GRADING THE PIVOT SHIFT
OBJECTIVE TESTS WITH IMPLICATIONS FOR TREATMENT

R. P. JAKOB, H. U. STÄUBLI, J. T. DELAND

From the University of Berne

A logical, objective and reproducible grading system for the pivot shift test is proposed. The rationale is based on performing the examination in varying positions of rotation of the tibia, allowing the type and degree of the different laxities to be defined and quantified. The system has been assessed against a new “unblocked” test for anterior subluxation and against radiographic measurements, operative findings and results. This grading system can be valuable in pre-operative assessment and planning and its use in postoperative evaluation would enable results from different centres and different procedures to be compared more accurately.

The pivot shift test, described by Galway, Beaupré and MacIntosh in 1972, has become a routine part of the clinical examination for ligamentous laxity of the knee, and has been shown to give an accurate indication of injury to the anterior cruciate ligament (Noyes et al. 1980). As yet no objective and reproducible grading system has been described. Many authors have described subjective scales of severity with two, three or four levels, but estimations of these must all depend on the skill and experience of the examiner and the results and gradings will vary considerably (Johnson et al. 1984; Clancy 1985; Donaldson, Warren and Wickiewicz 1985; Jensen et al. 1983; Terry and H Hughston 1985).

A number of variations of the basic pivot shift test also have been described (Hughston et al. 1976; Slocum et al. 1976; Losee, Johnson and Southwick 1978; Galway and MacIntosh 1980). All these variations indicate anterior translation and rotational subluxation of the tibia on the femur. In the mildly positive pivot shift test laxity is mainly anterolateral; when it is gross there is also anteromedial shift and this can further be demonstrated by the anterior drawer and Lachman tests, which will show that both tibial plateaux are subluxating. The sensitivity of these tests varies from examiner to examiner, depending on the method used, the force applied, and whether the patient is apprehensive or relaxed. We believe that accurate, reproducible testing can only be carried out under anaesthesia. A positive test may result in a gentle slide or in a more severe “clunk”, “thud” or “jerk”. One method of testing may elicit the shift more clearly than another, and it has been our custom to try two or three techniques in each case.

THE GRADED PIVOT SHIFT TEST

MacIntosh’s method detects reduction of subluxation as the knee is moved from near full extension to 20° or 30° of flexion; our method of grading is based on this method, with the additional feature that the patient’s foot is held firmly against the examiner with the hand which applies an axial and valgus load. This hand is also used to control the rotational position of the tibia during the test. The examination is then carried out in each of three positions of rotation (Figs 1, 2 and 3). When the pivot shift is to be elicited with the tibia in lateral rotation, the femur is grasped with the opposite hand to help maintain the necessary degree of medial rotation (Fig. 3).

**Grade I pivot shift.** There is abnormal movement only when the tibia is held in maximal medial rotation, and this is absent in neutral or lateral rotation (Fig. 4). This shift can be felt, as a small and gentle sliding reduction, barely palpable when the patient is awake but more obvious under general anaesthesia. It corresponds with the American “trace” pivot shift and the French “ressaut en bâtard”.

**Grade II pivot shift.** The test is positive in the neutral position as well as in medial rotation, but negative when the tibia is held in a position of definite lateral rotation (Fig. 4). Movement on the lateral side of the joint is easily appreciated, but the less obvious shift on the medial side can be seen and also felt by the examiner’s fingers. When
the tibia is in the medially rotated position there is now a definite "clunk".

Examination with this technique allows a clear distinction between Grade I and Grade II pivot shift, both by the presence of abnormal movement with the tibia in neutral rotation and also by the different nature of the shift when the tibia is in medial rotation. The test is regarded as positive even if only one of these two distinctions is present.

**Grade III pivot shift.** Abnormal movement with a pronounced clunk can be produced when the tibia is held in neutral or moderate lateral rotation (Fig. 4). In medial rotation the shift is less obvious. This is seen in an acutely injured knee when there has been moderate to severe damage of the posteromedial and posterolateral structures as well as a complete anterior cruciate rupture; it is also found in knees with severe chronic instability and consequent stretching of the secondary posterior restraints.

