Does chronic medial collateral ligament laxity influence the outcome of anterior cruciate ligament reconstruction?

A PROSPECTIVE EVALUATION WITH A MINIMUM THREE-YEAR FOLLOW-UP

We have shown in a previous study that patients with combined lesions of the anterior cruciate (ACL) and medial collateral ligaments (MCL) had similar anteroposterior (AP) but greater valgus laxity at 30° after reconstruction of the ACL when compared with patients who had undergone reconstruction of an isolated ACL injury. The present study investigated the same cohort of patients after a minimum of three years to evaluate whether the residual valgus laxity led to a poorer clinical outcome.

Each patient had undergone an arthroscopic double-bundle ACL reconstruction using a semitendinosus-gracilis graft. In the combined ACL/MCL injury group, the grade II medial collateral ligament injury was not treated. At follow-up, AP laxity was measured using a KT-2000 arthrometer, while valgus laxity was evaluated with Telos valgus stress radiographs and compared with the uninjured knee. We evaluated clinical outcome scores, muscle girth and time to return to activities for the two groups.

Valgus stress radiographs showed statistically significant greater mean medial joint opening in the reconstructed compared with the uninjured knees (1.7 mm (SD 0.9) versus 0.9 mm (SD 0.7), respectively, p = 0.013), while no statistically significant difference was found between the AP laxity and the other clinical parameters. Our results show that the residual valgus laxity does not affect AP laxity significantly at a minimum follow up of three years, suggesting that no additional surgical procedure is needed for the medial collateral ligament in combined lesions.

Rupture of the anterior cruciate ligament (ACL) often occurs in conjunction with other ligamentous injuries. Rupture of the medial collateral ligament (MCL) has been reported to occur in between 20% 1 and 38% 2 of all ACL injuries.

The literature concerning the treatment of these combined injuries is controversial. 3-11 Many studies suggest that the ACL should be treated operatively while the MCL should be treated conservatively. 3-5 Shelbourne and Porter 5 showed that reconstruction of the ACL with non-operative treatment of an associated grade III 12 MCL injury could restore normal stability and good function. Various animal and clinical studies have shown that combined injuries with inadequately restored stability may compromise the healing of the ACL, due to load transfer from the injured MCL. 6-9

After reconstruction of the ACL in a combined injury, residual rotational laxity remains an important issue, whether or not other structures have been repaired. In a previous study which used computer navigation to compare intra-operative stability in patients with an isolated ACL injury and those in whom an ACL injury was combined with a chronic grade II MCL lesion, it was shown that patients with combined lesions had similar anteroposterior (AP) stability but a significantly greater valgus laxity at 30° degrees of knee flexion after reconstruction of the ACL (Fig. 1). 1

These findings raise the question as to whether this increased valgus laxity compromises healing of the ACL. There is a lack of prospective in vivo studies which include quantitative intra-operative assessment of knee laxity and assess the post-operative effect of a MCL tear on the remodelling of the ACL graft. The purpose of our study, therefore, was to evaluate the clinical and functional outcome in a cohort of patients after at least three years to determine if residual valgus laxity, observed intra-operatively, affected the reconstructed ACL and influenced the outcome.
were classified as combined lesions (group AM).1 In this
situation were deemed to have a grade II lesion of the MCL and
a chronic grade II12 MCL lesion (group AM). Each
patient underwent an arthroscopically-assisted over-the-
top double-bundle ACL reconstruction with hamstring ten-
dons between January 2005 and December 2005, using the
technique described by Marcacci et al.10 Intra-operatively,
all patients were evaluated using the navigation system
described by Martelli et al.11 The MCL lesion was not
treated in the AM group. The rehabilitation programme
was the same in both groups.

