

# Classification of Knee Ligament Instabilities

## Part II. The Lateral Compartment\*

BY JACK C. HUGHSTON, M.D.<sup>†</sup>, JAMES R. ANDREWS, M.D.<sup>†</sup>,  
MERVYN J. CROSS, M.B.B.S., F.R.A.C.S.<sup>†</sup>, AND ARNALDO MOSCHI, M.D.<sup>†</sup>, COLUMBUS, GEORGIA

*From the Tulane University School of Medicine, Division of Orthopaedics, Sports Medicine Section,  
New Orleans, Louisiana, and the Hughston Orthopaedic Clinic, Columbus*

**ABSTRACT:** Lateral instability of the knee is less frequent but more disabling than medial instability of a comparable amount. At the same time the diagnostic tests for lateral instability are more subtle and more frequently misinterpreted. Posterolateral rotatory subluxation is demonstrated by an apparently positive posterior drawer test with the tibia in neutral rotation or by the external rotation-recurvatum test with the knee in extension. Anterolateral rotatory subluxation is present when the anterior drawer test with the tibia in neutral rotation demonstrates that the lateral tibial condyle appears to become more prominent or that both condyles appear to become equally prominent. This instability is confirmed by the jerk test: a jerk elicited at about 30 degrees of knee flexion as the moderately internally rotated tibia is brought from a position of 90 degrees of flexion to full extension while a mild abduction stress is applied. Combined anterolateral and posterolateral rotatory instability is characterized by a positive anterior drawer test and apparently positive posterior drawer test; an adduction stress test that is 1+ or 2+ at 30 degrees of flexion; and positive external rotation-recurvatum and jerk tests. Straight lateral instability is confirmed by a positive adduction stress test at full extension without associated external rotation and recurvatum of the tibia, and is present when the lateral-compartment ligaments are completely torn with an associated tear of the posterior cruciate ligament.

Lateral instabilities of the knee, both acute and chronic, are not as common as medial ones and often are unrecognized because the clinical signs are subtle and misleading. To improve the diagnosis, prevention, and treatment of these instabilities, as noted in Part I of this report, a reproducible and easily applied classification is needed. Our purpose here is to describe our classification, which is based on a correlation of functional anatomy and the clinical and operative findings in patients with acute and chronic lateral-compartment instability.

### Functional Anatomy of the Lateral Compartment of the Knee

The lateral-compartment ligaments of the knee may be divided into three parts: the anterior, middle, and posterior thirds.

The anterior third, which includes the capsular ligament extending posteriorly from the lateral borders of the patellar tendon and patella to the anterior border of the iliotibial band, is reinforced by the lateral extension of the quadriceps tendon (retinaculum). This extension actually unites with the capsular ligament to form a single layer which is attached to the articular margin of the proximal end of the tibia and is continuous with the fibrotic expansion extending up from the origin of the extensor digitorum longus, with which the quadriceps acts in synergism. This anterior third of the lateral capsular ligament has no attachment to the femur.

The middle third of the lateral ligaments, composed of the iliotibial band and the capsular ligament deep to it, extends posteriorly as far as the fibular collateral ligament. Both the iliotibial tract, which provides static support, and the iliotibial band, which functions dynamically, partially reinforce the mid-third capsular ligament. Often this middle third is misinterpreted as merely areolar tissue because of its close association with the lateral extension of the fat pad, but it is technically strong and is a major lateral static support for the knee at around 30 degrees of flexion. The middle third of the lateral capsular ligament attaches proximally to the lateral epicondyle of the femur and distally at the tibial joint margin (see Figure 3 in Part I of this report).

The posterior third includes both capsular and non-capsular ligaments, forming a single functional unit which we term the arcuate complex. The components of this complex are the fibular collateral ligament, the arcuate ligament, and the tendoaponeurotic unit formed by the popliteus muscle. The posterior third receives dynamic reinforcement from the biceps femoris and popliteus muscles, as well as from the lateral head of the gastrocnemius.

### Classification of Lateral Instabilities of the Knee

We have seen six types of lateral-compartment instability. Our classification of these types is described here, followed by the evidence on which this classification is based.

