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Rehabilitation after one-stage anterior cruciate reconstruction and osteochondral grafting

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Abstract At least 10–20% of all ACL reconstructions require additional cartilage repair. The aim of this study was to compare the activity recovered by patients after one-stage open ACL reconstruction and osteochondral autologous grafting of articular cartilage lesions and after isolated open ACL reconstruction. The study group included 21 patients with chronic ACL deficiency and grade III or IV cartilage lesion according to the ICRS scale who were treated with combined ACL reconstruction and osteochondral grafting in one step. The control group included 32 patients with chronic ACL insufficiency and no chondral deficit higher than grade I on the ICRS scale who underwent isolated reconstruction of the ligament. For the assessment, the Lysholm and Gillquist (L&G) score and the functional Marshall score were used. Both groups displayed a statistically significant improvement in the L&G score and the Marshall score between the preoperative and 12-month assessments. The mean gain in L&G score over this period was 30.66 ± 7.79 in the study group and 31.65 ± 6.96 in the control group. The difference between the control group and the study group was not significant. The difference between 12 months and initial assessment was counted. The mean gain in Marshall score was 9.05 ± 3.81 in the study group and 10.71 ± 3.43 in the control group. The difference between the initial and the 12-month evaluation was statistically significant ($p=0.49$). Return to normal activity was slower and patient satisfaction was lower during the first year after operation in the study group than in the control group, however the overall advantage of the one-step operation outweighs the slightly inferior functional results at 12 months.

Résumé Au moins 10 à 20% des reconstructions de ligament croisé antérieur nécessitent un geste sur le cartilage. Le but de ce travail était de comparer la fonction des patients après ligamentoplastie et autogreffe de cartilage en un temps et après ligamentoplastie isolée. Le groupe d'étude comprenait 21 patients avec des lésions cartilagineuses de grade III ou IV selon l'échelle ICRS et le groupe de contrôle, traité avec une ligamentoplastie isolée, comprenait 32 patients avec des lésions cartilagineuses ne dépassant pas le grade I. Pour l'évaluation le score de Lysholm et de Gillquist ainsi que le score fonctionnel de Marshall ont été utilisés. Les deux groupes ont eut une amélioration significative dans ces scores entre l'état préopératoire et celui 12 mois après. Pour le premier, le gain moyen en points était de $30,66 \pm 3,43$ dans le groupe d'étude et de $31,65 \pm 6,96$ dans le groupe de contrôle, sans différence statistique notable. Pour le deuxième, le gain moyen du groupe d'étude était de $9,5 \pm 3,81$ et celui du groupe de contrôle était de $10,71 \pm 3,43$, avec une différence significative ($p=0,49$). Le retour à une activité normale et la satisfaction des patients dans la première année après l'opération est moins bonne dans le groupe d'étude que dans le groupe de contrôle.

Introduction

Simultaneous incidence of chronic anterior cruciate ligament (ACL) deficiency and cartilage lesions is well known. Most authors agree that in at least 10–20% of ACL reconstructions there is a need for additional cartilage repair of the damaged joint surface [5, 6, 8, 17]. Selected osteochondral grafting procedures (e.g. Mosaicplasty) have been found effective in restoring defects between 1 cm² and 4 cm² with long follow-up [4]. Regardless of the controversies concerning how and which cartilage defects should be treated, there is no doubt that some lesions have to be repaired in order to prevent further deterioration [3, 12]. Now that effective techniques of osteochondral grafting have become routine, some surgeons advocate paying much more attention to chondral lesions accompanying ACL deficiency require than has been the case to date.

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The sequence of treatment is another source of controversy—should the ACL be addressed first and the cartilage defect subsequently in another step, or is a combined procedure preferable?

Those who treat this complicated problem encounter many obstacles. The extent of the operation differs between one-stage and combined procedures. A two-stage procedure is less complicated but involves two operations and two arthrotomies. The one-step procedure is much more demanding, especially in the case of large chondral lesions, but allows for a complete solution of the problem.

There are insufficient data in the literature about the postoperative regime and rehabilitation after combined repair [9, 14]. The aggressive rehabilitation protocol after ACL reconstruction and osteochondral grafts are similar but many doubts persist about the timing of weight-bearing, use of a brace, return to sporting activities, etc.

In two-stage procedures the patient must undergo surgery twice and always, whatever the nature of the first step, experiences limited function of the knee subsequently.

In one-step procedures a complicated rehabilitation protocol and a demanding exercise schedule are recommended. The procedure—usually open, longer and more extensive—increases the risk of infection. The management of postoperative oedema is somewhat challenging and there is a higher risk of arthrofibrosis.

The aim of the study was to compare the recovery of activity after one stage open ACL reconstruction and osteochondral autologous grafting of articular cartilage lesions.

Material and methods

The functional results of two groups of patients were assessed and compared. The study group included patients with chronic ACL deficiency and grade III or IV cartilage lesions according to the ICRS scale [13] over 1 cm² but below 4 cm² treated with combined ACL reconstruction and osteochondral grafting in one stage. The control group included patients with chronic ACL insufficiency and no chondral deficit higher than grade I on the ICRS scale who underwent isolated reconstruction of the ligament.

