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Stress radiography in the diagnosis of anterior cruciate ligament deficiency

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Summary. *A prospective study was carried out to test the sensitivity and specificity of stress radiography in detecting anterior cruciate ligament deficiency in both knees of 116 patients using the Telos device. In 47 of these a total or partial rupture of the anterior cruciate ligament was diagnosed by arthroscopy, while the ligament was intact in the remaining 69 patients. The mean difference in radiological translation between the injured and the normal knee was greater than 5 mm (p <0.001) in those with anterior cruciate deficiency, and less than 3 mm in the others. A differential displacement of up to 3 mm was considered normal. The sensitivity of the method was less than 67% and the specificity was 100%. Clinical diagnosis had a sensitivity of 70.2% and a specificity of 98.5%. Our findings suggest that, although a differential translation of more than 3 mm can be diagnostic, smaller differences do not rule out anterior cruciate deficiency.*

Résumé. *Les auteurs ont réalisé une étude prospective pour évaluer la sensibilité et la spécificité des radiographies en position forcée dans le diagnostic des insuffisances du ligament croisé antérieur (LCA). Une radiographie en tiroir forcé des deux genoux a d'abord été faite, en utilisant l'appareil Telos, chez 116 patients devant subir une arthroscopie unilatérale. Chez 47 de ces patients une rupture totale ou partielle du LCA a été confirmée par arthroscopie, qui a montrée un ligament intact chez les 69 autres. La différence moyenne de translation entre le genou blessé et le genou sain a été supérieure à 5 mm (p <0.001) chez les patients ayant une insuffisance du LCA et inférieure à 3 mm chez les autres (une différence de 3 mm a été considérée comme normale). La sensibilité de la méthode a été de moins de 67% et le spécificité de 100%. L'examen clinique a une sensibilité de 70.2% et une spécificité de 98.5%. Ces résultats permettent de penser que, bien qu'une translation supérieure à 3 mm puisse avoir une valeur diagnostique, une moindre différence n'exclut pas une insuffisance du ligament croisé antérieur.*

Introduction

The diagnosis of anterior cruciate ligament (ACL) deficiency is made on the clinical findings in most centres. However, the accuracy of clinical diagnosis depends on the skill and experience of the surgeon. Stress radiography is a more sensitive method for diagnosing ACL deficiency than clinical examination or commercially available arthrometers [4, 5, 6, 8, 13, 14, 15].

Normal knees may show considerable tibial displacement on stress radiography due to ligamentous laxity, but there is no agreement about the cut-off point at which the differential displacement between the injured and uninjured knee can be regarded as abnormal. This value can vary between 0 and 3 mm [3, 4, 7, 8, 10]. Some authors have observed that differential displacement of less than 3 mm may be present in patients with ACL defi-

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Table 1. Mean displacement of the tibia in patients with ACL deficiency expressed in mm (x ± sd)

	Injured knee	Normal knee
Medial translation	5,8 ± 4,9	1,07 ± 3,5[a]
Lateral translation	10,21 ± 5,9	3,5 ± 4,7[a]

[a] $p < 0.001$, Two-tailed Student test for paired samples

ciency [7, 16]. These findings were considered to be related to testing ACL laxity with the knee in 90° of flexion when hamstring contraction would reduce the anterior displacement of the tibia.

Most research on the objective diagnosis of ACL deficiency has been undertaken in patients who have a clinically suspected ligament injury. The aim of the present study was to assess prospectively the sensitivity and specificity of stress radiography in the diagnosis of anterior instability of the knee.

Material and methods

One hundred and sixteen patients with a history of acute unilateral injury of the knee, including those with late instability, who were arthroscoped were included in this study. The criteria for arthroscopy were locking, giving way, persistent or recurrent effusion, suspicion of ACL deficiency, and for diagnostic reasons. Patients with posterior or posterolateral instability were excluded.

