Prior to 1989 there were few reports on the use of continuous passive motion (CPM) following the surgical release of a joint contracture. Frykman\textsuperscript{9} reported statistically superior outcomes (p<.05) on the use of CPM for stiff MP and PIP joints for posttraumatic ankylosis in 1989. CPM for six weeks in duration was tried after a vigorous hand therapy program had failed or after a previous surgical intervention without CPM had failed. Bradley\textsuperscript{5} reported significant positive results with CPM use for 10 hours per day after arthroscopy and manipulation for primary adhesive capsulitis of the shoulder in 1991. Also in 1991, a retrospective study by Breitfus\textsuperscript{6} found CPM to be superior to physical therapy and 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\textsuperscript{25} between 1982-1988 and found CPM the only rehabilitation variable of value. CPM was initiated following an arthrolysis procedure for a contracted joint and resulted in a statistically significant improvement (p<.01) both in range of motion and function (88% of CPM users improved more than 10° while only 29% of non users had similar success).

Efficacy of Shoulder CPM
A study by Gates\textsuperscript{11} in 1992 compared physical therapy to a CPM (six weeks) protocol following a release of a joint contracture. The CPM group improved a mean of 47° compared to only 25° in the physical therapy group. Ippolito\textsuperscript{12} also reported functional improvements with CPM after six weeks of use compared to a similar series who only utilized physical therapy in 1999. The importance of an intensive early CPM program was emphasized by both Olivier\textsuperscript{22} and Bennet\textsuperscript{4} following surgical releases in 2000. Olivier\textsuperscript{22} had ninety-one patients and Bennet\textsuperscript{10} had sixty-eight patients who reached statistically significant (p<.0.05) gains in range of motion and function after a capsulotomy and post op use of CPM. Aldridge\textsuperscript{4} compared the efficacy of CPM to a traditional splinting program in 2004. Splinting programs following a surgical release of a stiff joint had been the standard of practice with many surgeons. This study of 106 joints joins the growing body of research demonstrating statistical superior results of CPM (p=0.27) over splint only and physical therapy only programs.

Nicholson\textsuperscript{20} found that CPM following an arthroscopic release in the shoulder was equally effective across five identified etiologic groups as well as providing pain relief in 2003. Recent studies by Bae & Waters\textsuperscript{3} in 2001, Tsionos\textsuperscript{27} in 2004, and Wu\textsuperscript{28} in 2003 confirm that CPM following a joint release to the shoulder, elbow or hand is needed to reach functional range of motion. The average period of use was six weeks following a surgical release or manipulation of the shoulder, elbow or hand in order to reach statistically significant improvements in range of motion and function.

The initial goal of therapy following a surgical release of a contracted joint is to maintain the range-of-motion gained after the release. If passive motion is not started within the first 48 hours following the release the prognosis for improvement is significantly diminished.\textsuperscript{6} O’Driscoll and Giori\textsuperscript{21} have demonstrated that CPM immediately following a surgical release 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,\textsuperscript{24} Kim,\textsuperscript{14} Kroeder\textsuperscript{16} and Moran\textsuperscript{19} 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,\textsuperscript{10} Lee,\textsuperscript{18} Xu\textsuperscript{29} and Ferretti\textsuperscript{7} have helped explain the molecular basis for the beneficial effects of CPM on the inflamed joint. A CPM device by applying cyclic tensile stress on the involved joint for an extended time counteracts the effects of the inflammatory agents even better than immobilization.

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 contracture and as long as improvements are seen.
1. SET UP

- The patient is fitted and instructed on use of the Kinex Shoulder CPM Device (preoperatively if possible to improve compliance).\(^{17,26}\)
  - **Repeatable Anatomical Position:** Kinex Head Positioner is aligned to the patient to ensure correct positioning each time the CPM device is used.
  - **Anatomical Shoulder Alignment:** Kinex Multi-plane Adjustable Arm helps ensure the CPM device is aligned with the shoulder 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.\(^{1,6,9,17,20,28}\)
- The Kinex Shoulder CPM Device is positioned in **scapular elevation**, abduction or flexion.
  - Scapular elevation, abduction or forward flexion is started above 30° and increased to operative range or tolerance level.
  - Rotation is set at operative range or tolerance level.\(^{13,17,26}\)
  - External rotation should be at 30° before scapular elevation, abduction or forward flexion, is beyond 90° to avoid impingement.\(^{13,26}\)

2. WEARING SCHEDULE GUIDELINE

- The Kinex CPM Device is used for 6-8 weeks or as needed.\(^{3,8,11,17,27}\)
- Week one, CPM is used 6-20 hours per day or as needed.\(^{15}\)
- Week two and beyond, the CPM is used for 4-8 hours per day in 3-4 sessions or as directed.\(^{17,26}\)
- **Kinex End-Range-Repeat Mode:** Three hour daily use schedules or severe contractures are usually performed in the Kinex End-Range-Repeat Mode; Last 10° of the ROM arc is repeated 10X followed by 1 complete ROM arc (10:1 ratio) in order to maximize functional use or need.
• **Kinex Static-Progressive-Stretch Mode:** This mode is used to gain motion in a contracted joint, usually not postoperatively. 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.

