# *Peer-Reviewed Studies Evaluating Outcome Measures for the Efficacy of CPM Following an ACL Reconstruction*

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| **Quadruple Hamstring Anterior Cruciate Ligament Reconstruction; A Multicenter Study: Scranton et al (2002, J. Arthroc. & Rel Surg).** | This study evaluated the ACL repair technique and the standardization of a rehabilitation technique. | Not reported. | Not reported. | The multicenter study reported success with this surgical technique and reported a successful rehabilitation protocol that featured CPM for passive motion. | CPM use was found to be significant after surgery and is part of the standardized protocol developed from this series. |
| **The Physiologic Basis of Continuous Passive Motion for Articular Cartilage Healing and Regeneration: Salter B (1994, Hand Clinics** | An overview of the author's first 23 years of experience with basic research relevant to the biological concept of continuous passive motion (CPM) of synovial joints in vivo, response to ligament and tendon repair as well as the first 15 years of experience with clinical application of CPM. | Six to eight hours of use per day appears to offer the best benefits. This summary of studies did not report duration of CPM as part of the summary. | N/A | Basic research demonstrated the safety of CPM and benefits that included: regeneration of hyaline cartilage, improved fracture healing, improved motion, anti-inflammatory effects, & **thicker/stronger tendon healing**. Clinical benefits include: decreased pain, increased motion, high compliance, faster wound healing, no complications and reduced rehabilitation. | This summary of extensive research has led to the following accepted uses of CPM following: stable fractures, arthrotomy, capsulotomy, arthrolysis, synovectomy, biological resurfacing, acute ligament repair, tendon graft for ligament repair, tendon repair, osteotomy and prosthetic joint replacement. |
| **Accelerated Rehabilitation following Anterior Cruciate Ligament Replacement Surgery: Zarins et al (2000, Harvard Orthopedic Journal).** | Reviews past and present approaches to rehabilitation following ACL repair. The author's provide biomechanical and clinical evidence to support their ACL rehabilitation protocol. | Not reported. | Not reported. | The author's protocol minimizes loading of the patellofemoral joint and is believed one of the keys to successful rehab. CPM allows a focus on regaining full extension and flexion with out over stressing the repair. | Our rehabilitation protocol following ACL replacement combines early motion with protective exercises with good success over a 5 year period. "Since the patients themselves control the amount of flexion during the use of the CPM machine, we have encountered very few complications with this accelerated rehabilitation protocol". |
| **Accelerated Rehabilitation after Arthroscopic Meniscal Repair; A Clinical and Magnetic Resonance Imaging Evaluation: Mariani et al. (1996, J Arthrosc & Rel Surg).** | Twenty-two patients were placed in an accelerated rehab program with CPM at home immediately following ACL and Meniscal repair. PT was started 2-4 weeks after surgery. | CPM was utilized up to 4 weeks after surgery. | Not reported. | There were no significant complications with this group of patients. | The favorable results within this series indicates that an accelerated rehab program with home CPM can be instituted without deleterious effects. |
| **Therapeutic Value of Continuous Passive Motion after Anterior Cruciate Replacement: Gaspar et al (1997, Acta Chir Hung).** | This study evaluated 41 patients for the therapeutic value of CPM after ACL replacement. Thirteen patients did not receive CPM and 28 patients did receive CPM. | Not reported. | Not reported. | The CPM group demonstrated significantly more flexion-extension ROM when compared to the non-CPM group. | The CPM group demonstrated significantly better outcomes at 3 months and 6 months compared to the non-CPM group. |
| **Rehabilitation after Meniscus Repair: Mclaughlin et al (1994, Sports Med Reh Series).** | This study evaluated the safety of home CPM and early weight bearing after combined ACL and Meniscus repair. | CPM was used up to $90^0$ during weeks 0-3 and beyond after 3 weeks until full ROM was obtained. | Not reported. | 80% of menisci healed, 14% partially healed and 5% failed. | The authors reported no complications or deleterious effects on meniscal repairs from immediate knee CPM at home. |
| **Rehabilitation following Reconstruction of the ACL: O'Meara (1993, Orthopedics).** | The author describes a post-operative rehabilitation protocol based on kinesologic, histologic, and biomechanical factors affecting the ACL. | CPM is used 6-8 hours a day as reported by Coutts et al, 1990. | Not reported. | The authors report no deleterious effects following early CPM after ACL reconstruction. | Early motion with CPM provides controlled stress to the ACL substitute, which is important for the formation and reorganization of the transplanted tissue. |

