|  |
| --- |
| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

|  |
| --- |
| In adults with knee pain caused by OA, are open-chain (OKC) exercises as effective as closed-chain (CKC) exercises, in increasing LE strength and reducing knee pain during ADLs? |

**AUTHOR**

|  |  |  |  |
| --- | --- | --- | --- |
| **Prepared by** | Jayson Hull | **Date** | 12-9-14 |
| **Email address** | Jayson\_hull@med.unc.edu | | |

**CLINICAL SCENARIO**

|  |
| --- |
| Many patients suffering from knee osteoarthritis have difficulty with ADLs involving squatting, kneeling and bending because of pain. Additionally, knee OA pain has been linked with lower extremity strength deficits, particularly to the quadriceps muscle group (Arthritis Rheum 2000). Weight-bearing exercises are favoured due to their high coloration with functional daily activities such as walking, squatting, bending and negotiating stairs. However, many patients are limited by pain when performing common weight-bearing exercises such as squatting or lunges. Choosing an effective pain free mode of exercise is the ideal scenario for both clinician and patient. If open-chain exercises achieve the same goal of increasing lower extremity strength, decreasing pain, and improving function without patient complaints of pain they would be a better option.  Open-chain exercises such as seated leg extensions, allow for less weight to placed on the knee joint while strengthening the quads. Many older adults with knee OA pain experience sudden knee buckling due to pain, which contributes to a fear of falling they may already possess during weight-bearing activities (Unver et al., 2014). Performing seated or non-weight bearing exercises may provide a patient with an increased since of security (Ratsepsoo et al., 2013). Lower extremity strengthening in the seated position may allow for greater concentration on the task, creating improved strength gains as well as increased adherence and buy-in to the PT plan of care. Understanding standing the effectiveness of OKC exercises compared to CKC exercises in relation to pain reduction, strength, and function may help a therapist to develop to most effective plan of care when treating this population.  This CAT seeks to investigates weather open-chain exercises are as effective as closed-chain exercises in decreasing pain, and improving strength allowing for improved function. |

**SUMMARY OF SEARCH**

|  |
| --- |
| * Eight studies were located that met the inclusion/exclusion criteria, including 7 RCTs, rated between 3/10 and 8/10 on the PEDro scale and one systematic review rated 10/11 using the AMSTAR scale. * Three articles directly compared the open and closed chain exercises, with pain as an outcome measure were critiqued. * All studies critiqued had a small sample size of thirty or less consisting mostly of females * Two studies found no significant difference in OKC and CKC in decreasing pain * Two studies found CKC exercises superior to OKC exercises for increasing strength and functional mobility. * No evidence was found identifying the most efficient exercises prescription to improve pain, strength, and function in this population. |

**CLINICAL BOTTOM LINE**

|  |
| --- |
| The evidence suggests that closed chain exercises are superior in improving lower extremity strength compared to open-chain exercises. However, both types of exercises equally reduced knee OA pain in the short-term. The exact exercise prescription involving intensity, frequency, and duration in order to see improvements is still unknown. |

|  |
| --- |
| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

**SEARCH STRATEGY**

|  |  |  |  |
| --- | --- | --- | --- |
| **Terms used to guide the search strategy** | | | |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| Knee  Osteoarthritis  OA  Arthritis | Open- chain exercis\*  Open chain exercis\*  Open kinetic chain exercis\* | Close – chain exercis\*  Close chain exercis\*  Close kinetic chain exercis\* | Pain |

**Final search strategy:**

**EMBASE**

1st search

* Returned 3062 results
* Terms used, each in different lines of search
  + Knee AND osteoarthritis OR OA AND open kinetic chain or closed kinetic chain or weight bearing or non-weight bearing

2nd search

* Returned 262 results
* Terms used, each in different lines of search: Knee AND osteoarthritis OR OA AND kinetic chain or closed kinetic chain or weight bearing or non-weight bearing AND exercise AND pain