Pre-operative evaluation of the ligamentous integrity of
the knee was performed after spinal anaesthesia, with the
tourniquet in place, but before entering the operating
theatre by the operating surgeon or by an independent
examiner. Using the International Knee Documentation
Committee (IKDC)13 knee ligament evaluation form, the
knees were categorised as IKDC grades A (normal), B
(nearly normal), C (abnormal), or D (severely abnormal).
According to the Hughston classification,12 patients with
grade A valgus/varus rotation were classified as grade I
MCL injury and considered as pure lesions of the ACL
(group A).1 Patients with grade B or C valgus/varus rot-
ation were deemed to have a grade II lesion of the MCL and
were classified as combined lesions (group AM).1 In this
latter group, the MCL lesion was not treated surgically or
by rehabilitation in the acute phase and the time from
injury was more than three months. Patients who presented
with a grade III lesion of the MCL were excluded as in our
experience such an injury, especially in a combined lesion,
mandates an operative approach. We also excluded patients
with bilateral insufficiency of the ACL, a previous ligament
reconstruction of either knee, and those with a concomitant
meniscal injury of the affected knee.1

Laxity was quantified intra-operatively by measuring the
increased valgus angulation with a navigation system. The
immediate post-operative evaluation showed that patients
with combined lesions had a greater mean valgus laxity at
30° (unpaired Student’s t-test, p = 0.002) but a similar mean
AP laxity at 30° (unpaired Student’s t-test, p = 0.545) after
ACL reconstruction1 (Fig. 1).

A total of 53 of the original 57 patients previously
reported1 were available for follow-up. Of these 53, two
had experienced graft failure following further injury and
had already undergone revision surgery (one patient from
each group). Between December 2008 and April 2009, the
remaining 51 patients (32 in group A and 19 in group AM)
derewnt clinical and instrumented evaluation with a
minimum follow-up of three years (mean 39 months (36 to
49)), by the same examiner (SZ). Age, gender distribution,
and time from injury to surgery were similar in the two
groups (Table I).

The study was approved by our Institutional Review
Board and each patient gave informed consent.

All patients completed a self-administered questionnaire
which included a subjective IKDC form, Lysholm score14
and Tegner level15 and a Western Ontario and McMaster
Universities osteoarthritis index15 (WOMAC) score. In
addition, an orthopaedic surgeon blinded to the patient
group (SZ) clinically examined each patient using the IKDC
form, measured the circumference of the thigh at 5 cm and
15 cm from the superior pole of the patella in both legs and
recorded the interval between surgery and return to work
and sports.

All the instrumented tests were performed by the same
examiner (SZ) who was blinded to the patient group. In
order to assess the effect of the residual valgus laxity on the
ACL graft we analysed the AP laxity using a KT-2000
arthrometer (MEDmetric Corporation, San Diego, Califor-
nia) at 30° of flexion, which is considered the most effective
position in which to evaluate the ability of the ACL to pre-
vent anterior tibial displacement.16 The Manual Maximum
Test has been shown to be the most discriminating and reli-
able way to study any difference in AP laxity between knees
in the same patient.17 We were also able to compare the
intra-operative values obtained by navigation with the
follow-up clinical measurements from the KT-2000

**Table I. Patient demographics in group A (isolated lesion of
the anterior cruciate ligament (ACL) and group AM (com-
bined lesions of the ACL and medial collateral liga-
ment)**

<table>
<thead>
<tr>
<th>Group</th>
<th>Group AM</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 32</td>
<td>n = 19</td>
<td></td>
</tr>
<tr>
<td>Mean age (sd) (years)</td>
<td>34 (8.4)</td>
<td>38 (14.7)</td>
</tr>
<tr>
<td>Male:female</td>
<td>31:1</td>
<td>18:1</td>
</tr>
<tr>
<td>Mean time (sd) from injury (months)</td>
<td>12 (12.8)</td>
<td>9 (4.7)</td>
</tr>
</tbody>
</table>

* Mann-Whitney U test

![Bar chart showing the anteroposterior and valgus laxity values at 30° of knee flexion intra-operatively after reconstruction of the anterior cruciate ligament (ACL), as measured by navigation system (AM, combined lesions of the ACL and medial collateral liga-
ment; A, isolated ACL lesion).](image_url)
arthrometer given the previously proven reliability of the navigation system in assessing AP displacement when compared with standard arthrometer assessment under conditions of manual maximum stress.18

In order to assess valgus laxity at 30° of flexion, a Telos stress radiograph (METAX Kupplungs und Dichtungs technik GmbH, Marburg, Germany) of both knees was obtained for each patient in both groups. This technique has been shown to be reliable in assessing ligament function with varus/valgus stress.19,20 In our study, residual valgus laxity was determined by measuring the opening of the medial joint space when a valgus stress was applied to the knee, in a similar way to that described by Andersson and Gillquist.21 The patient was positioned supine, with a thigh support to keep the affected knee flexed at 30°, and instructed to relax. A radiograph was taken of the unstressed knee then a lateral 50 N load was applied at the level of the joint line with two pads constraining the tibia and femur medially at a point 20 cm from the joint line, and a stress radiograph was taken. The contralateral normal knee was subjected to the same examination for side-to-side comparison. The measurements of joint space opening were compared with the corresponding values obtained intra-operatively using the navigation system. Specifically we estimated the increase in joint space opening under valgus stress by measuring the variation of the distance between the medial femoral epicondyle and the corresponding medial aspect of the tibial plateau.