These three grades represent progression of what could be described as mild anterolateral laxity in Grade I through increasing degrees of anterior displacement until, in Grade III, there is marked shift and translation in both compartments of the knee. The successive use of three positions of tibial rotation selects the most clinically significant points from this continuum.
THE MAXIMUM SUBLUXATION TEST

This test is a new "unblocked" drawer test, by which the displacement can be conveniently and accurately seen and palpated. With the anaesthetised patient in a supine position and the knee in 50° to 60° of flexion, the tibia is subluxated with the examiner's forearm (Fig. 5). The lower leg hangs on the examiner's arm and is allowed to find its own path of maximal subluxation, without blocking or forcing rotation. The direction and extent of displacement of each tibial plateau is carefully observed and palpated. In a normal knee, the medial plateau moves through about 3 mm and the lateral plateau through 5 mm; an average of these two figures can be used as an indication of total subluxation. The test can be further refined by adding forced rotation in each direction.

Correlation with pivot shift grades. In a knee showing a Grade I pivot shift the medial plateau moves an average of 5 mm and the lateral plateau an average of 12 mm (Fig. 6), while the Lachman test gives about 9 mm shift. Grade II pivot shift is associated with an average of 10 mm medial and 18 mm lateral plateau movement and from 10 mm to 15 mm subluxation during the Lachman test. This grade of instability is most often found after a fresh "isolated" rupture of the anterior cruciate restraints. This grade of pivot shift is also seen in chronic instability of moderate degree. Grade III pivot shift corresponds with mean subluxation of 15 mm medially and 22 mm laterally and a Lachman test of greater than 15 mm.

RADIOGRAPHIC ANALYSIS

Stress radiographs obtained under anaesthesia were used to document the laxity in the various grades. It is difficult to obtain accurate films, because the tibia is in medial rotation when the knee is in the position of maximum subluxation. This makes it impossible to obtain a true lateral view of both the femur and the tibia on a single film.

We obtained stress radiographs with the knee in slight flexion only, near the position used for the Lachman test. A support was placed under the proximal tibia and maximal manual force was applied downwards on the femur, in each case by the same examiner. This ensured that an equivalent force was used which was measured at between 25 kg and 30 kg. A radiograph was then taken to show the femoral condyles superimposed, and anatomical landmarks were used to measure displacement on the medial and lateral sides of the joint (Figs 7 to 10).

Results. Of the 23 patients examined in this way, two sets of films were unsatisfactory and were discarded. Of the 21 films measured, six were taken within two months of acute injury, two between 2 and 11 months while 13 were taken of chronic cases, over 12 months after the original injury. The three knees which were locked by a torn meniscus or were considered separately.

Five patients with Grade II pivot shift and 10 with Grade III were examined, while three were considered to be intermediate between Grades II to III because the pivot shift was borderline in the laterally rotated position. Three knees with Grade II pivot shift in the presence of locking by an interposed meniscus were also examined. The results are given in Table I. As in the normal knee, the lateral side was almost always the most mobile.

Statistical analysis was made of the significance of the radiographic differences between Grade II and Grade III knees. Because the distribution of results was not known to be normal both the Mann–Whitney and the Student t-test were used. The t-test gave $p = 0.0025$ for the medial side and $p = 0.004$ for the lateral side, while the Mann–Whitney test gave $p = 0.01$ for the medial side and $p = 0.05$ for the lateral side. The medial side was always the better predictor.