The study group comprised 21 ACL reconstructions with use of one-third of the patellar ligament (LP) in 12 patients and quadrupled semitendinosus and gracilis tendons (ST+GR) in nine patients with osteochondral grafting. For osteochondral transplants OATS (Arthrex), SDS (Sulzer) and Mosaicplasty (Smith&Nephew) tools were used. Medial femoral condyle lesions were found in 19 cases, lateral femoral condyle lesions in one case, and in one case both condyles were affected. The average size of the defects was 1.52 cm², and one to six osteochondral plugs ranging in diameter from 4.5 mm to 8.5 mm were implanted. The mean number implanted was 2.45 plugs. There were two women and 19 men in the group; their mean age was 30.87 years. The duration of follow-up varied from 12 to 34 months (mean 17.1 months). The mean time from injury to reconstruction in the study group was 25.6 months.

For the control group 32 consecutive patients with chronic ACL deficiency were chosen. In nine patients one-third of the LP and in the remaining 23 patients quadrupled ST+GR tendons were used for the reconstruction. There were ten women and 22 men in the group; their mean age was 33.12 years. The duration of follow-up varied from 12 to 36 months (mean 19.1 months). The mean interval from initial injury to surgery in the control group was 23.4 months.

All procedures were performed via arthrotomy. For the fixation of the LP grafts interference screws and for the ST+GR grafts an endo-button proximally and a cancellous screw distally were used. The same team of surgeons operated on all patients.

For assessment, the Lysholm and Gillquist (L&G) score [7] and the functional Marshall score [10] were used. Patients were evaluated before operation, 6 weeks and 3, 6 and 12 months after operation, then once a year.

Statistical analysis was performed using SPSS Statistica 6.0 PL software. The non-parametric Mann–Whitney U-test and non-parametric Wilcoxon test were used for testing. A p value ≤ 0.05 was considered as significant, $p \leq 0.01$ and $p \leq 0.001$ as highly and very highly significant respectively.

Rehabilitation protocol

Both groups of patients were advised to use a long brace allowing for 0–30° range of movement immediately after operation and then, as tolerated, two-crutch ambulation—non-weight-bearing for the first 7–14 days then gradually progressing to full weight-bearing after 4–6 weeks. CPM was applied 24–48 h after surgery in painless range with full extension and flexion as tolerated. All patients were encouraged to perform quadriceps and hamstring closed chain exercises, isometric exercises, and manual self-mobilisation of the patella. Proprioception and co-ordination exercises were introduced 6–8 weeks after the reconstruction.

The rehabilitation protocol was our modification of protocols described by Hangody and Fules [4] and by Shelbourne and Gray [15]. The key factors to monitor were, as usual, joint effusion, pain during motion, and quadriceps and hamstring strength. The simplified schedules are presented in Tables 1 and 2.

Complications

In the study group, 12 months after operation three patients still complained of prolonged pain that was minor, yet interfered with daily activities and occasionally required medication. Joint oedema and effusions were common in this group up to 6 months postoperatively. In five patients in this group, recurrent joint effusions related to extensive activity were present up to 18 months after surgery. No important morbidity was observed at the osteochondral graft donor site. There were no infections in the group. In the control group one manipulation under anaesthetic was

Table 1 Rehabilitation protocol after ACL reconstruction and osteochondral grafting

Rehabilitation measure	Time after operation				
	0–2 weeks	2–4 weeks	4–6 weeks	6–8 weeks	8–12 weeks
Crutches	+	+	Single	–	–
Long brace	0°–30°	0°–60°	0–90°	0–120°	short protective
Weight-bearing	Tip-toe	Partial	Partial to full	Full	Full
CPM	+	–	–	–	–
Quadriceps	Isometric	Isometric	Strengthening	Strengthening+load	Strengthening+load
Hamstrings	Isometric	Isometric	Strengthening	Strengthening+load	Strengthening+load
Patella self-mobilisation	–	+ !!!	+ !!!	+	–
Proprioception	–	–	–	+	+!!!
Co-ordination	–	–	–	+	+!!!
Water exercises	–	–	+ !!!	+ !!!	+
Bicycle	–	–	–	+	+
Running	–	–	–	–	+

(!!!) Very important part of the programme

required 6 months after operation to increase flexion beyond 90°. This patient regained full range of motion without loss of joint stability. In two cases steroids in a dosage of two ampoules of betamethasone sodium phosphate were administered for persistent irritation of the mucosa and joint effusion. In one case a single injection was performed, in the other case three. Both had resolved by 6 months after surgery.