3rd search

* Returned 80 results
* Terms used: Knee AND osteoarthritis OR OA AND open kinetic chain or closed kinetic chain or weight bearing or non-weight bearing AND exercise
* Applied the following limits: human trials, control study, clinical trail, RCT, controlled clinical trail, prospective study, article, review, years 2000-2014
* Categorized by disease: knee OA, knee arthritis

4th search

* Returned 46 results
* Terms used: Knee AND osteoarthritis OR OA AND open kinetic chain or closed kinetic chain or weight bearing or non-weight bearing AND exercise AND pain
* Applied the same limits as search #3

|  |  |  |
| --- | --- | --- |
| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed**  **CINAHL**  **EMBASE** | **259**  **115**  **262** | 71. Limits applied: RCT, review, Meta-analysis, systematic review, human subjects, written in the last 10 years  46. Limits applied: Human, controlled trail, clinical trial, RCT, controlled clinical trial, review, research article, knee osteoarthritis, since 2000 |

## INCLUSION and EXCLUSION CRITERIA

|  |
| --- |
| **Inclusion Criteria** |
| * Randomized controlled trials, controlled trials, uncontrolled trials, systematic reviews * Published up to September 2014 * A protocol that includes strictly open-chain exercise or close chain or a protocol that comapars the tow exercise interventions * Studied a population patients diagnosed with knee osteoarthritis * Measured pain objectively during physical activity before and after the intervention * Published in English |
| **Exclusion Criteria** |
| * Case studies or case series * Abstracts, conference proceedings, letters to the editor, dissertations, narrative review articles * Studies that involved patients diagnosed pain disorders |

**RESULTS OF SEARCH**

|  |  |  |
| --- | --- | --- |
| A total of | \_8\_\_ | *(insert number)* relevant studies were located and categorised as shown in the following table (based on Levels of Evidence, Centre for Evidence Based Medicine, 2011) and (insert name of) quality assessment rating scale |

**Summary of articles retrieved that met inclusion and exclusion criteria**

*Note that this table is arranged differently from the example CAT on Sakai. For each article that meets your inclusion and exclusion criteria, score for methodological quality on an appropriate scale, categorize the level of evidence, and note the study design (e.g., RCT, systematic review, case study). Add more rows as necessary.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Author (Year)** | **Study quality score\*** | **Level of Evidence** | **Study design** |
| Tanaka et al., 2013 | 10 / 11 (AMSTAR) | 1a | Systematic Review and meta-analysis of RCT |
| Lin, 2008 | 8 | 1b | RCT |
| Huang, 2003 | 7 | 1b | RCT |
| Jan, 2009 | 6 | 1b | RCT |
| Lim, 2002 | 6 | 1b | RCT |
| Verna, 2012 | 6 | 1b | RCT |
| Ozdincler, 2005 | 5 | 1b | RCT |
| Gbiri, 2013 | 3 | 2b | RCT |

\* PEDro scale used for quality scoring of RCT (scores out of 10, the criteria of eligibility criteria was removed)

**BEST EVIDENCE**

The following 3 studies were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were: These studies directly compare open vs. closed chain exercises for patients with knee OA and clearly measured pain objectively. The systematic review was not used because it failed to include studies that compared open vs. closed chain exercises and included other forms of exercises within their analysis. Additionally Huang, 2003 received a favourable score on quality of evidence. However, the study compared isokinetic, isotonic and isometric exercises and did not specifically identify all exercises as open or close chain. Though some of the studies chosen scored lower than others excluded, this was based on the fact that they were the only ones to specifically compare open and closed chain exercises, detailing the exercises and having pain as an outcome measure.

|  |
| --- |
| * Lim BW. A comparative study of open and closed kinetic chain exercise regimes in patients with knee osteoarthritis. *PHYSIOTHER SINGAPORE*. 2002;5(2):34-40 * Verma S. Comparing open kinetic chain with closed kinetic chain exercise on quadriceps strength and functional status of women with osteoarthritic knees. *Sports Medicine Journal / Medicina Sportivâ*. 2012;8(4):1989-1996. * Ozdincler AR, Yeldan I, Kinali P. The effects of closed kinetic chain exercise on pain and functional performance of patients with knee osteoarthritis. *Pain Clinic*. 2005; 17(1): 107-115. |

