

There is some clinical evidence that straight leg raises in the early period after cruciate ligament surgery do no harm to the graft or cause other negative outcome.

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CLINICAL SCENARIO:

The straight leg raise is one of the open kinetic chain exercises that is in question of causing graft loosening through too much anterior tibial forces. Early muscular tension of the quadriceps muscle would be important for functional tasks, muscular pump and prevention of loss of muscular pattern and strength. Straight leg raises would be an easy exercise to be performed by the patient on his own.

FOCUSSED CLINICAL QUESTION:

Do straight leg raises with patients in the early period (two weeks) after anterior cruciate ligament (ACL) surgery have any negative effects on knee stability (transplant loosening, feeling of giving way) or healing (more edema, more pain)?

SUMMARY of Search, 'Best' Evidence' appraised, and Key Findings:

Two RCTs after anterior cruciate ligament surgery have compared quadriceps exercises in an open kinetic chain without resistance to no quadriceps exercises (Shaw et al., 2005) or to closed kinetic chain exercises (Morrissey et al., 2000), both in the early period after ACL surgery. Both interventions did not indicate either lengthening of the graft or other clinically relevant adverse results. Morrissey et al. found a greater increase in the looseness of the OKC-group in comparison to the CKC-group immediately after the intervention period (6 weeks). 9% more looseness (95% confidence interval of -8% to +29%). Which was not statistically significant ($P=0,32$), and with less than 1mm neither considered clinically significant. Shaw et al. found after six months a significantly greater proportion of subjects in the No quadriceps exercise group demonstrated laxity at each test force ($p=0,01$). As the period between intervention (0-2weeks) and laxity measurements (6 months) was rather long, confounding factors can not be excluded.

Several biomechanical studies and some older clinical trials indicate that OKC exercises put more strain on the graft than CKC exercises (Jonsson & Kärrholm, 1994) (Markolf, O'Neill, Jackson, & McAllister, 2004) (Bynum, Barrack, & Alexander, 1995). One group of researchers measured the strain directly in the ACL and came to the conclusion that CKC exercises put similar strain on the ACL as OKC exercises without resistance (Bennyon et al., 1997) (Beynon & Fleming, 1998).

CLINICAL BOTTOM LINE:

With this limited evidence that straight leg raises do no harm, they can be used safely to achieve quadriceps activity in difficult situations (pain, intraarticular edema, loss of deliberate neuromuscular response, fear), to facilitate cocontraction of hamstrings and quadriceps as the main exercise.

Limitation of this CAT: This critically appraised paper (or topic) has not been peer-reviewed by one other independent person/a lecturer.

SEARCH STRATEGY:**Terms used to guide Search Strategy:**

- **P**atient/Client Group: Patients after cruciate ligament surgery
- **I**ntervention (or Assessment): straight leg raises in the early period after surgery
- **C**omparison: no straight leg raises
- **O**utcome(s): laxity, functional stability, pain, edema

Databases and sites searched	Search Terms	Limits used
Cinahl Pedro Medline Embase	Straight leg raises OR Quadriceps exercises AND anterior cruciate ligament surgery	1995 – 2006 humans english

INCLUSION and EXCLUSION CRITERIA

Inclusion: Comparison of different quadriceps muscle activities in RCTs, in biomechanical studies and in Reviews.

Exclusion: Comparison of electrical stimulations of the quadriceps muscle.
Comparison of different rehabilitation programs without focus on the quadriceps muscle.

RESULTS OF SEARCH

13 relevant studies were located and categorised as shown in Table 1

Table 1: Summary of Study Designs of Articles retrieved

Study Design/ Methodology of Articles Retrieved	Number Located	Author (Year)
RCTs	5	Shaw, Williams & Chipchase (2005); Hooper, Morrissey, Drechsler, Morrissey & King (2001); Morrissey, Hudson, Drechsler, Coutts, Knight & King (2000); Bynum et al., (1995); Perry, Morrissey, King, Morrissey & Earnshaw (2005)
Laboratory Experiments in vitro	2	Dürselen, Claes & Kiefer, (1995); Markolf, O'Neill, Jackson & McAllister, (2004)
Laboratory studies in vivo	2	Beynnon et al. (1995), Beynnon et al. (1997)
Narrative Reviews	4	Fitzgerald (1997); Beynnon & Fleming (1998); Ross et al.(2001); Fleming, Olsendahl & Beynnon (2005)

BEST EVIDENCE

The following studies/papers were identified as the 'best' evidence and selected for critical appraisal. Shaw, Williams & Chipchase (2005) and Morrissey, Hudson, Drechsler, Coutts, Knight & King, (2000).

Reasons for selecting these studies were:

- Fitted best my research question
- RCTs
- The strength of one study (good control) was the flaw of the other (risk of contamination) and v.v.(longitudinal design versus short follow up).