\* Read at the Annual Meeting of The American Orthopaedic Association, San Francisco, California, June 12, 1974.

<sup>†</sup> 105 Physicians Building, 1315 Delauney Avenue, Columbus, Georgia 31901.

*Anterolateral Rotatory Instability*

This type is caused by a tear of the middle one-third of the lateral capsular ligament but it may be accentuated by other tears, principally a tear of the anterior cruciate. It is most accurately demonstrated by the jerk test but is also manifested by a positive anterior drawer test with the tibia in neutral rotation (anterior subluxation of the lateral tibial plateau). The adduction stress test done with the knee at 30 degrees of flexion, on the other hand, may be normal or only mildly positive (1+).

*Posterolateral Rotatory Instability*

In this type, caused by a tear of the arcuate complex, the external rotation-recurvatum test is positive, as is the adduction stress test at 30 degrees of knee flexion. The adduction stress test done with the knee at zero degrees may also seem to be positive but close observation reveals that it is posterolateral rotatory subluxation which is occurring, and not lateral opening.

*Combined Anterolateral and Posterolateral Rotatory Instability*

This combination is the result of disruption of all of the lateral-compartment capsular ligaments with or without a tear of the iliotibial band, while the posterior cruciate ligament remains intact. In this type of instability the anterior and posterior drawer tests with the tibia in neutral rotation demonstrate that the lateral tibial plateau rotates forward and backward as pull and push are applied. The adduction stress test with the knee in full extension is negative if tibial rotation is prevented. If rotation occurs, this test appears to be severely positive (3+) due to the posterolateral rotatory subluxation that occurs during testing with the knee extended and rotated. At 30 degrees of knee flexion, on the other hand, an intact iliotibial band may migrate posteriorly, with the result that the adduction stress test seems comparatively less positive.

*Combined Anterolateral and Anteromedial Rotatory Instability*

This combined instability is the result of tears of both the medial and the lateral capsular ligaments in their middle one-third while the posterior cruciate ligament remains intact. In a knee with these lesions the anterior drawer test is usually severely positive (3+), both tibial condyles subluxating anteriorly when the test is performed with the tibia in neutral rotation, but is negative when performed with the tibia internally rotated. Both the abduction and the adduction stress tests are positive, although they may be no more than 1+, and the jerk test is also positive.

*Combined Posterolateral, Anterolateral, and Anteromedial Rotatory Instability*

This triple instability is caused by tears of both the lateral and the medial ligaments. In a knee with these lesions, the anterior drawer test is 3+ with the tibia in neutral rotation and negative with the tibia in internal rota-

tion, the posterior drawer test causes the tibia to rotate externally and backward, and the adduction and abduction stress tests are positive with the knee at 30 degrees of flexion but negative with it at zero degrees.

*Straight Lateral Instability*

This type is the result of tears of all of the lateral-compartment ligaments and the posterior cruciate ligament. In an acutely injured knee, the adduction stress test with the knee fully extended demonstrates true lateral opening of the joint space with no rotation. However, the posterior drawer test may be either positive or negative depending on whether or not the posterior oblique ligament of the medial compartment is stretched or torn.

**Clinical Material**

For this study we reviewed eighty-nine consecutive patients who were operated on for acute and chronic lateral-compartment instabilities, with particular reference to the operative and clinical findings. In the acute cases the clinical findings could be correlated with specific ligament lesions found at operation, while in the chronic cases the findings could be related to the observed scar-tissue healing or looseness of specific ligaments.

*Anterolateral Rotatory Instability*

*Operative findings:* Acute instability of this type was demonstrated in six knees. At arthrotomy the middle third of the lateral capsular ligament was torn in five knees. In them this tear was the only lesion in one, while it was associated with the following lesions in the other four: a tear of the anterior cruciate ligament combined with a tear of the lateral meniscus, a tear of the lateral meniscus only, a tear of the medial meniscus only, and tears of both menisci. In the sixth knee, the one without a tear of the lateral capsular ligament, there was an acute tear of the anterior cruciate ligament and no other abnormality except for 15 degrees of congenital recurvatum which, combined with the tear of the anterior cruciate ligament, was sufficient to increase the laxity of the lateral capsular ligament to the point of being pathological and disabling. In the three knees with tears of the menisci there was no correlation between these tears and the degree of increased instability.