**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of** ‘A comparative study of open and closed kinetic chain exercise regimes in patients with knee osteoarthritis’byLim BW. A comparative study of open and closed kinetic chain exercise regimes in patients with knee osteoarthritis. *PHYSIOTHER SINGAPORE*. 2002;5(2):34-40.

|  |
| --- |
| **Aim/Objective of the Study/Systematic Review:** |
| The objective of this study was to compare the effects of open chain and closed chain exercises on pain, disability and functional performance in patients with knee OA. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * Randomised controlled trial with outcomes assessed pre and post intervention. * 34 subjects were randomly assigned to an open kinetic chain (OKC) or closed kinetic chain (CKC) exercise group for 6weeks * Western Ontario McMaster Osteoarthritis Index (WOMAC) and isometric strength were measured before and after the intervention |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| The exercise interventions took place at an outpatient physical therapy department in Singapore. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| The study consisted of 34 subjects (eight male, 26 women), all independent ambulators, who were diagnosed with knee OA via radiograph. The two groups did not differ in age, which ranged from 45-80 with a mean age of 60.3 +/- 9.9 years (p=.848). There was a 5.9% dropout rate. Two participants withdrew prior to the conclusion of the study, both for either personal reasons or reasons unrelated to the study. Both dropouts were women, leaving each group with thirteen females and three males. All participants were recruited by referral to outpatient physical therapy. At baseline both the open chain and closed-chain group displayed no significant differences in measures being compared, specifically the WOMAC subscales and peak and average knee extension torque. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control - Closed Kinetic Chain Group* |
| Intervention group was instructed and supervised by a physical therapist for each treatment.  Sessions: 50min. 2x per/wk for 6 weeks  Warm-up: 5min on cycle ergometer, 10x10 stretches of gastrocnemius, hamstrings and quadriceps  Exercises: Leg press on Total Gym for 20min  Exercise progression: All subjects started with 30% body weight resistance and increased 10-15% each session according to each individuals ability  15min of short wave diathermy followed exercise |
| *Experimental - Open Kinetic Chain Group* |
| Intervention group was instructed and supervised by a physical therapist for each treatment.  Sessions: 50min. 2x per/wk for 6 weeks  Warm-up: 5min on cycle ergometer, 10x10 stretches of gastrocnemius, hamstrings and quadriceps  Exercises: 20min. isometric (static) quadriceps exercises, inner range quadriceps exercises, supine straight leg raise, seated long arc quads. All exercises were performed 10x with a 5sec hold during each rep for 20min.  Exercise progression: All subjects started with 2lbs ankle weights and increased .5 – 1lbs each session.  15min of short wave diathermy followed exercise |
| **Outcome Measures** (Primary and Secondary)  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| All outcome measures were administered by the same PT investigator, pre and post intervention. The investigator was not blinded to group allocation.  The Western Ontario McMaster Osteoarthritis Index (WOMAC) was used to assess pain, stiffness and physical function. The total score of 96 includes the three sub-categories, which the patient rates via a visual analogue scale. The patient answers each of the 24 questions; rating them on a scale of 0-4 (0 =none, 4 = extremely) on how difficult it is for them to perform the task, with a higher score indicating more disability. The subscales are divided as follows making up the total 24 questions: Pain- 5 questions, stiffness – 2 questions and physical function- 17 questions.  Isometric strength was measured using a dynamometer with knee at 45 degrees to calculate the peak and average torque. Standardized instructions were given to ensure understanding of the test. For peak torque, each subject performed three 6-sec isometric contractions with a 2min rest between trials and the average was taken. After a five-minute rest, patients performed an isometric contraction of as long as possible or 60sec in order to calculate the average torque. |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| The two groups did not significantly differ on any of the evaluated variables at baseline.  The CKC group improved on all variables, but the OKC group only improved on WOMAC –pain, peak torque and average torque. When combining results from both groups pain had a mean improvement of 50.4% (p=.001), stiffness improved 32.1%(p=.042), and physical function resulted in a mean improvement of 42.2%( p=.001). Significant improvements were also seen in strength measures with an average improvement of 31.6%(p=.001), and 33.0% (p=.001), for peak torque and average torque respectively. Although not statistically significant, the CKC group showed larger improvements in all aspects of the WOMAC. Additionally the combined strength gains observed for all the subjects are considered to be clinically important  **Open Kinetic Chain**   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | **Pre Treatment Means** | **Post- Treatment Means** | **Mean Change** | **Effect size** | | **WOMAC-Pain** | 31.3±17.3 | 18.3±18.2 | 12.9±6.28 | .732 | | **WOMAC- stiffness** | 28±22.8 | 27.1±27.2 | .9±4.4 | .0358 | | **WOMAC – physical function** | 35.3±20.9 | 24.3±19.6 | 11±1.3 | .537 | | **Mean torque (Nm)** | 184.5±52.2 | 247.3±62.8 | 62.8±10.6 | 1.087 | | **Average torque (Nm)** | 123.7±58.1 | 167.6±43 | 43.9±15.1 | .858 |   **Closed Kinetic Chain**   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | **Pre Treatment Means** | **Post- Treatment Means** | **Mean Change** | **Effect size** | | **WOMAC-Pain** | 34.1±25.1 | 13.3±8.8 | 20.8±16.3 | 1.11 | | **WOMAC- stiffness** | 39.9±28.4 | 19.0±14.7 | 20.913.7 | .924 | | **WOMAC – physical function** | 41.6±24.2 | 20.2±14.7 | 21.4±9.5 | 1.07 | | **Mean torque (Nm)** | 155.7±52.3 | 205.0±64.3 | 49.3±12 | .841 | | **Average torque (Nm)** | 111.5±54.5 | 140.8±52.8 | 29.3±1.7 | .546 | |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| The author concluded that open chain and closed chain exercises were equally as effective in decreasing knee pain, increasing strength and improving physical function in patients with knee OA based on the WOMAC and isometric strength outcome measures. There were no statistically significant differences in outcomes between exercise groups. |
