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| Authors, Title, Journal, Year | Study Purpose, Study Design | Subjects’ Characteristics | Protocol(s) | Outcomes/Results  \*Significant (p<0.05) | Authors’ Conclusion | Clinical Relevance |
| Bruce D. Beynnon, Robert J. Johnson, Shelly Naud, Braden C. Fleming, Joseph A. Abate, Bjarne Brattbakk and Claude E. Nichols  Accelerated versus nonaccelerated rehabilitation after anterior cruciate ligament reconstruction: A prospective, randomized, double-blind investigation evaluating knee joint laxity using roentgen stereophotogrammetric analysis  The American Journal of Sports Medicine, 2011 | What is the difference in envelope of knee laxity when comparing an accelerated and nonaccelerated protocol following ACL reconstruction?  RCT Design | *Accelerated Group:* N =19  Age: 29.7 (16-48)  Weight: 75.3kg (49-98kg)  Gender: 13 M, 6 F  *Nonaccelerated Group:* 17 (1/17 had reinjury)  Age: 30.2 (16-46)  Weight: 71.8kg (55-97)  Gender: 9 M, 8 F  University of Vermont Medical Center | Accelerated Protocol (AP):   * 19 weeks * 8 days w/crutches * SAQ at 5 weeks   Nonaccelerated Protocol (NP):   * 32 weeks * 22 days w/crutches * SAQ at 12 weeks   All exercises the same for each group, exercises initiated earlier for accelerated protocol. Frequency: 3x/week +HEP | **Laxity (A-P, M-L, P-D, absolute displacement, ER, Varus Rot, Ext Rot):**  AP: 3.2\*,-0.9, 0.4, 3.2, 2.6\*, 2.3\*, 3.5  NP: 4.5\*, -2.7, 0.4, 4.3, 1.9\*, 2.5\*, 0.1  **IKDC:**  AP\*: 78% improved to A or B  NP\*: 88% improved to A or B  **Tegner:**  AP\*: increased 1.5  NP: increased 0.2  **KOOS\*:**  Both groups improved.  **One-leg hop:**  AP\*: 4.0±13.2cm  NP\*: 9.6±18.5cm  **Strength\*:**  Knee extensors stronger at 3 months\* for AP, all other times similar | The researchers concluded that because of the lack of difference between the two protocols in reagards to knee laxity specifically (and other outcome measures) there appears to be evidence to support accelerated rehabilitation in patients undergoing bone-patella tendon-bone ACL reconstruction. | Compared to many of the other studies, this is one of the quicker recovery times that show laxity is not increased with early strain on the graft. Results showed no difference in patient satisfaction or function, meaning accelerated rehab would be more cost effective and provide the same results. |
| Mark S. De Carlo, K. Donald, Shelbourne, John R. McCarroll, Arthur C. Rettig  Traditional versus Accelerated Rehabilitation following ACL Reconstruction: A One-Year Follow-Up  Journal of Orthopaedic & Sports Therapy, 1992 | What is the difference in outcomes at 1 year following ACL reconstruction and participation in either a traditional or an accelerated rehabilitation protocol?  Case-Control Design | N= 1,508  Gender: 1,054 Males, 454 Females  Mean Age: 22 (12-53)  *Traditional* (years 1982-1986): N = 600  *Accelerated* (years 1987-1989):  N= 1052 | *Traditional:*   * NWB 2-4 weeks * Braced 30-90 knee flexion (2-4 weeks), and progressed slowly to 0-120 (4 months) * 10-12 weeks: step-ups & calf raises * 6 months: sports drills * 9-12 months return to play   *Accelerated:*   * WBAT 2-3 days * 7-10 days: step-ups & calf raises * Early ROM 0-90 +terminal extension, 5-6 weeks begin sports drills * 10 weeks: Full ROM * Return to play 16-24 weeks | **ROM:**  **Hyperextension 3,6,12 months (degrees):**  *Traditional:* 0.20±0.05, 0.12±0.04, 0.21±0.08  *Accelerated\*:* 2.79±0.10, 2.93±0.12, 4.06±0.21  **Flexion 3, 6, 12 months (degrees):**  *Traditional:* 121.77±1.10, 131.07±1.09, 133.55±1.73  *Accelerated\*:* 131.21±1.72, 138.37±2.28, 137.88±0.71  **Quadriceps Strength (% compared to uninvolved side) 3, 6, 12 months:**  *Traditional:* 63.94±2.3, 71.48±1.2, 80.02±1.5  *Accelerated\*:* 69.63±0.5, 76.81±0.5, 87.42±0.9  **Hamstring Strength (% compared to uninvolved side) 3,6,12 months:**  *Traditional:* 79.40±2.3, 90.99±1.2, 95.13±1.5  *Accelerated:* 92.65±1.1\*, 97.76±0.5\*, 98.73±0.9  **Laxity\*** 12 months (mm):  *Traditional*: 2.59±0.17  *Accelerated*: 2.08±0.11 | The authors concluded that an accelerated protocol following ACL reconstruction was more beneficial than a traditional protocol, especially when emphasis was placed on quadriceps control, early weight bearing, and regaining terminal extension of the knee quickly. | Study is outdated for definitions of “accelerated” and “traditional” protocols. Accelerated protocol in this study is now accepted as a standard protocol. Results show that 4-6 month return to sport is safe and improves ROM and strength, without increased laxity, compared to a 9-12 month protocol. |
| Siede Karasel, Berrin Akpinar, Selmin Gulbahar, Meltem Baydar, Ozlem EL, Halut Pinar, Hasan Tatari, Osman Karaoglan, Elif Akalin  Clinical and functional outcomes and proprioception after a modified accelerated rehabilitation program following anterior cruciate ligament reconstruction with a patellar tendon autograft  Acta Orthopaedica Et Traumatologica Turcica, 2010 | Can a modified accelerated rehabilitation program that emphasizes strength, balance, proprioception, activity levels, and functional capacity, provide effective outcomes in patients following ACL reconstruction with BTB grafts?  Cohort Design | N = 38  Gender: 33 M, 5 F  Age: 27.6 ± 6.4 (18-45)  BMI: 25.1 ± 2.6 (19.8-31.3)  Pre-Op Time (months): 15.4 ±19.0 (1-72)  Post-Op Time (months): 16.0 ± 9.8 (6-40)  Subjects had surgery between 2000-2007 with patellar tendon graft. | Modified Accelerated Protocol of the study above, increasing the time before “strain” was placed on the graft. Time frame returned subjects to sports between 5-6 months compared to the 4-6 months above. Same exercises were used. | **Mean Lysholm\*:** 62.1 ± 16.9 (baseline) increased to 62.1 ± 16.9 (post-op)  No statistically significant difference in results for: Tegner, Lachman test, single hop, triple hop, cross over hop, proprioception, static balance, ROM, or hamstring strength, when compared to uninvolved limb.  **Single hop (% compared to uninvolved limb):** 85.5±15.0 (44.7-100)  **Triple hop (% compared to univolved limb):** 88.2±15.0 (32.9-100)  **Cross over hop for distance (% compared to uninvolved limb):** 91.2±17.2 (39.5-100)  **ROM (degrees):**  *Knee Extension:* Involved limb: 10.1±0.8; Uninvolved limb: 0.00±0.0  **Isokinetic Quadriceps Strength (60, 180, and 240 degrees/sec):**  Involved limb: 110.4±40.1\*, 69.3±23.0, and 52.3±19.9; Uninvolved limb: 128.1±41.1, 74.2±29.9, and 55.6±25.4 | A modified accelerated rehabilitation program, following ACL reconstruction with patellar tendon graft, shows satisfactory clinical results in returning to daily and sports activities, when dynamic and static stability are incorporated in the protocol. | Protocol is “modified accelerated” which means it was even slower of a progression compared to the study above. Authors did not present many positive results for their study and side-to-side comparison of most measures still reported a 10-15% difference. |
| J Parry Gerber, Robin L Marcus, Leland E Dibble, Patrick E Greis, Robert T Burks, Paul C LaStayo  Effects of Early Progressive Eccentric Exercise on Muscle Size and Function After Anterior Cruciate Ligament Reconstruction: A 1-Year Follow-up Study of a Randomized Clinical Trial  Physical Therapy, 2009 | What are the effects of early eccentric exercises in an accelerated rehabilitation protocol on a subjects’ muscle volume and function compared to subjects performing a standard rehabilitation protocol?  