Chronic instability was detected in twenty knees, all of which were found at operation to have demonstrable laxity of the middle one-third of the lateral capsular ligament. In three this was the only lesion, and in two the associated lesions were tears of the menisci (of the lateral meniscus in one and of both menisci in the other). In the other fifteen knees the anterior cruciate ligament was also torn. In three the tear of the cruciate was the only associated lesion and in twelve there were associated meniscal tears: of the medial meniscus in one, of the lateral meniscus in seven, and of both menisci in four.

Of these twenty knees, all with persistent disabling anterolateral instability, eight had had previous surgi-

cal treatment. This prior treatment had included repair of acute medial-ligament ruptures in two (with resultant excellent medial stability on clinical testing when we first saw them); medial meniscectomy alone in two; medial and lateral meniscectomies only in two; removal of a "loose body" in one; and medial and lateral meniscectomies with a subsequent Hey Groves medial reconstruction in one.

*Clinical findings:* Often anterolateral rotatory instability was caused by a fall when a basketball player landed after a jump shot, lost his balance, and fell forward with an internal-rotation and varus stress on one knee, which collapsed beneath him. The same mechanism, of course, could occur in any fall.

Symptoms after the acute injuries were often minimum, usually no more than mild to moderate pain over the lateral joint line. Walking was not uncomfortable and there was no sensation of instability while walking. However, the patient noticed difficulty (instability) when running, when decelerating suddenly, and when "cutting". Often the joint was not swollen and palpation demonstrated nothing more than moderate tenderness about the anterior one-half of the lateral tibial plateau. The adduction stress test at 30 degrees of flexion demonstrated no more than a 1+ increase in adduction on the injured side. This relatively benign picture tended to confuse the examiner unless more specific tests were employed.

Two signs were relatively specific for anterolateral rotatory instability. The first was the anterior drawer test, performed with the tibia in neutral position, which demonstrated anterolateral rotatory subluxation which could be mistakenly interpreted as simultaneous anterior subluxation of both tibial plateaus. When performing this test it should also be recalled that a 1+ straight anterior drawer test with the tibia in neutral position may be normal, especially in a boy who has not yet completed his growth or in patients with mild congenital recurvatum.

The second specific sign was the jerk test, performed as described in Part I of this report. When this test was positive the patient usually volunteered that the test produced the feeling of slipping or popping associated with the knee disability. When the anterior cruciate ligament was also torn the severity of the jerk test, anterior drawer sign, and functional disability was increased.

In cases of chronic anterolateral rotatory instability, the primary complaint was momentary, painful giving-way of the knee when walking on rough ground, or when cutting or pivoting away from the side of the affected extremity. Such instability was caused by mechanisms other than acute trauma in some cases. One such mechanism was repeated submaximum stress on the lateral compartment of the knee joint in a roller skater who persistently rotated the foot inward, dragging the skate along the floor for purposes of slowing or stopping. Chronic instability also followed removal of a torn lateral meniscus through a transverse surgical approach in which the capsular ligament had been divided. Undoubtedly this transverse surgical approach is used by many operators without residual an-

terolateral instability. If the capsular incision is firmly repaired and the postoperative rehabilitation is sufficiently cautious, healing may occur without residual instability. However, if the repair is not firm and if rehabilitation is too rapid, the capsular ligament may become lax and instability may result. Approach through a vertical incision in the capsular ligament has proved adequate in our hands and does not cause residual instability.

The findings in knees with chronic anterolateral instability could cause confusion since the anterior drawer test with the tibia in neutral position revealed simultaneous anterior subluxation of both tibial plateaus (the displacement of the lateral tibial condyle predominating) and the jerk test reproduced the patient's complaint of snapping and popping with pain usually felt in the medial compartment, possibly due to the effect of the abduction stress. This combination of pain at the medial joint line and popping caused by the anterolateral subluxation could be misinterpreted as evidence of a torn medial meniscus and lead to its removal. We suspect that this error may have occurred in some of our eight patients who had had previous unsuccessful operations.

