Elbow CPM Following a Stable Intra-Articular Fracture

CPM after a stable fracture has been used extensively in the elbow.[9,19,20,21,22,28,30,43,46,48] The initial goal of therapy following a stable fracture is to maintain the range-of-motion. If passive motion is not started within the first 48 hours the prognosis for improvement is significantly diminished.[10] O'Driscoll and Giori[36] 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. A contracted joint typically has an inflammatory component which can be aggravated by the surgical release itself resulting in limited or no improvement in range-of-motion following the surgical procedure. Salter,[42] Kim,[26] Kroeder[27] and Moran[34] 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 Gassner,[17] Lee,[29] Xu[49] and Ferretti[14] have helped explain the molecular basis for the beneficial effects of CPM on the inflamed joint. A CPM device by applying cylic tensile stress on the involved joint for an extended time counteracts the effects of the inflammatory agents even better than immobilization.

Efficacy of Elbow CPM

The efficacy of CPM following a stable fracture in the elbow, is clearly demonstrated in several peer-reviewed studies. CPM leads to greater functional outcomes, greater ROM, improved healing by acting as an anti-inflammatory agent and higher patient satisfaction. The duration of CPM use is determined by the severity of the injury and as long as improvements are seen.

ROM	CPM Group	Non-CPM Group Splint/Cast
At Discharge	96°/-26°	------
1 Month post-op	108°/-21°	88°/-60°
6 months post-op	133°/-12°	125°/-22°
Last Recorded	141°/-10°	134°/-16°

* Comparison of elbow ROM between patients started on CPM with in 2 days after surgery and those splinted or casted for ≥ 4 weeks.

In 1991, a retrospective study by Breitfus[10] found CPM to be superior over physical therapy or a splinting program. The author also looked at start time and found superior results were seen when CPM was started within 48 hours following the surgical procedure. A second retrospective study was done by Schindler[44] between 1982-1988 and found CPM the only rehabilitation variable of value. Remia[41] found early post-op CPM increased ROM significantly following open reduction of a T-condylar distal humerus fracture through a Bryan-Morrey triceps-sparing approach. Re[40] concluded in a study on T-condylar fractures, "The use of (CPM) in the immediate postoperative period resulted in a functional range of motion sooner and yielded a statistically significant increase in flexion at follow-up examination than when not used ($p <= 0.05$)". Soffer[45] utilized CPM following an internally fixated distal humerus with good results. Letsch[30] evaluated 88 patients with intra-articular fractures of the distal humerus and found the principle feature of post-op management was functional CPM therapy.

Aldridge[1] compared the efficacy of elbow CPM to a traditional splinting program in 2004. Splinting programs following a surgical release of a stiff joint or post-trauma had been the standard of practice with many surgeons. This study of 106 joints joins the growing body of research demonstrating statistically superior results of elbow CPM ($p=0.27$) over splinting and physical therapy only programs. Only two authors out of twenty-four cited mentioned that they used CPM for only four weeks or less. **The average period of use was six weeks following a surgical release or post trauma of the elbow in order to reach statistically significant improvements in range of motion and function.**

Elbow CPM Following:

Surgical Release, Manipulation Under Anesthesia, Contracture/Stiffness[1,2,3,4,8,10,16,18,24,28,35,38,39,44,47]

1. SET-UP GUIDELINE

- The patient is fitted and instructed on use of a Kinex KE2 Elbow CPM Device (preoperatively if possible to improve compliance).[28]
  - Repeatable Anatomical Position: Kinex Head Positioner is aligned to the patient to ensure correct positioning each time the CPM device is used.
  - Anatomical Elbow Alignment: Kinex Multi-plane Adjustable Arm helps ensure the CPM device is aligned with the elbow and forearm throughout the arc-of-motion.
  - Postsurgical Grade Computer Sensor: Kinex extra-sensitive sensor will reverse direction of movement if too much strain is detected; set between levels 20 (light) & 25 (heavy) depending on extremity size.
- CPM use is initiated 24-48 hours postoperatively, if possible.[1,2,10,12,15,16,17,18,23,24,25,28,31,35,36,38,39,44]
- The elbow CPM is positioned with the shoulder at 90° of scapular elevation and with the humerous and wrist stabilized. The shoulder can be postioned at less than 90° if the patient has discomfort or an associated shoulder injury.
- Isolated Kinex CPM Mode: The KE2 is set up in the ISO mode which offers three reps of flexion-extension followed by one rep of pronation-supination (3:1 ratio). The surgeon or therapist determines what position of pronation/supination the hand is in during the flexion-extension arc and what position the elbow is in during the pronation-supination arc.
- Initial ROM: CPM is started at the available post-operative arc of motion.