| **Critical Appraisal** |
| **Validity**  [Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]  Comment on missing information in original paper. |
| This study loses credibility for reasons related to subject selection, specific exercise intervention and analysis of final results. The author presented limited information on sample selection simply stating “the subjects were referred for outpatient physical therapy treatment”(Lim 2002.pg 35). The author does not state whether the referrals were all from one doctor or clinic. The sample was 81% female, leading one to wonder if the study findings could be applied equally to males. Furthermore the author did not specify the severity of knee OA noted from the radiograph. As for many other musculoskeletal disorders, radiographs don’t tell the whole story. For example, a person may present as asymptomatic, however, have a radiograph that displays knee osteoarthritis. The investigator also failed to provide critical information about the exercises performed, by never stating the specific sets and repetitions. It is unclear whether the list of exercises were completed continuously for 20min with or without rest breaks, or whether subjects completed one set of 10 reps of each exercise, which took about 20min. Additionally the author did not specify number of squats performed for the closed chain group. Moreover, during the data analysis the investigator describes the results collectively for all the subjects rather than presenting the results for each group. For example the author states “mean improvements were 50.4% for WOMAC pain score”(Lim 2002.pg 36), this statistic would have more meaning if he specified how much improvement the OKC group experienced compared to the CKC group. Lastly, the use of t-test to compare per-post data within each group, and changes between groups post-intervention, and at baseline can lead to an elevated risk of making a Type I error. The use of a Group x Time ANOVA instead of multiple t-tests would lower the high risk of making a Type I error, leading to more a more reliable statistical analysis.  This paper was reviewed using the PEDro scale, receiving 6/10 based on Eligibility Criteria: Yes; Random Allocation: Yes; Concealed Allocation: No; Baseline Comparison: Yes; Blind Subjects: No; Blind Therapist: No; Blind Assessors: No; Outcomes for >85%: Yes; Adequate Follow-up: Yes; Intention-to-treat analysis: No; Between Group Comparison: Yes; Point Estimates and Variability: Yes. (Eligibility score does not contribute to total score).  Notable points of concern were the unconcealed allocation and non-blinding of assessors to at least one outcome. Without sufficient allocation concealment “random” assignment sequences can be weakened. Knowledge of the next assignment may have led to the exclusion of certain patients based on anticipated prognosis or other reasons. To avoid allocation bias the author should have ensured adequate allocation concealment during the randomization process. The author in this study may of not concealed allocation in order to ensure that there were an equal amount of males in each group, since males only made up 19% of the entire sample. However, this process of not concealing allocation leaves room for potential bias. Additionally assessors measuring outcomes were not blinded. If investigators are not blinded, their attitudes for or against an intervention may be conveyed to participants during the intervention or when measuring outcomes. For example, while giving verbal encouragement during an isometric strength-testing, if the tester possesses bias toward OKC, he may be more vocal and enthusiastic when encouraging members of that group to push as hard as they can. Having one investigator perform the outcome test is reasonable to ensure standardization, but having them blinded to interventions would have reduced the chances for potential bias. |
| **Interpretation of Results**  [Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| The results as described by the author conclude that open kinetic chain and closed kinetic chain exercises are equally effective in improving strength, decreasing pain and improving function. However, after calculating the differences in effect size and percentage from pre treatment to post treatment change for each treatment group it appears that close chain exercises are more effective in all sub scales of the WOMAC. Although not statistically significant, clinically I would be persuaded to use closed chain exercises, as this may be a more efficient method. I believe the results suggest both interventions are effective and useful in treating patients with OA knee pain. However, the findings also clearly showed that closed chain exercises produced a larger change on the WOMAC. Although there were larger gains in the CKC group, effects are harder to detect within this small samples size. Increasing the sample size in future studies will increase the statistical power of the test. |

