



Clinical Guidelines for CPM following an ACL Reconstruction

The primary goal of post-surgical rehabilitation following an ACL reconstruction is to control pain, protect repaired tissue during the healing process, restore function, improve range-of-motion, restore strength and accelerate remodeling of the graft. During the initial healing phase following surgery, four weeks or more of passive range of motion is performed to protect the integrity of the repair.⁸ Protecting tissue does not mean avoiding motion. Passive range of motion is utilized to prevent adhesions, prevent the detrimental effects of immobilization, reduce pain, reduce edema, reduce inflammation and stimulate soft tissue healing.^{11,14,15,16,18,21,26-29,32,40,41} For a growing number of surgeons continuous passive motion (CPM) has become the Gold Standard for passive motion therapy during phase one of rehabilitation.^{3,8,14, 20,22,32-38,40,41} CPM has demonstrated enhanced tendon healing that is statistically superior to intermittent motion (patient-directed passive exercise) and counters the harmful effects of immobilization.²⁶ Active-assisted and in some cases active exercise may also be incorporated in the initial healing stage depending on the strength of the repair.

Anti-Inflammatory

O'Driscoll and Giori²⁰ have demonstrated that CPM immediately following a surgical procedure acts to pump blood and edema fluid out of the joint and periarticular tissues. The reduction of these fluids from a synovial joint reduces the risk of post-surgical joint stiffness. An aggressive or accelerated post-surgical rehabilitation program following an ACL reconstruction may lengthen the inflammatory component which can limit the gains in range-of-motion following the surgical procedure. Salter²⁶⁻²⁹, Kim⁹, Kroeder¹⁰ and Moran¹⁸ have all shown that CPM has reparative effects on inflamed joints. However, until recently the mechanism by which CPM acts as an anti-inflammatory agent was unknown. Recent studies by Gassner⁷, Lee¹², Xu³⁹ and Ferretti⁶ have helped explain the molecular basis for the beneficial effects of CPM on the inflamed joint. A CPM device by safely applying cyclic tensile stress on the involved joint for an extended time counteracts the effects of the inflammatory agents even better than immobilization.

CPM Improves ACL Reconstruction Strength

In experimental studies CPM following ligament repair resulted in a thicker callus formation, better fiber alignment and increased breaking strength. Salter²⁶ in an experimental model of semitendinosus tenodesis to replace the medial collateral ligament, found the CPM treated animals exhibited stronger healing of the tenodesis.

Home Exercise Compliance is Improved by the use of CPM

Milroy¹⁷ in a review of home exercise compliance found one-third of patients can be expected to comply with their home program, another one-third will partially comply and the final one-third will not comply. In contrast Rosen²⁴ reported a compliance rate as high as 122% for CPM as participants utilized the device for 7 hours on average which was higher than the 6 hour daily requested rate. High home compliance for CPM programs may be explained by the reduction in pain associated with knee CPM use.^{14,28,40} DeCarlo³ utilized CPM to gain full extension, hyperextension and flexion within the first 4-5 weeks stating "patients who failed to regain early leg control often struggled with regaining full quadriceps muscle strength later on". Home CPM has been successful replacing alternative exercises such as heel props, prone hangs with or without weight, dynamic splints, and heel or wall slides.

CPM Improves ACL Reconstruction Outcomes

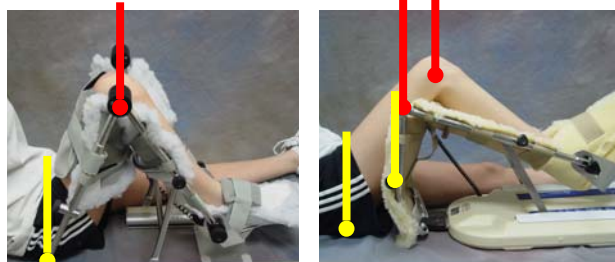
Gaspar⁴² compared two protocols following an ACL reconstruction and found CPM and active ROM did significantly better than the active motion only program when stability, ROM and complications were evaluated. Sekiya³², Barber and Click², Mclaughlin¹⁵ and Mariani¹³ all reported improved outcomes when CPM was used following combined procedures (ACL and meniscal repair, ACL and multiple ligament repair).