RCT Design | *Eccentric Exercise Group:* N=20  Gender: 12M, 8 F  Age: 29.3±9.3 Height (cm): 176.6±9.3  Body Mass (kg): 78.0±17.0  Tegner: 6.7±1.3  Graft Type:  10 hamstring, 10 BTB  *Standard Rehabilitation Group:*  N=20  Gender: 12M, 8F  Age: 29.3±9.7  Height (cm): 174.7±10.3  Body Mass (kg): 76.5±12.4  Tegner: 6.8±1.7  Graft Type:  10 hamstring, 10 BTB | Phase 1 (both groups): ROM, pain management, quad function  *Eccentric Group:* Eccentric Ergometer for 5 minutes progressed to 30 minutes, 20-40rpm, resistance during 20-90 degrees knee flexion  *Standard Rehabilitation Group:* Same protocol as eccentric group, except they used concentric ergometer  After 15 weeks:  HEP(both groups): 2-3days/week of PREs. | **Quadriceps Femoris Muscle Volume (cc):** both groups volume increased, increases significantly greater in eccentric group by more than 50%.  **Gluteus Maximus Muscle Volume (cc):** both groups volume increased, increases were significantly greater in eccentric group by more than 50%.  **Hamstring Muscle Volume (cc):** both groups volume increased  **Gracilis Muscle Volume (cc):** both groups volume decreased  **Quadriceps Femoris Muscle Strength:** peak torque gains for eccentric group where significantly greater.  **Single-leg hop:** Significantly greater improvement in eccentric group.  **ADLs of the Knee Outcome Survey and Tegner Scores:** both groups improved significantly.  **Knee Laxity (mm):**  Eccentric Group (pre-training and 1 year post-op): 5.8±2.5 and 1.7±1.6  Standard Rehabilitation Group (pre-training and 1 year post-op): 5.6±2.2 and 1.9±0.9 | The authors conclude that the results of the study show the importance of progessive resistive exercise in the early stages of rehabilitation, and the inclusion of eccentric exercise (high force) is a safe option to add to rehabilitation protocols. | The use of eccentric ergometer showed significant improvements in muscle volume, strength, function, and patient reported outcomes without increasing laxity. This program only took 15 weeks and then allowed for subjects to perform independent HEP until 1 year post-op. Eccentric group was able to maintain significant results over 1 year. |
| C. Cardone, Z. Menegassi, R. Emygdio  Isokinetic assessment of muscle strength following anterior cruciate ligament reconstruction  Isometrics and Exercise Science, 2004 | What are the effects on quadriceps and hamstring strength following bone-patellar tendon-bone ACL reconstruction and a 6-month accelerated rehabilitation protocol?  Cohort Design | N = 67  Age: 27.0±7.6 years old  Graft Type: Bone-patellar tendon-bone in all patients.  Exclusion Criteria: Any other related injuries. | Day 1: CPM, immobilized in full extension, WBAT without crutches  Days 2-4: Full ext for discharge from hospital, SLR, FWB  Days 7-10: ROM, prone leg hangs, wall slides, heel slides, step-ups calf raises, PWB to FWB, tapering off immobilizer.  Weeks 2-3: ROM (0-110), unilateral knee bends, stair master, leg press, quarter squats, stationary bike, swimming  Weeks 6-8: ROM (0-130), begin sports skills & cutting if strength 70%  Week 10+: Increase agility, sports skills  Months 4-6: Return to sport | **Measured Peak Torque** and **Total Work** for both knee extension and knee flexion at 2,4, and 6 months post reconstruction. Measurements taken at 60,180, and 240 deg/sec:  **Knee Extension:** Statistically significant different between uninvolved and involved limbs (large disparity favoring uninvolved limb).  Knee Flexion: Results similar between groups.  **Total Work:**  Knee Extension: Outcomes lower at all measurement points for involved limb when compared to uninvolved limb but no statistics reported.  Knee Flexion: Results showed involved limb scoring higher about 50% of the time when compared to uninvolved limb, no statistics reported. | The researchers concluded that a concentric extensor deficit of 25% or less at 60deg/sec appears to be a reliable measure for discharge or patients to return to sport. They also conclude that concentric flexion deficit does not carry the same weight and should not be used as criteria for discharge. | Similar protocol compared to previous studies. Most measures were similar between involved and uninvolved side, however, knee extension torque was significantly less for involved limb. Quadriceps strengthening needs to be a primary focus of rehabilitation in conjunction with full knee extension. This program needed more emphasis on knee extensor strengthening. |