**(2) Description and appraisal of** Comparing open kinetic chain with closed kinetic chain exercise on quadriceps strength and functional status of women with osteoarthritic kneesby Verma S, 2012. Comparing open kinetic chain with closed kinetic chain exercise on quadriceps strength and functional status of women with osteoarthritic knees. *Sports Medicine*. 2012;8(4):1989-1996.

|  |
| --- |
| **Aim/Objective of the Study/Systematic Review:** |
| The aim of this study was to investigate the effect of closed kinetic chain exercise (CKC) compared to open kinetic chain exercise (OKC), on females osteoarthritic knee. |
| **Study Design** |
| * 5-week RCT consisted of 30 female patients diagnosed with knee OA who were randomly assigned to one of two groups (n=15 for each group)—one receiving OKC exercises and hot pack and the other receiving CKC and hot pack * Objective measures using the WOMAC and quadriceps strength were taken pre and post intervention |
| **Setting** |
| Outpatient physical therapy clinic in Romania. |
| **Participants** |
| * Thirty female subjects with a mean age of 60.7±6.3 diagnosed with knee osteoarthritis based on clinical findings and radiograph * Subjects had a mean BMI of 30.4±4.5 * Patients were required to have unilateral knee OA, be able to walk 100m, have close to full ROM in both knees, have no PMH of knee surgery or knee treatment involving injections within the last six months * The two groups were similar at baseline, displaying no significant differences in Age, BMI, WOMAC scores or quadriceps strength * No subject attrition reported |
| **Intervention Investigated** |
| *Control – Open Kinetic Chain Exercise* |
| * Hot pack applied to knee for 15min before exercises * Warm-up on stationary bike, 20 cycles/ 5min * While supine patient performed short arc quads (SAQ); side-lying hip abduction, and quad sets * Length of intervention: 5 weeks |
| *Experimental- Closed Kinetic Chain Exercise* |
| * Hot pack applied to knee for 15min before exercises * Warm-up on stationary bike, 20 cycles/ 5min after hot pack application * Patient performed exercises on the seated leg-press with 1/3 knee flexion, rowing machines exercises, step-ups, progressive jumping exercises, and stationary bike. * Length of intervention: 5 weeks |
| **Outcome Measures** (Primary and Secondary) |
| * Outcome measures were taken by the same physical therapist pre and post intervention * The Western Ontario McMaster Osteoarthritis Index (WOMAC) was used to assess physical function. The total score of a 96 includes the three sub-categories, which the patient rates via a visual analogue scale. The patient answers each of the 24 questions; rating them on a scale of 0-4 (0 =none, 4 = extremely) on how difficult it is for them to perform the task, with a higher score indicating more disability. The subscales are divided as follows making up the total 24 question: Pain- 5 questions, stiffness – 2 questions and physical function- 17 questions. * A strain gauge was used to measure isometric quadriceps strength |
| **Main Findings** |
| Changes in WOMAC-(no significant difference between groups)  At baseline the OKC group had a mean score of 63.7±7.2 and improved to 61.7±7.2, creating an overall absolute change of 2.5±7.2. The CKC group had a mean score of 64.8±5.9 at baseline and a post intervention score of 55.7±6.5, with an absolute change of 9.1.  Changes in strength-(The CKC group had a significant increase in strength)  At baseline, the OKC group had a mean score of ­49.12±8.72 which improved to 50.48±8.65, creating an overall absolute change of 1.36. The CKC group had a mean score of 64.8±5.9 at baseline and a post intervention score of 55.7±6.5 creating a change of 9.1.  When comparing the two groups using a t-test, statistics revealed a significant difference between groups for both WOMAC and strength with a p-value of .027 and .04 respectively. The results concluded that closed chain exercises are more effective in improving function, pain, and strength as well as decreasing disability.  Precent Change in WOMAC Scores Between Groups:   |  |  |  | | --- | --- | --- | |  | **OKC** | **CKC** | | **Pre-test** | 63.7 | 64.8 | | **Post-test** | 61.6 | 55.7 | | **% Change** | 3.3% | 14% | |