#### *Posterolateral Rotatory Instability*

*Operative findings:* Acute posterolateral rotatory instability without associated anterolateral rotatory instability was demonstrated in six knees and at operation a tear of the arcuate complex was found in all six. This was the only lesion in three, while in the other three there were additional lesions: a tear of the anterior cruciate ligament, a tear of the biceps femoris tendon from the fibular head, and a tear of the lateral meniscus in one; a tear of the biceps femoris in another; and a tear of the lateral head of the gastrocnemius in one. In these six knees the middle third of the lateral capsular ligament and the iliotibial band were intact.

Chronic posterolateral rotatory instability was found in eight knees. At reconstruction, all eight were shown to have considerable scarring, pathological laxity, or both, in the arcuate complex. The lesions associated with this were an avulsion of the popliteus tendon from the femur in three knees; disruption of the popliteus tendon at its musculotendinous junction in one; rupture of the anterior cruciate ligament as well as tears of both menisci in two; a tear of the lateral meniscus in two; and a tear of the lateral head of the gastrocnemius in two. In all of these knees, therefore, the lesions were more or less limited to the posterolateral part of the knee. However, the functional disability in each instance was severe and incompatible with even the amount of activity necessary for a sedentary existence.

*Clinical findings:* Acute posterolateral rotatory instability was usually the result of a posteriorly directed force on the knee causing hyperextension. Four of our six cases were the result of such a force caused by a block in football. In the other two, jumping and landing with the knee hyperextended and the foot and tibia internally rotated was

responsible. Symptoms varied with the severity of injury, sometimes being no more than minimum pain and disability, so that after the injury the athlete remained in the game for a few plays. In such cases tenderness was mild, swelling was infrequent, and the adduction stress test yielded equivocal results. The patients noted that standing was uncomfortable or painful and had the sensation that the knee bent too far backward and did not become normally stabilized in extension. In some instances the adduction stress test at 30 degrees was only 1+. Hence, this test alone did not establish the diagnosis. A positive external rotation-recurvatum test was most diagnostic, but the findings in this test could be subtle and difficult to interpret. The posterior drawer test was also helpful if it produced posterolateral rotatory subluxation. Performing this test with and without internal rotation of the tibia helped to distinguish a test positive for posterolateral rotatory subluxation from one positive for a tear of the posterior cruciate ligament.

The findings in knees with chronic posterolateral rotatory instability were similar to those with the acute form, but in addition chronic instability was characterized by gradually increasing pain and disability, and medial-compartment narrowing and osteoarthritis visible on roentgenograms. These knees were often diagnosed as cases of tibia vara deformity. It is therefore important in cases of symptomatic tibia vara deformity to evaluate the lateral stability of the joint.

#### *Combined Anterolateral and Posterolateral Rotatory Instability*

*Operative findings:* Acute complete disruption of the lateral-compartment ligaments was found in six knees. There were tears of the arcuate ligament complex and the lateral capsular ligament in all six, two of them having a partial tear of the iliotibial band as well. The associated lesions included a tear of the anterior cruciate ligament in five, a tear of the lateral meniscus in four, avulsion of the lateral head of the gastrocnemius in four, and avulsion of the biceps femoris muscle from the fibular head in five.

Chronic combined anterolateral and posterolateral rotatory instability was demonstrated in four knees in which there were old tears of the arcuate complex and lateral capsular ligament. In addition, there was an incomplete old tear of the iliotibial band in one, a tear of the lateral gastrocnemius head in one, a tear of the anterior cruciate ligament in three, and tears in both the medial and the lateral meniscus in two.

*Clinical findings:* The mechanism of injury producing this complete disruption of the lateral compartment was similar to that responsible for posterolateral instability, only more severe. The deforming force applied to the front of the knee caused severe recurvatum and more or less tibia vara. The greater the varus stress the more extensive the disruption of the lateral-compartment supporting structures.