3. **PROM GOALS**

- The patient increases ROM as tolerated to meet ROM goals.\textsuperscript{13,17,26}
- CPM use should continue if PROM goals have not been met.\textsuperscript{17}
- Kinex CPM device can be set at dynamic-progressive-stretch or static-progressive-stretch mode if patient is not progressing as expected.
- Full joint motion may be less during the first 2-3 weeks postoperatively due to swelling.\textsuperscript{17}
- Scapular elevation, abduction, flexion and rotation end range goal is 85% or better of the operative range.\textsuperscript{17}

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

• **Kinex Dynamic-Stretch Mode:** This mode is used to gain motion in a contracted joint, usually not postoperatively. 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.

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

\begin{figure}
\centering
\includegraphics[width=\textwidth]{image1.png}
\caption{Duration of CPM Use}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{image2.png}
\caption{Clinical studies that reported duration of use following a surgical release procedure and that reached statistically significant gains in ROM or other outcome measures.}
\end{figure}
### Clinical Study

<table>
<thead>
<tr>
<th>Purpose of Study</th>
<th>Duration of Use</th>
<th>Results</th>
<th>Primary Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthroscopic Treatment for Adhesive Capsulitis, Bradley (1991, Operative Techniques in Orthopaedics)</td>
<td>Not Reported</td>
<td>CPM is used 10 hours per day w ith positive results.</td>
<td>This preliminary study demonstrated the safety of shoulder CPM w ith positive results following manipulation under anesthesia for adhesive capsulitis.</td>
</tr>
<tr>
<td>Addressing Glenohumeral Stiffness while Treating the Painful and Stiff Shoulder Arthroscopically, Bennet et al. (2000, J Arthrosc Rel Surg)</td>
<td>Not Reported</td>
<td>Thirty of thirty-one patients had a statistically significant increase in ROM (p&lt;0.05).</td>
<td>CPM use was a primary factor in the statistically significant results achieved.</td>
</tr>
<tr>
<td>Arthroscopic Capsular Release for Stiff Shoulders Effect of Biology on Outcomes: Nicholson (2003, J Arthrosc Rel Surg)</td>
<td>Not Reported</td>
<td>The study population showed a statistically significant improvement, p=0.001. Mean improvement in ASES score was 55.5 to 93. Flexion improved from 92º to 165º &amp; Ext. Rot Improved from 12º to 56º.</td>
<td>Arthroscopic shoulder capsular release w ith postoperative CPM w as equally effective across 5 identified etiologic groups and provided pain relief, restoration of motion and function w ith an average of 3 months.</td>
</tr>
<tr>
<td>Anterior Capsulotomy and Continuous Passive Motion in the Treatment of Posttraumatic Flexion Contracture of the Elbow: A Prospective Study: Bates et al. (1992, J Bone Jt Surg)</td>
<td>Thirty-three patients w ho had a post-traumatic flexion contracture of the elbow under w ent an anterior capsulotomy. Fifteen patients did not receive CPM &amp; eighteen patients did receive CPM postoperatively.</td>
<td>CPM was used for a mean of 6 w eeks.</td>
<td>The mean postoperative arc of motion improved 25º in the physical therapy group and 47º in the CPM group. The difference w as statistically significant.</td>
</tr>
<tr>
<td>Arthrolysis of Posttraumatic Stiff Elbow: Which Factors Influence the End Result: Breitius et al. (1991, Unfallichwir)</td>
<td>Not Reported</td>
<td>Patients started on CPM day one lost 15% of intraoperative function w hile those delayed to day five lost 30%. The combined PT and CPM group lost 17% compared to the splinting group w hic h lost 35%. The CPM gains w ere statistically significant.</td>
<td>Statistically superior results w ere obtained w ith CPM compared to a splinting program. CPM started w ith in 48 hours did better then w hen CPM w as started day 5. Even delayed CPM use was superior to non-CPM protocols.</td>
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</table>

### References