2. Wearing Schedule

- CPM use continues until passive range of motion goals are met and maintained.[28]
- After week one, dosage and ROM parameters are increased daily as tolerated to improve ROM and prevent stiffness.[28,36]
- The CPM is used for 6 weeks or longer, depending on the condition and specific physician standard of practice.[1,5,28,30,45,46]

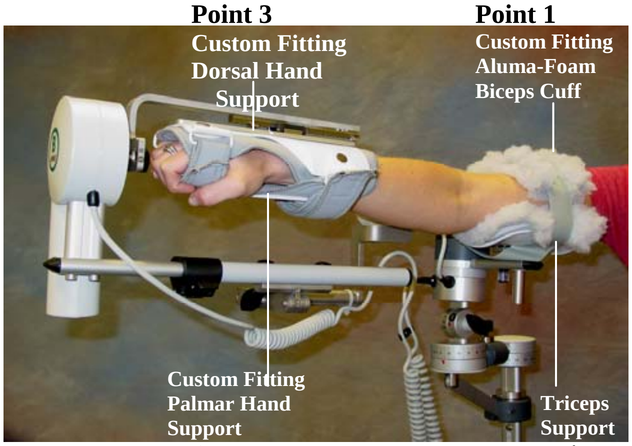
WEARING SCHEDULE GUIDELINE

- The Kinex CPM Device is used for 6-8 weeks.[3,24,16,18,32,25,47]
- Week one, CPM is used 4-20 hours per day.[25,28]
- Week two and beyond, the CPM is used for 4-8 hours per day in 3-4 sessions.[25,28]

3. End Range GOALS

- The patient increases ROM daily as tolerated to meet ROM goals (minimum of 5° per day).[25,28]
- Elbow extension/flexion and pronation/supination end range goal is 85% or better of the operative range of motion.[28]
- Full joint motion may be less during the first 2-3 weeks postoperatively due to swelling.[28]
- Kinex CPM device can be set at dynamic-progressive-stretch or static-progressive-stretch mode if patient is not progressing as expected with standard CPM.

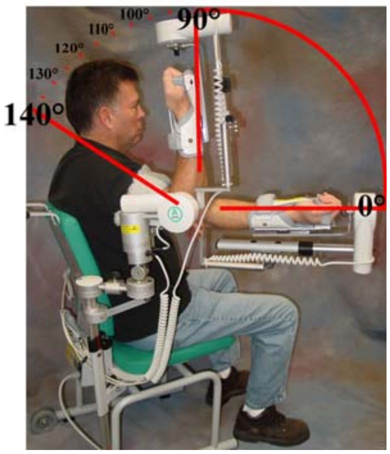
Note: This device must be used under the advice and care of a physician.



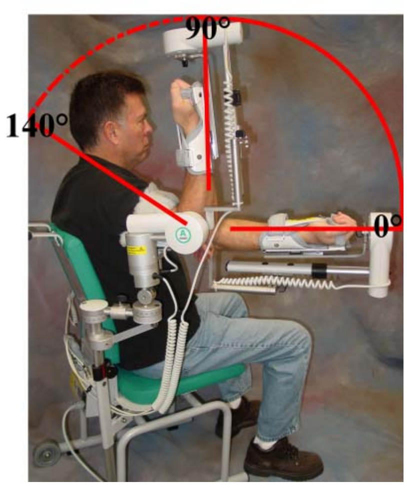
Recommended use of stretch mode:

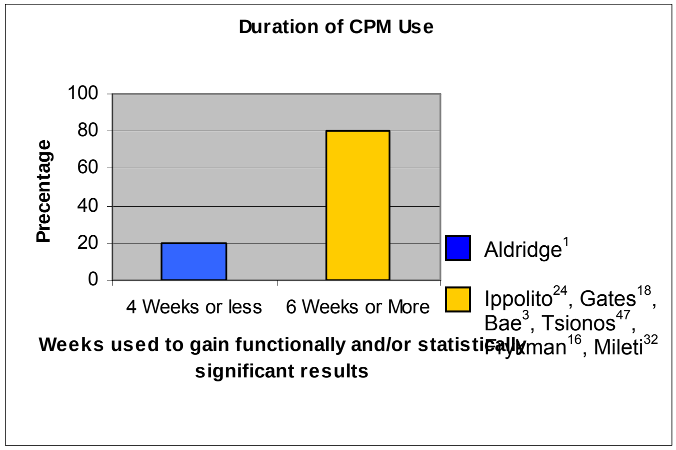
Kinex KE2 Elbow CPM stretch mode is utilized if the patient stops progressing or if not progressing as expected with standard CPM program.