The patients with this injury often had considerable

pain and were unable to walk. Their adduction stress test with the knee in full extension appeared to be 2+ or 3+, but what seemed to be straight lateral opening of the joint on closer evaluation could be identified as external rotation and posterolateral subluxation with a varus displacement of the knee. The adduction stress test with the knee at 30 degrees of flexion was only mildly positive in some knees in which the iliotibial band migrated enough posteriorly during flexion to provide support for the lateral compartment.

#### *Combined Anterolateral and Anteromedial Rotatory Instability*

*Operative findings:* In four knees with acute injuries the abduction stress test with the knee at 30 degrees of flexion was 2+ to 3+; the straight anterior drawer test with the tibia in neutral, 3+; and the jerk test (which, of course, could only be performed under general anesthesia after these acute injuries) was 3+. Arthrotomy using both a medial and a lateral approach in each of these cases demonstrated tears of the medial capsular ligament, the tibial collateral ligament, and the posterior oblique ligaments in the medial compartment; an associated tear of the middle third of the anterior cruciate ligament; and an acute tear of the lateral capsular ligament. In addition, the lateral meniscus was torn in one; the medial meniscus, in one; and both the medial and the lateral meniscus were torn in another. In the remaining knee both menisci were intact.

Chronic combined anterolateral and anteromedial rotatory instability was demonstrated in twenty-six knees. Eighteen of these had been operated on previously without functional recovery. At reconstruction old tears of the middle third of the lateral capsular ligament and of the posterior oblique ligament were found in all twenty-six. In three, these were the only lesions. In the other twenty-three there was an old tear of the anterior cruciate in nine; a tear of the medial meniscus in association with a torn anterior cruciate ligament in five; a torn lateral meniscus and a tear of the anterior cruciate ligament in four; tears of both menisci associated with a tear of the anterior cruciate ligament in four; and tears of both menisci only in one. In this group the presence of a meniscal injury correlated with the severity of the instability. The knees with a torn medial meniscus showed increased anteromedial rotatory instability compared with those having a normal medial meniscus.

Of the eighteen knees previously operated on, eleven had had one; six, two; and one, three operations. Four had had a medial meniscectomy; two, a pes anserinus transplant without any intra-articular operative procedure; three, a medial meniscectomy, reconstruction of the medial ligaments, and a pes anserinus transplant; one, removal of bone chips; and one, a medial meniscectomy and medial ligament repair. Five had had an initial medial meniscectomy followed some time later by a reconstruction of the medial ligaments and pes anserinus transplant; and one, an initial open reduction of a tibial-plateau fracture, followed later by a reconstruction of the medial liga-

ments and a pes anserinus transplant. The remaining knee had had three previous operations: a lateral meniscectomy initially and two reconstructions of the lateral fragments, both failures.

*Clinical findings:* In the four acute cases the injury was a twist of the weight-bearing knee without any bodily contact. These injuries occurred while one patient was snow skiing; one was playing tennis; one, pole-vaulting; and one, playing basketball. While no patient could recall the mechanism of injury exactly, each remembered landing with the foot (tibia) internally rotated and the knee in extension, and then twisting and falling with the tibia externally rotated and abducted so as to cause a valgus deformity at the knee. Inability to stand or walk without aid was noted immediately.

In the twenty-six patients with chronic instability of this type, the most specific clinical sign was a markedly positive anterior drawer test performed with the tibia in neutral position. This test demonstrated that both condyles came straight forward with no apparent rotation, but the anterior drawer test with the tibia in internal rotation was negative. The jerk test was 3+.

Other patients with chronic instability had had an acute medial-ligament tear treated non-operatively, and then a subsequent football injury caused by either a contact force or a twist, followed by severe functional loss and disability even for recreational sports.

Still others with a history compatible with anterolateral rotatory instability had been treated by a medial meniscectomy or other surgery with resultant increased disability.

#### *Combined Anterolateral, Posterolateral, and Anteromedial Rotatory Instability*

*Operative findings:* In two knees, both acutely injured, there were tears of the lateral capsular ligament, the anterior cruciate ligament, the lateral meniscus, the arcuate complex, and the medial ligaments. In addition, one had a tear of the lateral head of the gastrocnemius and the other, an avulsion of the biceps femoris tendon and a partial tear of the iliotibial band.

