angled flexion. The surgeon sits on the patient's toes to fix the lower end of the tibia. Both hands grasp the tibial head immediately below the joint. If the muscles are relaxed, as detected by the fingers in the popliteal space, a forward pull reveals the presence or absence of abnormal mobility by comparison with the opposite side. This is the so-called 'drawer-sign'—drawer forwards (Fig. 1,4).

Alternatively, and suited to a high examination couch, the left hand is placed behind the upper end of the tibia and interlocked with the fingers of the right hand while the right elbow rests on the patient's instep to fix the foot. The left hand is now in a position, using the elbow as a fixed point, to pull the head of the tibia forward (Fig. 1,5).

A method in common use whereby the test is carried out with the patient's leg hanging over the end of the couch is not recommended.

The sign is minimal (slight or moderate), that is to say the tibia can be pulled forward fractionally beyond the profile of the sound side, in isolated ruptures. The degree of mobility is influenced by the condition of the medial ligament. It is maximal (marked) with total rupture.

A common error of interpretation leads to the erroneous diagnosis of rupture of the anterior ligament when, in fact, the posterior is at fault. This mistake occurs because the posterior 'drawer-sign' (see Posterior Cruciate Ligament),

FIGS 1,6–7. **Examination: ligaments. Rupture of posterior cruciate ligament and posterior capsule:** Note backward sag of tibial head in profile superimposed on normal (Fig. 1,6). The tibial head can be pulled forward (Figs 1,4–5) until the anterior cruciate ligament is taut when the profiles of the knees will be comparable. The leg raised by the heel to demonstrate hyperextension due to rupture of the posterior capsule (Fig. 1,7).

These photographs were obtained in a recent lesion. Note absence of swelling of the knee, but swelling of the calf (Fig. 1,6). Haemorrhage and effusion has passed into the calf through the rent in the capsule.

in contradistinction to the anterior 'drawer-sign' appears spontaneously, taking the form of backward sagging of the head of the tibia when the knees are at right angles and the feet on the couch (Fig. 1,6). If this recession of the tibial head passes unnoticed—and it is only likely to be noticed by deliberate observation in comparison with the sound side—the fact that the tibia can be pulled forward until the anterior cruciate ligament becomes taut may be misinterpreted as a positive 'drawer forwards' sign.

Record observations of laxity as:

1. None.
2. Slight.
3. Moderate.
4. Marked.

Posterior Cruciate

It is important to recognise that the so-called posterior drawer-sign whereby rupture of the posterior cruciate ligament is indicated by the ability to push the tibia backwards is theoretical in conception. Thus the posterior drawer-sign—drawer backwards—is a myth. It is not a matter of pushing the tibia backwards: it sags backwards spontaneously. It is necessary to compare the profiles of the two knees in right-angled flexion with the patient in the supine position; and to appreciate the difference between the two the examiner must stand well away from the couch (Figs. 1,6 and 1,7). Most important of all is not to confuse, in this position, rupture of the posterior with rupture of the anterior ligament. The mistake, and a common one, arises from the ability to pull the tibia forwards. In isolated rupture of the posterior ligament it comes forward only in so far as the anterior ligament becomes taut and the profile compares with the sound side.

If it is shown by such means that the posterior cruciate ligament is ruptured it becomes necessary to determine whether the posterior capsule too is ruptured or, in other circumstances such as quadriceps paralysis, stretched. To do this each limb, completely relaxed, is raised from the couch by the heel and the degree of extension or hyperextension estimated (Fig. 1,7). But a comparison between the two sides is not readily made when the difference between the two is minimal. In such circumstances resource should be made to the method applicable to genu recurvatum.

Hyperextension. If the knees hyperextend as in genu recurvatum, comparison of the degree of hyperextension between the two will not be possible with the limbs lying on the couch. To compare hyperextension a hand is placed on the knee over the suprapatellar pouch and the lower end of the femur firmly fixed against the couch by backward pressure. The other hand is now placed beneath the tendo achilles and the heel raised from off the couch. A comparison is made between the two sides (Fig. 1,8).