Statistical analysis. Differences in muscle power, time to return to activities, subjective IKDC, Lysholm, Tegner and WOMAC scores between the two groups were evaluated using independent Student’s t-tests. Differences in the objective IKDC score were evaluated with Pearson’s chi-squared test. Differences in instrumented evaluation, including the KT-2000, stress radiographs and time-zero navigation measurements were evaluated with paired Student’s t-tests. Measurement agreement analysis22 was performed to verify the relationship between the laxity values, obtained intra-operatively and post-operatively using the navigation system, the KT-2000 and Telos radiological evaluations. Results are reported as mean values and SDs. The level of significance for all tests was set at a p-value < 0.05.

A power analysis for evaluation of sample size was performed based on the hypothesis of finding a difference of 1 mm and 1° between the two groups. With this data setting, in order to obtain a power of 0.80, at least 17 patients were needed in each group.

Results
There were no statistically significant differences (p = 0.64) between the two groups with respect to objective IKDC score: laxity was normal or nearly normal in more than 80% cases in both groups (Table II).

The time to return to activity was similar in both groups. Patients returned to work after a mean of 2.5 months (SD 1.3) in the isolated ACL injury group (A) and 2.7 months (SD 1.1) in group AM (p = 0.791). Time to return to sports was a mean of 5.1 months (SD 2.4) in group A and 4.3 months (SD 1.4) in group AM (p = 0.2932). The reduction in quadriceps bulk was also similar: there was a side-to-side mean difference of 0.7 cm (SD 2.7) measured 5 cm proximally to the superior pole of the patella and 0.6 cm (SD 1.3) measured 15 cm proximally in group A, and a mean of 0.3 cm (SD 0.7) and 0.5 cm (SD 1.2) at 5 cm and 15 cm, respectively, proximal to the superior pole of the patella in group AM (p = 0.683 and p = 0.901, respectively).

The Tegner level showed no statistically significant difference between the groups when comparing the mean score at final follow-up, which was 6.5 (SD 2.0) in group A and 5.8 (SD 1.7) in group AM, or when studying the mean difference from pre-injury level (0.5 (SD 1.7) versus 1.0 (SD 1.7), respectively, p = 0.453). Furthermore, there were no statistically significant differences between the groups with respect to the subjective functional scores. The mean Lysholm score was 93.1 (SD 6.3) in group A and 96.5 (SD 3.3) in group AM (p = 0.121). The mean WOMAC score was 97.2 (SD 3.3) in group A and 98.5 (SD 2.3) in group AM (p = 0.243). The mean subjective IKDC score was 96.1 (SD 5.3) in group A and 97.3 (SD 3.0) in group AM (p = 0.171).

No statistically significant difference was found in the instrumented evaluation of the mean side-to-side difference in AP displacement with manual maximum force, which was 1.3 mm (SD 2.2) in group A and 2.4 mm (SD 2.5) in group AM (p = 0.231). The mean AP displacement on the side of the injury was 5.3 mm (SD 2.4) in group A and 5.8 mm (SD 1.9) in group AM. These measurements were not statistically significant different between the two groups (p = 0.591) (Fig. 2).

The Telos valgus stress radiographs revealed a mean medial joint space opening (side-to-side difference of medial joint opening with and without stress applied) of 0.9 mm (SD 0.7) in group A and 1.7 mm (SD 0.9) in group AM. This difference was statistically significant (p = 0.013) (Fig. 3).

Examination of agreement between the methods of measurement revealed that the navigation system had a positive bias, measuring a mean of 0.9 mm (SD 1.3) more than the Telos valgus stress radiographs (p = 0.001). The KT-2000 also had a positive bias for AP displacement at follow-up, and measured a mean of 2.0 mm (SD 2.6) more than the navigation system (p < 0.001).
Discussion

The hypothesis of this study was that residual valgus laxity after reconstruction of the ACL could compromise the healing of the graft which could be identified after three years using clinical and functional outcome criteria. Previously, we had found in the combined ACL and MCL injury group that there was greater valgus laxity but similar AP laxity at 30° of flexion after ACL reconstruction than in patients with an isolated ACL disruption and repair.¹ (Fig. 1).