In the 24 hours before arthroscopy, stress radiographs of both knees were taken using a Telos device (Fa Telos, Medizinisch-Technische GmbH, D-6103 Griesheim, Germany). With the patient lying on the side to be tested, an anterior displacing force of 14 kg (137 newtons) was applied to the tibia and monitored through the instant digital display in the arm of the device. The upper limit of the pusher was at the level of a line crossing the anterior tibial spine and perpendicular to the cortex with the knee flexed 20°. The patient was told to relax and standard radiographs were taken after the force had been applied for one minute. Fluoroscopy was used to check the lateral position of the knee. Displacement was measured on the medial and lateral sides of the knee using Franklin's criteria [4]. The measurements were made by three independent observers, the mean value being used for statistical assessment. The interobserver error was less than 1 mm. ACL deficiency was assumed when the difference of the displacement between both knees was equal to, or greater than, 3 mm. The Student's t-test for paired samples, or unpaired samples when applicable, and the ANOVA test were used for statistical analysis.

Results

ACL rupture was diagnosed at arthroscopy in 47 of the 116 patients; 24 were partial and 23 complete. Ligament deficiency had been suspected clinically in 33 of the 47 and the remaining 14 were thought to be stable. Forty-three were professional or semiprofessional athletes, and 3 were recreational sportsmen. Of the 69 patients with an intact ACL at arthroscopy, ligament instability had been suspected in one, and there had been doubt about stability in 3 knees.

There were no significant differences in measured displacement in radiographs of both knees in the patients with no ACL deficiency, and none had a different displacement between the two knees greater than 3 mm. Patients with ACL deficiency showed a mean displacement of the injured knee significantly greater than the normal (Table 1).

The mean difference between the displacement of the injured and normal knees was 4.7 ± 5.7 mm on the medial side and 6.6 ± 6.1 mm on the lateral. In spite of these differences, the differential displacement between both knees was less than 3 mm for the medial side in 20 patients, and less than 3 mm for the lateral in 16, showing the sensitivity of the method as 57.5% and 66% respectively. The specificity was 100%.

A differential translation greater than 3 mm was found in all but one of the patients in whom ACL deficiency was suspected clinically. Whether the rupture was partial or complete, the time since injury and an associated meniscal tear did not significantly influence the differential displacement which was observed.

Discussion

The clinical diagnosis of ACL deficiency is difficult, even for experienced surgeons, and devices to detect instability may help. There are, however, several factors such as soft tissue damage, muscle activity and the displacing force, which can impair accuracy [1, 2, 6, 15]. Stress radiography is more precise than the use of arthrometers in detecting anterior translation of the tibia after the application of a displacing force [4, 8, 13, 14].

The efficacy of the Telos device to standardise radiological testing of ACL integrity has been proved [13, 15]. The mean differential displacement observed between the injured and the normal knee of our patients with ACL deficiency was greater than 3 mm, which is similar to that reported by others [4, 5, 6, 8, 13, 14, 16]. This value was therefore taken as a cut-off point since no patient with an intact ACL in both knees had a greater differential displacement.

Our findings show a relatively low sensitivity of the method, and we have not found any references to testing the sensitivity and specificity of stress radiography by other authors. False negatives in ACL ruptures, with a differential displacement of less than 3 mm, have been reported, but were considered to be due to errors in technique [6, 16]. We carried out the test with the knee flexed 20° which is the position at which the tibial translation should be maximal [5, 8, 9], and radiographs were taken after the displacing force had been applied for one minute to ensure that the muscles would be relaxed after their initial contraction. The displacing force in our method was greater than that applied by others [5, 8, 16].

When stress radiography has been used to detect ACL deficiency, rupture has usually been suspected clinically [4, 5, 6, 8, 13, 14], and in these reports the differential displacement has been greater than 3 mm, which coincides with that found in our patients with clinically diagnosed ACL deficiency. A considerable number of our patients with ACL ruptures had a displacement of less than 3 mm. Similarly, Torzilli et al. had a smaller displacement at the injured knee in 9 out of 25 patients in whom ACL damage had been proved at operation [16]. They considered that this was due to the position of the knee during the test, but we do not believe that this is a factor determining false negative results.

ACL deficiency was not suspected clinically in 14 of our patients in whom rupture was confirmed by arthroscopy, showing a sensitivity of our clinical diagnosis of 70.2% and a specificity of 98.5% which is similar to that found by Oberlander et al. [11]. These findings suggest that stress radiography is more specific, but less sensitive, than clinical examination. Stress radiography has been considered to be useful in distinguishing between isolated and combined ACL ruptures [4, 8, 15], but we think it is useful only in those cases in whom there is a clear clinical suspicion of ACL deficiency.

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