Record observations of laxity as:

1. None.
2. Slight.
3. Moderate.
4. Marked.

LIGAMENTOUS INSTABILITY: SUBJECTIVE SYMPTOMS. Clinical examination is important; but not everything. Objective phenomena do not necessarily coincide with subjective symptoms.

In ligamentous laxity objective phenomena as manifest, for example, in the anterior drawer-sign, and subjective phenomena do not necessarily coincide. It is well-known that first-class football is possible in the presence of isolated rupture of the anterior cruciate ligament clinically recorded as 'slight' and confirmed at operation. In such circumstances subjective phenomena are of major importance and may be classified:

Grade 0. No complaint of instability. No interference with athletic activities.

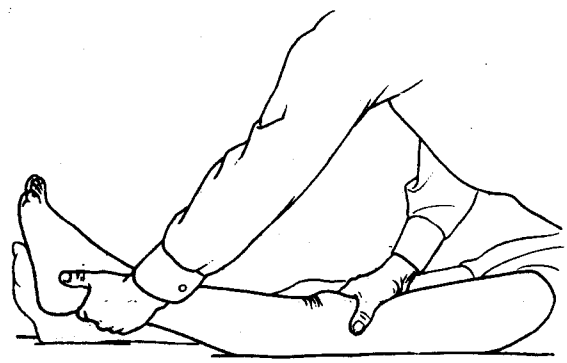


FIG. 1,8. **Examination.** Method of assessing loss of extension, or degree of hyperextension or recurvatus deformity as in this example, comparing the two knees.

1. There is disability under stress. The knee is not as sound as the other one.
2. Instability is such that certain athletic activities are possible but not contact games and certainly not football.
3. Instability is such that no athletic activities are possible and have been abandoned. There is no serious interference with physical work.
4. Instability is gross and such as to make physical work impossible.

SWELLING

General

The first point to be decided is whether the swelling is general, involving the entire joint, and, if so, whether it is fluid or soft tissue, i.e. synovial membrane as in rheumatoid arthritis.

A synovial effusion outlines the horse-shoe shape of the suprapatellar pouch and is detected by the experienced at a glance. The test taught to generations of medical students whereby a hand placed on the suprapatellar pouch raises the patella from off the femoral condyles and permits the 'patella tap' sign to be elicited, is not normally performed. In any event it is not pathognomic for fluid in that pressure on a synovial swelling as in pigmented villonodular synovitis or rheumatoid arthritis has the same effect. Synovial thickening can be distinguished from effusion by finger palpation of the margins of the suprapatellar pouch. Difficulties arise when the effusion contains massive fibrin clots and in haemarthrosis when clotting has occurred.

The second question to be answered, if it has been decided that the swelling is general rather than local, is whether the entire synovial lining is affected, or whether it is the suprapatellar pouch in isolation. In this regard attention is directed to the 'joint lines', that is to say, the interval between femur and tibia on either side. In a tense effusion, which will be obvious, bulging at these sites is always present and should cause no problems of identification. It is in other circumstances that difficulties arise. If the joint is observed on the lateral side it will be seen, in general synovial thickening of whatever origin, that the suprapatellar pouch is enlarged. Lower down, and corresponding to the joint line, is a second linear area of swelling.

If it is decided that the swelling is general and affecting the entire lining of the joint, all the possible diagnoses related to such circumstances must be considered.

Local

A soft tissue swelling of firm but compressible consistency within the joint will alter in shape depending on whether the knee is in full flexion, mid flexion or full extension. If, for example, the space-occupying lesion is in the anterior compartment it will be under compression in full flexion and in full extension. The maximum swelling in such circumstances will be at the weakest points in the capsule. The weakest point of all, particularly in the female, is the interval

FIG. 1.9. **Examination: inspection.** The weakest area of the capsule, in the female knee in particular, is the gap between patellar tendon and iliotibial band. It is at this site that the extrasynovial fat protrudes in extension as a spindle-shaped swelling in the presence of increased intra-articular tension from synovial effusion or space-occupying lesion in the anterior compartment.