- *Kinex Static-Progressive-Stretch Mode*: This mode is used to gain motion in a contracted joint. The Kinex CPM device is placed at end-range with the pause mode set at 5 minutes. After 5 minutes the CPM device is increased to the new end-range. This continues 1-2X a day for 30-60 minutes, week one. Week two the duration is increased to 2-3X a day. Week 3 and beyond the sessions are 60-90 minutes 3X a day.[6,7]



- *Kinex Dynamic-Stretch Mode*: This mode is used to gain motion in a contracted joint. The Kinex CPM device is set at end-range. The force reversal is set between levels 15 (low) and 25 (high) depending on the extremity size or stiffness. The device will move through one full cycle followed by 10 stretch cycles (1:10 ratio). In the stretch cycle the Kinex device will attempt to move the joint 5° beyond end-range. The device will automatically reverse if a force that is stronger then the setting force is met. Duration is 1-2X for 30-60 minutes a day, week one. Week two the device is used 30-60 minutes a day for 2-3X. Week 3 and beyond the device is used 60-90 minutes a day 3X a day.[6,7]





Clinical studies that reported duration of use following a surgical release procedure and that reached statistically significant gains in ROM or other outcome measures.

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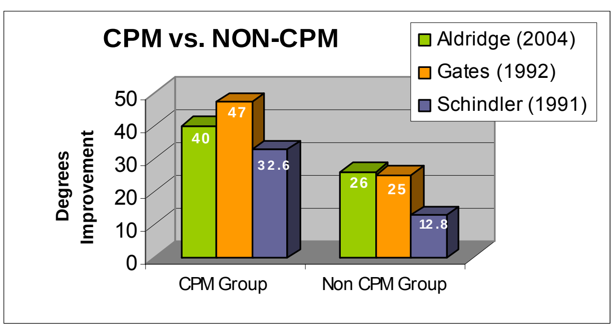
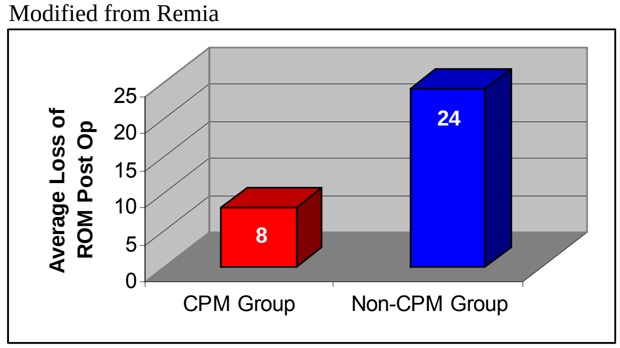
Peer-Reviewed Studies Evaluating Outcome Measures for the Efficacy of Elbow CPM Following Surgical Release and Stable Fracture