SUMMARY OF BEST EVIDENCE

Table 2: Description and appraisal of (name study design) by (authors, Year)

1: Shaw, Williams & Chipchase (2005). Do early quadriceps exercises affect the outcome of ACL reconstruction? A randomised controlled trial.
 2: Morrissey, Hudson, Drechsler, Coutts, Knight & King, (2000). Effects of Open Versus Closed Kinetic Chain Training on Knee Laxity in the Early Period After Anterior Cruciate Ligament Reconstruction.

Aim/Objective of the Study/Systematic Review:

1: "the aim of this study was to investigate whether specific quadriceps exercises in an acute postoperative rehabilitation program significantly altered postoperative outcome for anterior cruciate ligament reconstruction over six months, relative to a program that excluded these exercises." (p.9)

2: The authors wanted to compare the two exercise regimens of OKC and CKC knee extensor training in the early period after surgery, when the graft fixation site is weakest.

Study Design: 1. and 2. RCTs

Setting: 1. and 2.: Urban area, hospital patients

Participants: 1. Patients after anterior cruciate ligament reconstruction. No previous surgery, but arthroscopy, no collateral ligament repair, no concurrent injury at the controlateral knee. Different surgical methods included. Patients recruited in one hospital, (convenience sample) and had to give informed consent. Sample limited by geographical accessibility to follow up. 2. Patients's were recruited at five London hospitals as in-patients after ACL surgery, exclusion criteria were prior history of pathology in the controlateral leg. Two different surgical techniques were applied. The participants volunteered after written and verbal explanation.

Intervention Investigated 1. The therapeutic intervention contained straight leg raises and isometric quadriceps tension, in comparison to no quadriceps exercises. (10 repetitions, 3 times daily in the first two weeks after surgery.) This is not a very high load and the authors have not provided exact details like length of the isometric tension or position of the patient during the exercise. Control group: no quadriceps exercises. 2. The therapeutic intervention contained open kinetic chain exercises for hip and knee with ankle weights or machines. The control group used: closed kinetic chain resistance training of the hip and knee extensors on a leg press machine. Three sets of 20 repetitions were used in each session, ROM and velocity were equalized. Between 2 and 6 weeks after surgery.

Outcome Measures 1. Range of motion, Quadriceps lag, Limb circumference, Pain and Satisfaction were measured at Day 1, 2 weeks, 1 month, 3 months and 6 months, The Cincinnati Knee rating system was applied at 1 month, 3 months and 6 months, knee laxity was measured at 3 months and at 6 months, hop tests and isokinetic strength only at 6 months. Good to excellent intra-rater reliability was reported as only one tester took all the tests, but the isokinetic measurements. 2. Baseline data were taken at 2 weeks after surgery by a blinded PT. Knee laxity was tested on a Knee Signature System, the authors provide a reference with good validity to simultaneous radiography. Test-Retest least reliable difference ranged from 2.0 to 4.1 mm. Knee girth and muscular strength were tested as well as biomechanical analyses of gait. But these data were not evaluated in this article. The tests were repeated at six weeks.

Main Findings:

1.

Significant results	1m	3m	6m
ROM: a F	No Q: 122.3 degrees \pm 14.5 Q: 128.2 degrees \pm 12.7, $p = 0.05$		
ROM: a E	No Q: -14.8 degrees \pm 6.4 Q: -12.1 degrees \pm 4.8, $p = 0.05$		
Knee Circumference		Btb-graft No Q: 103.7 \pm 1.6 cm Btb-Graft Q: 101.5 \pm 1.5, $p < 0.01$	
CKRS Symptom score (the more, the better)			No Q 6.8 \pm 1.1 Q 7.5 \pm 1.2, $p = 0.005$
CKRS Sports score (the more the better)			No Q 61.6 \pm 15.2, Q 66.4 \pm 14.4 vs $p = 0.05$
Knee laxity Number of subjects with extraordinary laxity (more than 3mm) 15b			NoQ: 12 (44) Q: 3 (47) $p=0.01^*$

2. The mean difference in laxity between the OKC group and the CKC group was considered 9% [ratio of geometric means (O/C)=1.09; 95% confidence interval: 0.92, 1.29; $t=1.01$, $P=0.32$], which is not statistically significant.