Chronic combined anterolateral, posterolateral, and anteromedial rotatory instability, demonstrated in four knees, was associated with old tears of the lateral capsular ligament, the arcuate complex, and the posterior oblique ligament. In addition, three had a tear of the anterior cruciate ligament; two, a tear of the lateral head of the gastrocnemius; one, a torn medial meniscus; and one, a torn lateral meniscus. Three of these four knees had had previous operations: two, a medial meniscectomy and one, five previous reconstructions of various types.

*Clinical findings:* The mechanism of injury in each of these cases was a hyperextension-varus force with no recognizable cause for the associated medial-ligament tear. However, we would suspect that a twist of the knee, occurring as the patient fell to the ground, was responsible.

In these knees the disability was primarily that of

posterolateral instability with a positive external rotation-recurvatum test and varus instability as well. The patients had pain, both on the medial side of the joint and in the region of the biceps tendon, and found running difficult or impossible. Examination revealed that the abduction test with the knee flexed 30 degrees was 2+; the anterior drawer test was 3+ with the tibia in neutral rotation and negative with it in internal rotation; the posterior drawer test was 2+ with the tibia externally rotated and negative with it internally rotated; the jerk test was 2+; and the external rotation-recurvatum test was 3+.

#### *Acute Straight Lateral Instability*

*Operative findings:* In three acutely injured knees there was straight lateral instability. Operation revealed that the posterior cruciate, lateral capsular, and arcuate ligaments were torn as well as the lateral meniscus. In addition, the anterior cruciate ligament was torn in two; the lateral head of the gastrocnemius, in two; and the biceps femoris tendon at its insertion, in two.

*Clinical findings:* The three cases of acute straight lateral instability were the results of an automobile accident in two and a motorcycle accident in one. The mechanism of injury therefore could not be ascertained. The adduction stress test at zero degrees was 3+ with no tibial rotation, and the posterior drawer test with the tibia in neutral rotation was positive in all three knees.

### **Discussion**

Ligament instabilities of the lateral compartment of the knee differ from those of the medial compartment for several reasons. When the knee is at or near maximum extension during standing and walking, the medial compartment is under compression with its ligaments taut but not under stress while the lateral-compartment ligaments are under extreme tension. If one stands with one knee somewhat flexed and the other extended and supporting most of the body weight, one can detect that there is considerable distraction of the lateral compartment, especially the posterolateral corner. During normal walking, the same medial compression and lateral distraction occur as the weight-bearing knee reaches full extension. We believe that this distraction is the reason that instability in the lateral compartment causes significantly more disability than a comparable amount of instability in the medial compartment. We also have found that the posterolateral ligaments are larger and stronger than the medial ones, presumably reflecting this continual distraction stress, even though we have heard some authorities describe the lateral-compartment ligaments as being much weaker than the medial ones. Both acute and chronic anterolateral rotatory instability cause subtle changes. After the acute injuries, one must be mindful of the possibly mild initial complaints, the mechanism of injury, and the sometimes mild, objective clinical signs.

If both the anterior cruciate ligament and the lateral capsular ligament are torn in an acute injury, the correct

diagnosis is more difficult because of the hemarthrosis with its associated pain and pseudolocking which make it impossible to elicit a positive anterior drawer test or a positive jerk test. In this series a coexistent tear of the anterior cruciate ligament increased the chronic anterolateral rotatory instability as well as the disability caused by it, and facilitated the diagnosis. However, the examiner must be aware of the clinical difference between anteromedial and anterolateral rotatory instability and of the possibility that there may be a combination of the two. If the jerk test is not performed and correctly interpreted, the positive anterior drawer test may be misinterpreted as a sign of anteromedial rotatory instability leading to inappropriate or incomplete surgical treatment, as was the case in five of the nine patients with chronic anterolateral rotatory instability who had had previous surgical intervention.