We found that the residual valgus laxity identified after reconstruction of the ACL in the AM group persisted but did not significantly affect AP stability. Using the KT-2000 arthrometer, we identified a trend for those with medial laxity to have greater AP laxity, but this did not affect the final functional results. The subjective scores, activity levels and strength scores were satisfactory in both groups: there were no statistically significant differences between the groups.

Our findings reflect those of several clinical studies which have shown that isolated repair of the ACL can give good results.²,³,⁵,²³-²⁶ In our study, the clinical tests performed with the navigation system at the time of operation gave us the opportunity to document any difference in laxity between the two groups. Nevertheless, isolated reconstruction was able to restore the functional capacity in both groups, even in the presence of a tendency towards greater AP laxity in the combined AM group. Furthermore, we were able to show significantly higher valgus laxity with stress radiographs in the AM group. A study of 18 patients with combined ACL and grade II or III MCL lesions in which the ACL was reconstructed within three weeks of the initial injury while the MCL lesion was treated non-operatively found no difference in function or activity between patients with grade II lesions and those with grade III lesions.²³ Their report is at odds with previous work that advocated later reconstruction of the ACL, after a minimum of ten weeks, to reduce the risk of complications such as a reduced range of movement.²⁴

A prospective, randomised trial of 47 patients with combined knee injuries (ACL and grade III MCL) in which ACL reconstruction was performed less than 23 days after injury, while the MCL was treated surgically in 23 patients and non-operatively in the other 24 patients, found no functional difference in post-operative laxity, range of movement, muscle power, return to activity, Lysholm score and overall IKDC evaluation, between the two groups at a mean follow-up of 27 months.²⁵ Further, when comparing the two groups, there were no statistically significant differences in medial joint opening to valgus stress when compared with the contralateral side.

We did not compare two cohorts of patients with combined lesions treated differently for the MCL component of the injury, but compared patients with combined lesions to patients with isolated ACL tears. Not surprisingly, patients in the AM group had a statistically significant greater medial joint space opening to valgus stress when compared with the contralateral side.

Other work which compared patients with an isolated ACL injury with a smaller number with accompanying valgus laxity, at a minimum follow-up of 24 months, also found no statistically significant difference in the KT values and in clinical scores between the two groups.²⁶ A detailed evaluation of the combined lesions group was performed by assessing the IKDC grade for valgus laxity after ACL reconstruction. Patients who improved to grade A had a lower KT value than patients who had persistent grade B and C residual valgus laxity, but this difference was not statistically significant. They concluded that a
combined medial stabilisation was unnecessary for a patient with a combined lesion.

Consistent with their findings, we did not find any statistically significant difference between the two groups in terms of subjective or functional outcome measures or with regard to the AP laxity at 30° of knee flexion. The main advantage of our study was that we were able to compare laxity values at a minimum of three years follow-up with immediate post-operative values obtained from a navigation system. The comparison of these data and the lack of variation in AP laxity between the two groups suggests that residual valgus laxity did not affect AP stability, even though a trend towards higher AP laxity was seen in the combined lesions group.

We recognise the limitations of our study. Firstly, the instrumented evaluation used at follow-up has a different level of accuracy when compared with the computer-based navigation system used immediately after reconstruction, even though the reliability of the navigation system in measuring AP displacement compared with a commercial arthrometer has already been proven.18 The measurements of valgus laxity were performed using two different technologies with different methodological set-ups. The differences highlighted in the measurement performed with navigation, KT-2000 and Telos valgus stress radiographs respectively, are mainly related to the presence of the soft tissue which prohibits direct measurement of the movement of, or direct application of, loads to the joint. However, at present, no commercial arthrometer is available which can measure laxity both in the operating theatre and in outpatients.

In conclusion, at a minimum of three years follow-up, an increased valgus laxity was still present in the AM group but it did not affect either AP stability or the clinical results. These findings suggest that no additional surgical procedure is needed for the MCL when the surgeon is faced with a patient with a combined lesion.

References