| **Original Authors’ Conclusions** |
| The author concluded that CKC exercises were more effective than OKC exercises. The results showed larger increase in quadriceps strength, but no significant difference in WOMAC scores between groups. |
| **Critical Appraisal** |
| **Validity** |
| This study lacks credibility due to a lack of information regarding selection of subject, exercise parameters, and the use of the WOMAC outcome measure. The author does not state how the study participants where recruited, she merely states, “30 female patients with OA knee were selected on basis of inclusion criteria and divided into two groups” (Verma, 2012.pg 1990). Additionally, the results found in this study can only be applied to females between the ages of 50 to 70 years old, as the sample included no males. The description of the exercise intervention was extremely poor, making it impossible to recreate. The author only states the type of exercises being preformed in the closed chain and open chain groups three times per week, without specifics on intensity, or duration. Having these three components is essential to any exercise intervention, because it allows for systematic progression of exercise. Further, knowing the activity level prior to the intervention would have been useful. If some participants were already very active while others more sedentary the rate of change in muscle strength would not be comparable. The more sedentary individual would likely see larger increases in overall strength compared to the more activity person. Another cause of concern was the way the author measured pain. The investigators used the WOMAC, which consist of subscales (pain, stiffness, physical function), however the results did not show individual subscale scores. The reader is unable to tell with certainty, which subscale(s) improved during the intervention. It is possible that one or more subscales didn’t improve at all. Another interesting point is that the study included only subjective reporting of functional from the WOMAC. An additional functional measure of gait, or stair climbing would have increased the credibility of the outcomes observed.  This paper was reviewed using the PEDro scale, receiving 6/10 based on Eligibility Criteria: Yes; Random Allocation: Yes; Concealed Allocation: No; Baseline Comparison: Yes; Blind Subjects: No; Blind Therapist: No; Blind Assessors: No; Outcomes for >85%: Yes; Adequate Follow-up: No; Intention-to-treat analysis: No; Between Group Comparison: Yes; Point Estimates and Variability: Yes. (Eligibility score does not contribute to total score).  Outstanding points of concern include the unconcealed allocation and non-blinding of assessors to at least one outcome. Without sufficient allocation concealment “random” assignment sequences can be weakened. Knowledge of the next assignment may have led to the exclusion of certain patients based on anticipated prognosis or other reasons. To avoid allocation bias the author should have ensured adequate allocation concealment during the randomization process. |
| **Interpretation of Results** |
| According to the author’s findings, closed kinetic chain exercises are more effective for improving lower extremity (quad) strength. However there was no significant difference between WOMAC scores between groups. Both the CKC and OKC groups experienced positive changes on the WOMAC measure. Although positive changes were seen, no group reached a minimal clinical important difference of 17-18% change from baseline. Due to the small sample size, effects are harder to identify, which contributes to an inadequate power. Additionally, the author did not use additional outcome measures to delineate between improvements of function or pain. Using only the WOMAC without reporting the individual subscales makes it impossible to tell if OKC or CKC is optimal for pain relief, or improving function. One cannot assume that because the overall WOMAC improved that all subscales experienced improvement. |