A false positive jerk test may occur in the presence of a torn meniscus which becomes interposed between the joint surfaces and distracts the femorotibial joint. Prior to any ligament reconstruction for anterolateral instability, it is necessary to explore the knee joint through an anteromedial incision. If a torn meniscus is producing distraction and a false positive jerk test, the test will be normal after removal of the torn meniscus. We encountered this in three knees: two with a torn medial meniscus and one with a tear of the lateral meniscus. The anterior cruciate ligament was also torn in two of these knees and was grossly normal in the other.

In children or in persons who have mild to moderate congenital genu recurvatum, the jerk test and the anterior drawer test with the tibia in neutral rotation may be mildly positive in both lower extremities, yet there is no pain or disability. These findings must be considered normal.

It may not be possible to perform the jerk test in the presence of an acute complete medial-compartment tear because this maneuver is too painful. After induction of anesthesia, before the extremity is prepared and draped for surgery, a complete examination for ligament instability should always be performed. As evidenced by the findings in this series, if the jerk test is positive in the presence of a medial-compartment tear then the lateral compartment must be explored and the torn ligaments repaired.

Because anterolateral rotatory instability has been described as an anterior cruciate ligament insufficiency<sup>2</sup>, we reviewed 228 consecutive chronic anterior cruciate ligament tears seen over a five-year period and found that only thirty-five (15.3 per cent) were associated with anterolateral rotatory instability or combined anterolateral and anteromedial rotatory instability. Furthermore, in three acute and five chronic cases of anterolateral rotatory instability in this series there were no tears of the anterior cruciate ligament.

Combined anterolateral and anteromedial rotatory instability is probably as frequent as pure anterolateral instability, and is an even greater problem in terms of recognition and the selection of the appropriate form of operative treatment.

In a patient with acute posterolateral rotatory instability due to a tear of the arcuate complex, the physical signs may be misleading, including mild to moderate tenderness to firm palpation posterolaterally, no limitation of motion, a normal or 1+ adduction stress test with the knee at 30 degrees of flexion, no swelling, and minimum disability when walking or even jogging. If the external rotation-recurvatum test is not done, the degree of instability will not be appreciated and the patient may be treated conservatively, with resultant disability. Undoubtedly, in some of these patients adequate healing occurs so that they can engage in sedentary activities without difficulty. Other patients, shortly after removal of the plaster cast or discontinuing crutches, gradually stretch the scar simply by normal standing and walking and begin to have progressively increasing fatigue, pain when walking, and disability for athletics. The patient may describe the difficulty as an inability to lock the knee in extension.

After acute severe posterolateral injuries with instability, the knee is very painful initially and the patient is unable to walk without aid. Under these circumstances the posterior drawer test produces posterolateral rotatory subluxation of the tibia, a displacement that is frequently misinterpreted as indicating a tear of the posterior cruciate ligament. However, a negative posterior drawer test with the tibia in neutral or internal rotation helps to rule out injury to the posterior cruciate ligament.

Chronic posterolateral rotatory instability with apparent tibia vara, external rotation, and genu recurvatum may be misinterpreted as primary tibia vara deformity and treated by proximal tibial osteotomy. We saw six knees, not included in this report, which had been treated unsuccessfully in this way.

Frequently the iliotibial band is referred to as the most important stabilizer of the lateral compartment, but only Kaplan wrote about its stabilizing function. We saw four cases of acute rupture of the lateral compartment with 3+ instability to adduction stress in which no tear in the iliotibial band could be demonstrated. We therefore believe that this band acts more as a dynamic stabilizer, producing an effect comparable to the dynamic stabilizing action of the quadriceps retinaculum medially. The posterior fibers of the iliotibial band, the so-called iliotibial tract, which originate from the lateral intermuscular septum of the thigh and insert on the lateral tibial tubercle, may be considered to function as a static stabilizer. However, at about 30 degrees of flexion we believe that the static support for the lateral compartment is provided only by the middle third of the lateral capsular ligament and the arcuate complex.

## Conclusion

Instabilities due to tears of the lateral-compartment ligaments of the knee are less common but more easily overlooked and more disabling than the instabilities caused by lesions of the medial-compartment ligaments.

The adduction stress test, usually considered to be

pathognomonic of lateral-compartment instabilities, is likely to be only 1+ or 2+ in all types of lateral instability, and is generally not diagnostic. A negative test does not exclude lateral instability.