Clinical Study	Purpose of Study	Duration of Use	Results	Primary Finding
Anterior Release of the Elbow for Extension Loss: Aldridge et al (2004, J Bone Jt Surg)	Compared the efficacy of CPM to splinting alone following the surgical release of 106 elbow joints.	CPM was used 4 weeks or longer depending on the severity of the contracture.	The total arc of motion increased 45° in the CPM group & only 26° in the splinting alone group. This difference is statistically significant at p=0.27.	**CPM following a surgical release offers a statistically superior (p=0.27) functional outcome over splinting alone & physical therapy alone.**
Resection of Elbow Ossification and Continuous Passive Motion in Post-comatose Patients: Ippolito et al (1999, J Hand Surg)	Heterotopic periarticular ossifications were surgically excised in 16 elbow joints of traumatic brain injury patients.	The CPM was used for 6 weeks before starting a fully active rehabilitation program.	ROM improvements were greater then five previous investigators with a similar series of patients without CPM.	**CPM is more effective in reaching functional range of motion after 6 weeks then physical therapy alone following a surgical release.**
Anterior Capsulotomy and Continuous Passive Motion in the Treatment of Post-traumatic Flexion Contracture of the Elbow; A Prospective Study: Gates et al (1992, J Bone Jt Surg)	Thirty-three patients who had a post-truamatic flexion contracture of the elbow underwent an anterior capsulotomy. Fifteen patients did not receive CPM & eighteen patients did receive CPM post-operatively.	CPM was used for a mean of 6 weeks.	The mean post-operative arc of motion improved 25° in the physical therapy group and 47° in the CPM group. The difference was statistically significant.	**CPM following the release of a flexion contracture resulted in a statistically significant improvement in function compared to the non-CPM group.**
Surgical Treatment of Post-traumatic Elbow Contracture in Adolescents: Bae & Waters (2001, J Ped Ortho)	Thirteen adolescents with post-traumatic elbow contractures were treated with open surgical release followed by CPM.	CPM was used for 6 weeks post-operatively.	Average loss of extension improved from 57° to 15°, average flexion improved from 109° to 123° & total arc of motion improved from 53° to 107°.	**Open surgical release followed by the use of CPM for 6 weeks resulted in a significant improvement in functional ROM (>100°) in adolescents.**
Heterotopic Ossification of the Elbow in Patients with Burns; Results after early Excision: Tsionos et al (2004, J Bone Jt Surg Br)	Between 1992 & 2001, 35 elbows underwent a surgical release do to heterotopic ossification. CPM began on the second post-operative day.	CPM was used for 5-8 weeks.	The gains were statisticaly significant from a mean of 22° to 123° in flexion/extension & 94° to 160° in pronation/supination.	**A 100° arc is considered to be functional. The authors conclude that CPM is needed following a release to reach functional ROM.**
Progressive Surgical Release of a Post-traumatic Stiff Elbow, Techniques and outcome after 2-18 years in 46 patients: Marti et al (2002, Acta Orthop Scand)	This study evaluated surgical techniques and post-operative rehabilitation on 46 patients suffering from post-traumatic contracture of the elbow joint. Rehabilitation outcomes were evaluated at a mean of 10 years.	CPM was utilized immediately post-operativley.	The mean post-operative flexion was 114° and the mean extension lag was 5°. Pronation/Supination improved from a mean of 8° to a mean of 98°.	**The results of our rehabilitation program support the findings of Gates et al (1992) that post-operative use of CPM improves total range of motion and therefore function.**
Continuous Passive Motion after Internal Fixation of the Distal Humerus: Soffer et al (1990, Ortho Rev)	This small series preliminary study evaluated the use of CPM following stabilization of distal humerus fractures.	Not Reported	All patients recovered full pronation/supination and functional ROM in flexion/ extension.	**The authors concluded in this early study that CPM was a valuable therapeutic modality in the post-operative management of intra-articular fractures of the elbow.**
Intraarticular Fractures of the Distal Humerus, Surgical Treatment and Results: Letsch et al (1989, Clin Ortho Rel Res)	This preliminary study evaluated 104 patients who underwent a surgical repair of the distal humerus over a 12 year period. CPM was used immmeditely in the hospital and part of the home program. Outcome measures included ROM, pain,and working capacity.	Not Reported	The long term outcomes (81%) were rated as very good or good do to the surgical treatment and the post-operative use of CPM.	**The use of CPM post-operatively contributed to a 30% reduction in hospitilization time because home therapy was improved. The authors also report that the use of CPM decreased the incidence of myositis ossificans.**
T-Condylar Fractures of the Distal Humerus in Children and Adolescents: Re et al (1999, J Ped Orthop)	This was a retrospective review of 17 T-condylar fractures in children and adolescents. It examined the results by sex, age, arm injured, hand dominance, mechanism of injury, operative procedure, CPM use, and outcome.	Not Reported	Improvements contributed to the use of CPM were statistically significant at p<0.05.	**"The use of CPM in the immediate post-operative period resulted in a functional range of motion sooner and yielded a statistically significant increase in flexion at follow up exam compared to the group without CPM" (p<0.05).**



Elbow Comparison Studies-
Post-op programs that included elbow CPM demonstrated superior functional results.

Modified from Remia



The use of early CPM resulted in superior outcomes when compared to physical therapy alone or a splinting program alone.

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