Original Authors' Conclusions:

1: (p 7, 8) "Quadriceps exercises are a simple, economical intervention taking minimal time to provide. While this study did not find that acute postoperative quadriceps exercises resulted in significant improvements in muscle strength or lower limb function, subjects performing acute postoperative quadriceps exercises had faster recovery in range of motion and some more CKRS scores. Additionally, for a small proportion of anterior cruciate ligament reconstruction patients, quadriceps exercises resulted in a lower incidence of abnormal knee laxity. Therefore, this prospective, randomized controlled study has confirmed that isometric quadriceps exercises and straight leg raises can be safely prescribed during the first two postoperative weeks, and inclusion of such a regimen results in small but statistically significant improvements in recovery of range of motion and the frequency of knee stability. Whether the improvements associated with the inclusion of acute postoperative quadriceps exercises are of clinical significance remains to be seen."

2: The authors add that anterior tibial displacement, measured with laxity tests, is only one consideration in determining which type of kinetic chain resistance to use after ACL reconstruction. In additional analyses, not further explained in this article, the treatments do also not appear to differ in their effects on knee pain or function. In spite of these findings the authors conclude that as long as there is no evidence that OKC exercises offer an advantage over CKC exercises after ACL reconstruction, CKC training be the treatment of choice.

Critical Appraisal:

Validity

1: Longitudinal design, blinded tester, ethical approval and informed consent, sample big enough and with broad inclusion criteria, leading to good transferability of the results. Outcome measurements reliable and valid. Some were not well defined in the article, Intervention not described precisely. Design powerful and appropriate with two major flaws: No baseline data for laxity and a short intervention period followed by a long period of rehabilitation with no reported control.

2: Pretest, posttest design. Informed consent. No report on dropouts. Small sample, leading to risk of type II error. Not enough information about all the measurements. Laxity alone is not a gold standard for outcome measurements after ACL surgery. Little risk of contamination.

Interpretation of Results

1: No significant differences in quadriceps lag and in isokinetic strength, but in the range of motion at three months. The influence of straight leg raises on strength seems to be of little importance for this early period but the favorable influence on tissue healing through early quadriceps exercises might be supported by the greater

range of motion in extension and in flexion. The authors do not discuss the statistically significant findings of less circumference in the patients with a bone-tendon-bone graft, performing quadriceps exercises, but this might indicate that the quadriceps exercises might be of value for edema lessening with the surgical technique with more injury on the quadriceps muscle. The most surprising outcome is, that there were statistically significant more knees with laxity in the control group. While this information is only of limited functional relevance and has without baseline data only limited expressional power (Were the differences in laxity already before the intervention?), it indicates at least that there is no enhanced danger for the graft through early quadriceps exercises. The statistically significant findings that there was less pain, less reporting of partial giving way or giving way in the CKRS might underly the assumption that the early quadriceps exercises have provided less loss of muscular patterns and thus better functional stability.

2: This study just indicates that early open kinetic chain training does not seem to have great influence on the loosening of the graft. Explanations by the authors are: 1) The two exercises actually do not differ in their strain on the ACL. 2) The concerns about the safety of OKC training might have led to a lower intensity of the training in the OKC group. 3) The stresses placed outside the physiotherapy sessions might have had an influence. 4) Both loads were below the load to cause increased strain on the ACL. 5) Type II error might be an explanation. The authors argue that the differences in the two groups and the differences between pretest and posttest were so small, less than 1mm, that even with a greater number of subjects they had not been clinically significant. 6) The overall training load used in this study might have been too small to show any different effects in these two types of exercises.

Summary/Conclusion:

These two recently published clinical trials indicate that there are no major differences in the outcome measurements between protocols including OKC Quadriceps exercises in the early period after ACL surgery or excluding these. As long as there are still theoretical and experimental indications that the use of OKC exercises might cause harm and as there is only limited benefit reported, I would suggest to use these exercises only as a means to achieve quadriceps tension in safer exercises, making sure that not too much load is applied.

IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH

All clinical trials that measure laxity after an intervention have only limited validity if no baseline laxity measures are applied (Morrissey et al. 2000). Laxity alone is not a gold standard for outcome after ACL surgery. Subjective and functional outcome measures should be used for further clinical trials to these questions. (Morrissey, Hudson, Drechsler, Coutts, King, & McAuliffe, 2000). The biomechanical models and the cadaveric experiments do not seem to measure the forces that happen exactly in everyday movements. This would explain the different results from different experiments. While most models seem to indicate that CKC exercises apply less force

on the ACL, Beynnon et al. (1995, 1997, 1998) found in their studies similar strain on the ACL in CKC as in OKC exercises, when measured directly at the ACL. So far there seem to be still mixed results, even if recent clinical research tends to indicate that both methods have their strengths and flaws and that patients might benefit mostly from a well- balanced combination of the two methods (Mikkelsen et al. 2000), (Ross et al., 2001), (Perry et al., 2005). For the specific question of straight leg raises in the first period after ACL surgery there seem to exist safer exercises than straight leg raises and as long as there is not more evidence of benefit from straight leg raises, they should only be used as a means to learn quadriceps tension, applied in other exercises.

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