| G. Melegati, D. Tornese, M. Bandi, P. Volp, H. Schonhuber, M. Denti  The role of the rehabilitation brace in restoring knee extension after anterior cruciate ligament reconstruction:  a prospective controlled study  Knee Surgery, Sports Traumatology, Arthroscopy : Official Journal of the ESSKA, 2003 | Does locking a patient’s brace in full knee extension or knee flexion (0-90 degrees), during the first post-operative week, improve the return of or maintain knee extension following ACL reconstruction surgery?  Quasi-experimental Design | N=36  Gender: 36M  Graft: BTB  *Group A:*  Age: 29.7±7.4 years old  Mean time until surgery: 6.0±1.8 months  Mean leg length: 44.4±1.2cm  *Group B:*  Age: 27.6±3.2 years old  Mean time until surgery: 12.3±9.6 months  Mean leg length: 44.6±1.5cm | Group A:  N= 18  Brace locked from 0-90 degrees flexion for first 7 days.  Group B: N=18  Brace locked in full extention for first 7 days.  Both Groups: Brace: 0-120 2nd week, removed 3rd week.  All subjects performed the same accelerated rehabilitation program (not described). | **Full Extension:**  **Heel Height Difference (cm):**  Group A (Pre-op, 2,4, and 8 weeks post-op): 0.6±11.4, 2.9±15.2, 2.2±12, and 1.6±11.3  Group B (Pre-op, 2,4,and 8 weeks post-op): 1±14.8, 1.6±23\*, 0.6±17\*, and 0.1±13.9  **Laxity (side-to-side difference):**  Group A: 1.8±1.6mm  Group B: 1.5±1.1mm | The researchers concluded that subjects who underwent bone-patellar tendon-bone ACL reconstruction had more of a recovery of knee extension when the rehabilitation brace was applied in full extension and not in 0-90 degrees of flexion. | The use of a brace locked in extension follow surgery should be recommended for at least the 1st week. WBAT is also recommended and safe for patients. Regaining full extension is difficult and should be emphasized early and often during rehabilitation. |
| Giulio S. Roi, Domenico Creta, Gianni Nanni, Maurilio Marcacci, Stefano Zaffagnini, Lynn Snyder-Mackler  Return to Official Italian First Division Soccer Games Within 90 Days After Anterior Cruciate Ligament Reconstruction: A Case Report  Journal of Orthopaedic & Sports Physical Therapy, 2005 | What is the functional outcome and return to play timetable for an elite soccer player, following ACL reconstruction?  Case Report | N=1  Age: 35  Gender: male Height: 176cm Mass: 76kg  PMhx: R ACL injury 16 years prior.  Played in Italian First Division and played on 3 Italian World Cup Teams.  CC: Tear of L ACL during soccer game, without contact, and no other injuries.  Subject was NWB on crutches, with full extension, 15 degree deficit in flexion, and pain 2-3/10 on day following injury. Lachman test and anterior drawer test positive. | Week 1: HEP: ROM, e-stim for quadriceps activation, rest, ice, elevation  Frequency: 2x daily, 5 days a week, 1 session on Saturdays.  Once sutures removed: aquatic exercise (1/2 of program between weeks 3-5) and focused on sport-specific exercise.  Hamstrings: massage, flexibility, and isometric exercises only for first 4 weeks.  POD 15: Treadmill walking/running  POD 29: treadmill running for endurance, pool running, swimming w/resistance, walking incline.  POD 39: sport-specific drills on field (sprinting, changing direction, etc.), no brace for 120 minutes.  POD 77: 20 minute live game, conditioning training.  