Anterolateral rotatory instability, primarily the result of a tear of the middle one-third of the lateral capsular ligament, is accentuated by an associated tear of the anterior cruciate ligament. The most specific test for this type of instability is the jerk test. In the presence of anterolateral rotatory instability, the popping and snapping which is felt when the lateral tibial plateau subluxates during the jerk test, and which is often associated with medial joint pain, can easily be misinterpreted as evidence of a tear of the medial meniscus. If the positive anterior drawer test is misinterpreted as indicating anteromedial instability, and medial meniscectomy and pes anserinus transplant are performed, the preoperative disability is aggravated.

Posterolateral rotatory instability due to a tear of the arcuate complex is demonstrated most accurately by the

external rotation-recurvatum test. It can be missed entirely as the cause of posterolateral joint pain or misdiagnosed as a tear of the lateral meniscus, leading to meniscectomy with resulting increased disability. If the instability is severe, a positive external rotation-recurvatum test may be misinterpreted as instability due to a posterior cruciate ligament tear. In the presence of such severe instability, one must be prepared at the time of operation to correct posterolateral instability, posterior cruciate instability, or both, by appropriate reconstructions.

The lateral capsular ligament or the arcuate complex (especially the popliteus portion) may be divided inadvertently during removal of the lateral meniscus. Knee stability should always be evaluated before wound closure after lateral meniscectomy.

It is most important to evaluate carefully knee injuries that may be associated with a tear of the lateral-compartment ligaments and to identify the objective signs of lateral instability which are indications for surgical repair.

### References

1. KAPLAN, E. B.: Surgical Approach to the Lateral (Peroneal) Side of the Knee Joint. *Surg., Gynec. and Obstet.*, **104**: 346-356, 1957.
2. MACINTOSH, D. L.: The Anterior Cruciate Ligament: Over-the-Top Repair. Presented at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Dallas, Texas, January 22, 1974.

## The Anterior Cruciate Ligament

### A FUNCTIONAL ANALYSIS BASED ON POSTMORTEM STUDIES\*

BY W. FURMAN†, J. L. MARSHALL, D.V.M., M.D.†, AND  
F. G. GIRGIS, M.D., PH.D.†, NEW YORK, N.Y.

*From the Sports Medicine Service, The Hospital for Special Surgery, Affiliated with  
The New York Hospital-Cornell University Medical College, New York City*

**ABSTRACT:** In forty fresh human cadaver knees the function of the anterior cruciate ligament and of its two component parts, the posterolateral part and the anteromedial band, were studied by cutting these ligaments and others in different sequences and combinations and then manually stressing the knees. The anterior drawer sign cannot be obtained unless the anteromedial band is severed. The posterolateral part and the medial collateral ligament are, respectively, the secondary and tertiary restraints limiting the anterior drawer sign. Both internal and external rotation are limited by the anterior cruciate ligament, especially when the knee is in extension. The anterior cruciate ligament also limits hyperextension.

Abbott and associates observed that the anterior cruciate ligament consists of two parts, an anteromedial

band and a larger posterolateral part, and that the anteromedial band is tight at 90 degrees of knee flexion. Lam and Girgis and co-workers also reported on their observations on the anteromedial band and posterolateral part.

The role of the anterior cruciate ligament in relation to the clinical anterior drawer sign has remained unclear. Palmer observed in cadaver knees that as long as the anterior and posterior cruciate ligaments are intact, severing the medial and lateral collateral ligaments and the posterior part of the knee capsule does not produce a positive anterior drawer sign.

Contrary to these findings, Reynolds reported that if both the medial and the lateral ligaments are injured, the anterior drawer sign is positive. The observations of Robichon and Romero and of McMaster and associates suggested that the anterior drawer sign is only positive when both the anterior cruciate ligament and the posterior capsule of the knee are compromised. Hughston stated that since the anterior cruciate ligament is not tight at 90 degrees of flexion, it cannot affect the anterior drawer sign.

\* Supported by the Sports Medicine Fund of The Hospital for Special Surgery.

† 535 East 70th Street, New York, N.Y. 10021.