ACL RECONSTRUCTION 3,8,14,20,22,32-34,36-38,40,41

1. Set-up Guidelines

- If possible the patient is fitted and instructed on Kinex Knee CPM use preoperatively to improve compliance.⁸

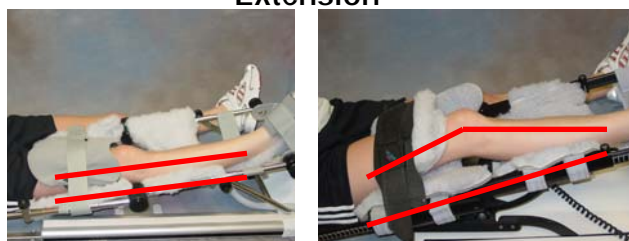
Flexion



Kinex CPM with 4-points of leverage

CPM without 4-points of leverage

Extension



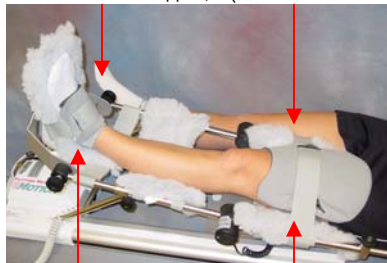
Kinex CPM with 4-points of leverage

CPM without 4-points of leverage

Note: CPMs with a thigh bar do not always ensure knee extension because there are only 2-points of leverage.

⇒ **Anatomical Knee Alignment:** Kinex 4-Point leverage system helps ensure the CPM device is in alignment throughout the arc-of-motion. Helps avoid stress on the repair.

Point 4 (Custom moldable foot support) Point 1 (Custom moldable thigh support)



Point 3 (Firm heel support) Point 2 (hip and thigh support)

Note: Calf is not a support point.⁵

- Initial Range of Motion settings:
 - ⇒ Extension 0° or as tolerated in a pain free arc
 - ⇒ Flexion 35-40° or as tolerated in a pain free arc
- CPM should be initiated 6-48 hours post-operatively.^{8, 11, 20}
- The Kinex Knee CPM is supported at the heel and thigh with no support at the calf.⁵
 - ⇒ Drez et al. (1991) reported that CPMs that used a calf bar for primary support caused strain on the healing graft and those CPMs that did not support at the calf did not contribute to anterior translation.
- CPM is only used in a pain free arc of motion to protect the repair.

2. Wearing Schedule

- The CPM is used for 4 weeks depending on the condition and specific physician PROM standard of practice.^{8,14, 24, 37}
- The CPM device is worn for 6-8 hours a day.^{8,28}
 - ⇒ Rosen et.al. (1992) reported average daily use time of 7.3 hour/day; more than the 6 hour/day rate requested.
- The patient increases PROM 5-10° a day as tolerated in a pain free arc of motion.

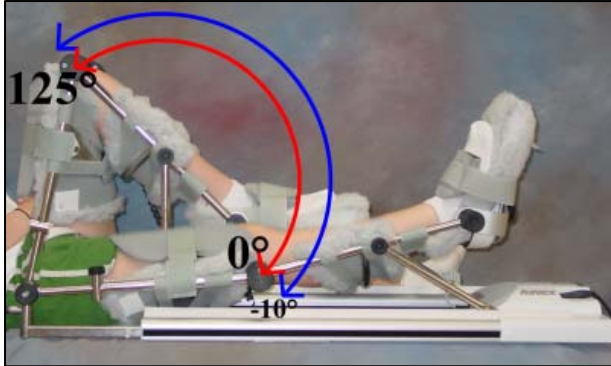
Wearing Schedule Guidelines:

- The Kinex CPM is used for 4-6 weeks.
- Kinex CPM is used 6-8 hours per day.

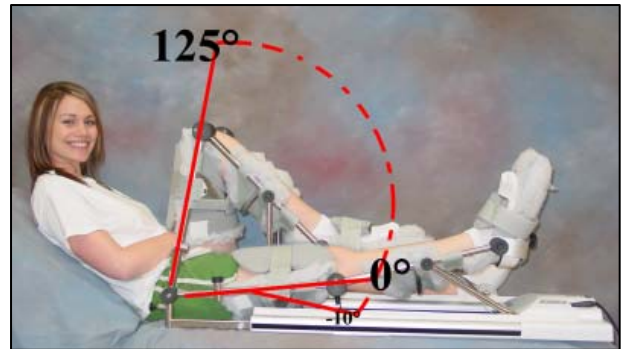
3. End-Range Goals:

- ⇒ Flexion 125°
- ⇒ Hyperextension/Extension 0° to -10°

- **Kinex ACL ISO™ Mode:** Extension force reversal setting is separate from flexion force reversal setting. Knee extension is set between 10-20 (low resistance) and extension ROM is set at 0°. The CPM will work toward 0° extension without the patient changing the ROM parameters. If too much resistance is detected the Kinex device will automatically reverse direction.



- **Stretch Mode:** The Kinex dynamic or static progressive stretch modes are utilized if ROM targets are not reached after standard CPM use. Stretch modes are utilized only after sufficient tissue healing.



CONTRAINDICATIONS

Acute inflammation of the joints, unless explicitly recommended by the doctor, spastic paralysis, unstable fractures. *This device must be used under the advice and care of a physician.*

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

Peer-reviewed Study	Purpose of Study	Duration of Use	Compliance	Results	Primary Finding
Quadruple Hamstring Anterior Cruciate Ligament Reconstruction; A Multicenter Study: Scranton et al (2002, J. Arthro. & 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.
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 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.
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.

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