**(3) Description and appraisal of ‘**The effects of closed kinetic chain exercise on pain and functional performance of patients with knee osteoarthritis.’ ByOzdincler AR, Yeldan I, Kinali P. The effects of closed kinetic chain exercise on pain and functional performance of patients with knee osteoarthritis. *Pain Clinic*. 2005; 17(1): 107-115.

|  |
| --- |
| **Aim/Objective of the Study/Systematic Review:** |
| The purpose of this study was to compare the effects of closed kinetic chain (CKC) exercises and open kinetic chain (OKC) exercises on improving pain and function in patients with knee osteoarthritis. |
| **Study Design** |
| * Randomized controlled trial with outcomes assessed pre and post intervention. * 30 subjects were randomly assigned to an open kinetic chain (OKC) or closed kinetic chain (CKC) exercise group for 5 weeks * Sampling of connivance * Pain intensity, quadriceps strength, functional performance using ambulating and stair climbing were measured before and after the intervention |
| **Setting** |
| The exercise interventions took place at an outpatient physical therapy department in Istanbul Turkey. |
| **Participants** |
| This study originally consisted of 35 subjects, however two subjects moved away because of active sinovitis and three subjects developed other health related problems. Data was done on the remaining 30 subjects (28 females, 2 males) with a mean age of 54.5±7.36 years. All subjects were required to have class 2 OA according to the Kellgren-Lawrence classification, and could not have neurologic deficits, active sinovitis, serious cardiovascular or respiratory diseases, or have experience of professional sports. Groups were similar at baseline testing. |
| **Intervention Investigated** |
| *Control-* Progressive Resistance Exercise Group (PRE; Open kinetic chain exercises) |
| * Sessions: 5x per week for 5 weeks, all supervised by a physical therapist * 10 rep maximum (10RM) for seated leg extension was determined each week * Exercises: 3 sets of 10 reps of seated leg extension at 50%,75% and 100% of their 10RM * Modalities: Hot pack and transcutaneous e-stim were used to improve compliance and decrease knee pain. |
| *Experimental –* Closed kinetic chain exercises (CKCE) |
| * Sessions: 5x per week for 5 weeks * Exercises: Mini squats, lateral step-ups, retro steps were repeated 30x a week * Stair climbing machine was used initially for 5min progressing to 15min by the end of the first week and was continued for 15min the remainder of the intervention * Heat pack and transcutaneous e-stim were used |
| **Outcome Measures** (Primary and Secondary) |
| * Isometric quadriceps strength: Knee flexion was tested two times with a dynamometer at 30 and 60 degrees knee flexion, with a contraction time of 6 seconds and 40sec rest between trails * Visual analogue scale for pain: patients were asked to quantify pain from zero to ten, with zero being no pain to ten representing severe pain * Knee pain scale: patients and physical therapist filled out this form together, which consisted of two parts. Part one related to frequency of transfer and ambulation / climbing rating the task on a scale from 1-5 (1=worst, 5=best). Part two related to pain while performing these task, measured on a scale from 1-6 (1=worst, 6=best). * Timed functional performance test included 10-meter walk, 10 times step-up/ step-down, and a timed 10 squats test. |
| **Main Findings** |
| A paired sample t-test was used for pre and post measures of strength and timed functional performance with values of p> .05 to indicate significance. Additionally, a Wilcoxon test was used to compare VAS before and after treatments. While there were no significant differences in pain assessments, isometric quad strength or functional performance between both groups at baseline, results showed a significant difference in pain reduction in both groups at the conclusion of the five-week intervention. Further only a statistical improvement was seen the CKC group for ambulation / climbing intensity, strength and functional performance measures. |