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| **The Effects of Immediate Continuous Passive Motion on Pain During the Inflammatory Phase of Soft Tissue Healing following Anterior Cruciate Ligament Reconstruction: McCarthy et al (1993, Orthop Sports Phys Ther).** | This study evaluated the potential for CPM to reduce acute pain following an arthroscopically-assisted ACL reconstruction utilizing a bone-patella-bone autograft. | CPM was started within 24 hours of the ACL procedure. | Not reported. | The initiation of CPM had a significant effect (P<.05) on decreasing the amount of medication consumed and requested (P<.05) during the inflammatory phase. | The authors reported a significant reduction of pain medication needed a reduction of hemarthrosis and a greater amount of ROM in the CPM group compared to the non-CPM group. |
| **Effects of Continuous Passive Motion Following ACL Reconstruction with Autogenous Patellar Tendon Grafts: Yates et al (1992, J Sport Reh).** | This study examined the benefits and possible risks of immediate CPM after autogenous patellar tendon reconstruction of the ACL. Patients with CPM and without CPM were randomized into separate groups. | Not reported. | Not reported. | The CPM group had significantly (P<.05) less swelling and effusion, required less pain medication, had greater knee extension. | The results suggest that CPM after ACL reconstruction is safe and facilitates early ROM be decreasing the amount of pain medication, effusion and soft tissue swelling. |
| **The Efficacy of Continuous Passive Motion in the Rehabilitation of Anterior Cruciate Ligament Reconstructions; Rosen et al (1992, Amer J Sport Med).** | This study evaluated the effect of CPM during the initial phase of rehabilitation on stability and ROM after ACL reconstruction. The participants were placed in one of three groups; PT 3X a week, PT and CPM and CPM only for 4 weeks. | CPM for 4 weeks. | CPM compliance was 122% as participants utilized the device an average of 7.3 hours per day compared to the 6 hours that were prescribed. | The CPM groups had significantly more ROM then the non-CPM group at the 1, 2 and 3 month intervals. CPM did not have a deleterious effect on stability of the knee after ACL reconstruction. | The authors report that all groups had acceptable outcomes with the best over all outcomes attained in the two CPM groups. Utilizing the standards developed in this 1992 study with 2006 cost updates for PT and home CPM, the most cost effective early motion modality is CPM for 4 weeks during the first phase of rehabilitation. Many patients felt that it was substandard care not to have CPM and 2 patients (both physicians) opted out of the study because they demanded CPM. |
| **Continuous Passive Motion after Arthroscopically Assisted Anterior Cruciate Ligament Reconstruction; Comparison of Short-versus Long-Term Use: Richmons et al (1991, J Arthroscop & Rel Surg).** | The authors evaluated the safety and compliance with home CPM use following ACL reconstruction. | Not reported. | Reported high compliance for home CPM and lower compliance for non-CPM home exercises. | The authors found knee laxity values that confirmed an earlier study by Noyes et al (1983) that the use of CPM is safe in the home following ACL reconstruction. | CPM in the home is safe with reported high compliance after ACL reconstruction. The authors reported lower then expected compliance for the non-CPM home exercise program. |
| **Rehab after ACL Reconstruction; Comparing Two Protocols: Ploski et al (1990, Rehab Mangmt, Sports Med).** | This paper compares two ACL protocols. Protocol A patients were immobilized followed by a less aggressive program and Protocol B utilized CPM and was more aggressive. | Not reported. | Not reported. | Outcome measures included ROM, arthroetry scores, strength and a subjective questionnaire. The CPM group had less stiffness and a 50% reduction in secondary procedures. | The CPM group had more positive results and the authors found that "soft tissue will remodel to stresses placed upon it by adapting so that it can withstand those stresses better. Early motion did not lead to more joint laxity compared to the immobilized group. |

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