There was one case of postoperative joint infection that resolved after 3 weeks of i.v. administration of clindamycin phosphate and amikacin sulfate: the knee remained stable and the patient returned to normal activity. In one other case, infection around the distal fixation screw necessitated early removal after 3 months. The wound healed within 3 weeks, and the knee remained stable with good follow-up. Both patients had undergone surgery on the same day in the same operating room. Another patient ruptured the reconstructed ligament 18 months after operation under moderate load and was lost for further follow-up. One

patient, despite prophylaxis with 4 weeks of nadoparine calcium in a single daily dose of 5700 units, developed clinically obvious deep vein thrombosis of the operated leg 3 months postoperatively. The symptoms impaired his knee function for nearly 18 months.

Results

The results are presented in the figures. Clinical assessment in the study group was worse than in the control group in any observation period during the first year of the study with statistical significance apart from the first evaluation after 6 weeks ($p=0.799$). However, the clinical difference diminished with time.

Both groups gained statistically important improvement in the L&G score (Fig. 1 and Fig. 2) and Marshall score (Fig. 3 and Fig. 4) between preoperative and 12 months assessment respectively.

Table 2 Rehabilitation protocol after isolated ACL reconstruction

Rehabilitation measure	Time after operation				
	0–2 weeks	2–4 weeks	4–6 weeks	6–8 weeks	8–12 weeks
Crutches	+	+	Single	–	–
Long brace	0°–30°	0°–60°	0–90°	Discontinued	Short protective
Weight-bearing	Tip-toe	Partial	Partial to full	Full	Full
CPM	+	–	–	–	–
Quadriceps	Isometric	Strengthening	Strengthening	Strengthening+load	Strengthening+load
Hamstrings	Isometric	Strengthening	Strengthening	Strengthening+load	Strengthening+load
Patella self-mobilisation	–	+	+	+	–
Proprioception	–	–	–	+	+!!!
Co-ordination	–	–	–	+	+!!!
Water exercises	–	–	+	+	+
Bicycle	–	–	–	+	+
Running	–	–	–	–	+

(!!!) Very important part of the programme

Fig. 1 Change in L&G score in study group during first year after operation. Results presented as median values

The mean L&G score was 89.19 ± 3.65 ($p < 0.001$) in the study group and 93.84 ± 2.87 points ($p < 0.001$) in the control group at the 12-month assessment.

The difference between 12 months and the initial assessment (i.e. gain in L&G points) was measured. The mean gain in the study group was 30.66 ± 7.79 points and in the control group 31.65 ± 6.96 points. There was no statistically significant difference between the control group and the study group.

The mean Marshall score was 43.24 ± 1.79 points ($p < 0.001$) in the study group and 44.81 ± 2.4 points ($p < 0.001$) in the control group at the 12-month assessment.

The difference between 12 months and the initial assessment (i.e. gain in Marshall score) was measured. The mean gain in the study group was 9.05 ± 3.81 points and in the control group 10.71 ± 3.43 points. The difference was statistically significant ($p = 0.49$).

There were no statistically significant differences between the groups regarding meniscal injuries. In the study

Fig. 3 Change in functional Marshall score in study group during first year after operation. Results presented as median values

group 52.3% of the knees had torn medial meniscus and 9.52% of the knees had torn lateral meniscus, while in the control group the incidence was 50% and 9.3%, respectively.

Discussion

Despite the challenges and demands of a one-step procedure, it should be advocated as the optimal procedure for combined ACL and articular cartilage deficiency.

Chondral lesions accompanying ACL deficiency should be treated like other intraoperative soft-tissue deficits. Most authors [1, 2, 9, 16] stress the good final results if all the deficits are addressed properly. Contrary to matrix-based autologous chondrocyte transplantation procedures that require a stable knee and initial chondrocyte harvesting [11], osteochondral grafting can be performed simultaneously with ACL reconstruction. In the same way as

Fig. 2 Change in L&G score in control group during first year after operation. Results presented as median values

Fig. 4 Change in functional Marshall score in control group during first year after operation. Results presented as median values

microfractures are advocated as a routine procedure during ACL surgery, larger and more extensive chondral lesions should be treated using osteochondral grafts in one step. We found no important postoperative deterioration of knee function if the combined procedure was performed.

In this study, the function of the knees with healthy cartilage was worse than before ACL reconstruction just after operation and up to the end of the first year. The difference in initial and 12-month L&G scores between the groups is not statistically significant. This suggests that the two groups had a similar L&G score gain.

The statistically significant difference between the groups in Marshall score gain between preoperative and final evaluation requires further consideration during follow-up. The Marshall score is thought to be affected more by subjective factors, and the results may reflect the degree of difficulty faced by study group patients during rehabilitation.

The overall advantage of the one-step operation outweighs the slightly inferior functional results at 12 months.

It would be important for final evaluation to compare the one-stage results with those of the two-stage procedure. In our opinion the difference in score points reflects the severity of the joint insufficiency before treatment, not the efficacy of the surgical treatment.

Conclusions

Recovery and return to normal functional activity and the patient's satisfaction during the first year after operation among those treated with one-stage ACL reconstruction and osteochondral grafting is slower than in those treated with isolated ACL repair. Proposed rehabilitation protocols are very similar and require a little more time and effort on the part of the patient and the hospital team in the group with combined ligament and cartilage reconstructions.

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