The knees which had been graded II to III gave results nearer those for Grade II and the locked knees all gave low Grade II results, though one of them had other
Lateral stress radiographs and diagrams showing the medial (m) and lateral (l) radiographic displacements measured in millimetres. Figures 7 and 8 - A knee with Grade II pivot shift. Figures 9 and 10 - Grade III pivot shift.

findings more suggestive of a Grade III pivot shift. Except for those patients with meniscal tears, these results support the proposed grading for laxity. It is not, however, suggested that a static measurement such as that of the Lachman test can be equated exactly with the dynamic rotatory movement which occurs during the pivot shift test. The grading merely indicates the relative levels of laxity on medial and lateral sides.

**Table 1.** The displacement (in mm) seen on stress radiography related to the grade of pivot shift

<table>
<thead>
<tr>
<th>Grade</th>
<th>Medial side</th>
<th>Lateral side</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td>Mean for group</td>
<td>9.8</td>
<td>17.6</td>
</tr>
<tr>
<td>II to III</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>Mean for group</td>
<td>13.3</td>
<td>18.7</td>
</tr>
<tr>
<td>II with interposed meniscus</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>Mean for group</td>
<td>11.7</td>
<td>17</td>
</tr>
<tr>
<td>III</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>Mean for group</td>
<td>14.6</td>
<td>21.4</td>
</tr>
</tbody>
</table>

**IMPLICATIONS AND TREATMENT**

The most important question about any grading system is how helpful it can be in making decisions concerning treatment. The senior author (RPJ) has used the system in the assessment, treatment and follow-up of all patients with a positive pivot shift for the last four years, correlating the results with the clinical pathology and the operative findings.

Of 41 consecutive patients undergoing patellar ligament reconstructions for the anterior cruciate ligament (Jakob et al. 1986), 31 had a Grade II shift and 10 a Grade III shift before operation. No patient with a Grade I shift required operation, unless a partial tear of the anterior cruciate ligament was considered likely to progress. An absent or non-functioning anterior cruciate ligament was found in all Grade II and III cases. Because of the predominantly anterolateral laxity, cruciate reconstruction with lateral augmentation was performed.

In all the Grade III knees, there was marked anteromedial and anterolateral laxity. If the anteromedial laxity was gross a posteromedial repair was added, plicating the posterior oblique ligament with bony advancement of the tibial attachment of the
semimembranosus. In the presence of a gross posterolateral component of laxity a strip of iliotibial band left attached at Gerdy's tubercle was guided deep to the lateral collateral ligament and the tendon of popliteus, anchored to part of the arcuate complex and then secured back on the tibia by a screw and plastic washer.

The results of treatment based on this plan of management were encouraging. After a minimum follow-up of three years, only five of the 41 knees showed a Grade I pivot shift test and none had Grade II or III tests, but none of the examinations have been carried out under anaesthesia. No patients were treated by anterior cruciate reconstruction alone, so there is no control series without lateral or medial reinforcement. We believe that these additions helped to achieve the good results, but have no proof. The grading system was helpful in defining the laxity and was consistently related to the findings at operation.

**DISCUSSION**

The pivot shift test has been in general use since its introduction in 1972, but its character and magnitude can vary considerably and this has been confirmed by stress radiography. Repeating the test in different positions of rotation gives a more accurate and reproducible way of quantifying it than the subjective assessment of severity.

Unfortunately, our system cannot be described as completely objective, since the examiner must decide whether or not there is a positive pivot shift. The examiner must therefore be given every advantage. When the patient is fully awake, eliciting and detecting pivot shift can be problematic, with up to 50% loss of accuracy (Noyes et al. 1980; Donaldson et al. 1985). Thus assessment should normally be done under anaesthesia. However, Grade III knees may show such laxity that the examination can be carried out with little or no discomfort and an even more pronounced positive test can be elicited in lateral rotation, while being less prominent in medial rotation. Even under anaesthesia, there may be difficulty in distinguishing between Grades II and III; such cases should usually be treated as being in Grade II.