POD 90: Full game played. | **POD 90:** Return to full play, full ROM, isometric quadriceps strength 95% of contralateral side, no instability (less than 2mm), aerobic threshold speed 11.8km/hr, anaerobic threshold 13.9km/hr. Vertical jump test (2 legs, then univolved, then involved limb): 0.20m difference between limbs and flight time difference of 0.404 seconds)  **POD 517:** Quadriceps Strength: 103% of contralateral side, hamstrings 102% of contralateral side. Laxity: 0.5mm more on involved side. | The authors believe that the use of criterion-based progression rather than time-based progression is necessary following ACL reconstruction. They state that the combination of surgical technique, a progression rehabilitation program, and on the field training, allowed for early return to competitive sports. Also, the personalization of the program, the subject's motivation, and closely monitored progression of exercise may have an effect on positive outcomes. | The use of criterion-based progression may be more beneficial than time-based progression. Each patient will respond differently to intervention, therefore, progression based on signs and symptoms appears to provide adequate results.  Results of this study should be used to guide personal progression and not a timeline for return. |
| Rick W. Wright, Emily Preston, Braden C. Flemming, Annuziato Amendola, Jack T. Andrish, John A. Bergfield, Warren R. Dunn, Chris Kaeding, John E. Kuhn, Robert G. Marx, Eric C. McCarty, Richard C. Parker, Kurt P. Spindler, Michelle Wolcott, Brian R. Wolf, Glenn N. Williams  A Systematic Review of Anterior Cruciate Ligament Reconstruction Rehabilitation, Part II: Open Versus Closed Kinetic Chain Exercises, Neuromuscular Electrical Stimulation, Accelerated Rehabilitation, and Miscellaneous Topics  Journal of Knee Surgery, 2008 | Can a universal protocol be devised for patients undergoing ACL reconstruction be devised from a review of current literature on intervention strategies?  Systematic Review | N=54 studies  Level 1 and Level 2 evidence.  Inclusion Criteria: English-language RCTs involving ACL reconstruction rehabilitation.  Exclusion Criteria: non-English languagem no true randomization, and subject matter not pertaining to ACL reconstruction rehabilitation. | Accelerated Rehabilitation:  *Study 1:* 20 male soccer players, goal to return to sport in 6 versus 8 months, autologus fascia lata graft. 8 month group delayed jogged and performed isokinetic strengthening for 4 weeks later than 6 month group. FWB at 3 months for both groups.  *Study 2:* 25 subjects, accelerated group (19 weeks) and nonaccelerated group (32 weeks), isolated ACL only. 3 lost to follow-up | *Study 1:* 6 month group performed better at running and strength testing at 8 months. No differnce at 12 months. 2 patients in 8 month group did not return to sports.  *Study 2:* No difference between groups in any parameter. | The authors had many conclusions due to the wide variety of topics covered in this review. Here are the conclusions as they related to accelerated protocols: Early weight bearing is beneficial to decrease PFPS. Early motion is safe. Accelerated rehabilitation appears safe in the 5-6 month time frame. Closed kinetic chain exercise should be used until further studies are performed. Too many questions still remain unanswered and further evidence is needed before a protocol can be developed for ACL reconstruction rehabilitation. | There is still a debate about ACL reconstruction rehabilitation. It appears that the use of closed-chain exercises is “safer” but that open-chain can be safe between the range of 30-90 degrees knee flexion. Early WB and ROM should be emphasized. Protocols that aim for 5-6 month return are safe. A review of shorter (less than 5 months) for return needs to be performed. |