Certain types of acute injury may prove difficult to grade. First, when the iliotibial band has been completely avulsed from the tibia, there can be no dramatic reduction of the joint displacement by its action during flexion of the knee. Secondly, there may sometimes be complete disruption of all the medial ligamentous structures which prevents the establishment of the valgus tension needed to produce an easily indentifiable pivot shift (Jakob, Hassler and Stäubli 1981). In such cases other evidence of complete rupture of the anterior cruciate ligament, such as a Lachman test of 10 mm to 15 mm, gives a clear Grade III rating. In chronic cases, the deceptive knee locked by a displaced bucket-handle meniscal tear has been mentioned; the pivot shift is partially blocked and may be underestimated.

Special care is needed during examination of the tibia in lateral rotation. The reversed pivot shift sign must be ruled out (Jakob et al. 1981). Both signs are positive with the knee in lateral rotation, but the reversed pivot shift is a sign of posterolateral and not anterior laxity, with posterior displacement of the lateral tibial plateau, indicating that there has been damage to the popliteus-arcuate complex with, in the most severe cases, an injury to the posterior cruciate ligament.

How can these two signs be distinguished? First by visual and digital confirmation of posterior rather than anterior displacement of the tibia in the subluxated position, and secondly by the fact that the true Grade III pivot shift is most obvious in the laterally rotated knee, will decrease in intensity in the medially rotated knee but nevertheless remain positive. However, the reversed pivot shift completely disappears in this position. The examiner should also seek other signs of posterolateral laxity by testing for excessive lateral rotation at 30° and 90° of flexion. Positive findings at 90° suggest that the posterior cruciate ligament has been torn (Gollehon, Torzilli and Warren 1985). The possible presence of posterior drawer movement in lateral rotation and an element of varus laxity should also be checked.

Some knees present with combinations of laxities, and in long-term chronic cases with anterior subluxation there is progressive development of additional posterolateral subluxation. The grading system offers an advantage in this situation by defining the components of the laxity. Our series has shown that since the anterior cruciate ligament is already non-functional in Grade II knees, the deterioration to Grade III is the result of additional anterior laxity on both medial and lateral sides, which must therefore involve the secondary restraints in the posteromedial and posterolateral corners as well as the purely medial and lateral structures. This point has been emphasised by other authors (Müller 1983).

The graded pivot shift test helps to identify laxity in these cases because in the laterally rotated test the posteromedial corner must be loose to allow anterior subluxation of a lateral plateau which has been rotated posterolaterally, and to allow this to occur the posterolateral corner must also be loose. We have noted posterolateral instability with a mild reverse pivot shift in about half of our Grade III patients. A Grade III pivot shift test in the presence of a mild reverse pivot shift tends to be accentuated by the tibia moving somewhat posteriorly on the lateral side. As such posterior laxity increases, both pivot shifts may occur in the same knee and can be distinguished from each other.

From the different grades of the test, the laxities which have been termed anteromedial, anterolateral and posterolateral can be defined and a progression in chronic anterior cruciate injury can be visualised. In
Grade I knees an instability which is mainly anterolateral, resulting from a partial cruciate injury or residual laxity, can be diagnosed. In Grade II more obvious anterior instability is present, due to a non-functioning anterior cruciate ligament and the beginning of laxity in the secondary restraints. Finally, in Grade III the secondary restraints are obviously lax, especially at the posteromedial and posterolateral corners.

Lemaire in 1967 published one of the earliest descriptions of the pivot shift test and clearly associated it with anterior cruciate injury. He has recently and independently reported on the influence on treatment of the test being carried out in lateral rotation (Lemaire and Miremad 1983), stating that when this is positive he adds a medial repair to his intra-articular reconstruction. We also believe in a more global approach to anterior cruciate insufficiency. Rather than just reconstituting the anterior cruciate ligament and tightening the capsule, other structures must be treated as their laxity becomes apparent on the graded test. In this way more accurate and effective treatment can be provided.

The authors wish to acknowledge the assistance of Rolf Zehnder in the statistical analysis, Mrs H. Maroti in preparing the manuscript and Dr Brian Casey from Sidney, Australia, in the critical analysis of the manuscript.

REFERENCES