| **Original Authors’ Conclusions** |
| The authors concluded that closed kinetic chain exercises are more effective in improving muscle strength and functional performance compared to open chain exercise. |
| **Critical Appraisal** |
| **Validity** |
| The study raises many concerns associated with selection of subjects, difference in volume of work completed between groups and an unclear description of prescribed exercises. Without clarity in these areas, replication of this study is impossible and the finial conclusions stated by the authors should be critically analysed. First, the authors neglected to give details on recruitment of the participants. The article just states: “subjects recruited for this study suffered from painful knee OA”(Ozdincler 2005.pg108). Having subjects referred from one physician, one demographic or geographical region can effect how one interprets the results of a study. Further, having only two males in the study only allows clinicians to confidently apply results to females of approximately the same age range.  The second concern with this study is the lack of consistency and clarity of total volume of work completed by each group during an exercise session. The author clearly states frequency, duration, and intensity used by the OKC group, which was three sets of ten leg extensions at 50,75,100% of 10RM performed five days a week. However, when discussing the CKC group exercise prescription it is extremely disproportional and unclear compared to the OKC group. First, the CKC group is completing three strength exercises (mini squats, lateral step-ups, retro step-ups) and 15 min on a stair climber compared to one single exercise in the OKC group, of seated leg extension. Additionally, the frequency, duration, and intensity aren’t clearly stated for these exercises. The author simply states “ Mini-squats and lateral and retro step-up exercises were repeated 30 times a week for 5 weeks” (Ozdincler 2005.pg110). It is unclear whether the participants completed each exercise 30x a week or each exercise ten times for a combined total of 30x reps each week, or something completely different. Regardless, it would be unfair to compare any results related to function or strength when one group is performing multiple strengthening exercises for multiple muscle groups (quads, gluts, abductors) and another groups is performing one exercise for one muscle group (quads). Furthermore this doesn’t take in to account the additional 15 min on the stair climber done by the CKC group, which improves muscle endurance, a variable that is crucial during functional activities.  In conclusion, it appears that the CKC group participated in more strength training compared to the OKC group over the five-week intervention. Therefore, one can only expect greater improvements in strength from the CKC group, and a true comparison and not be truly made, due to the vase important differences in frequency and duration of exercises.  This paper was reviewed using the PEDro scale, receiving 4/10 based on Eligibility Criteria: Yes; Random Allocation: Yes; Concealed Allocation: No; Baseline Comparison: Yes; Blind Subjects: No; Blind Therapist: No; Blind Assessors: No; Outcomes for >85%: Yes; Adequate Follow-up: NO; Intention-to-treat analysis: No; Between Group Comparison: Yes; Point Estimates and Variability: Yes. (Eligibility score does not contribute to total score).  A primary concern with this article is that all measures were performed by the same physical therapist at baseline and at the conclusion of the study. Although this may decrease the chance for inter-rater error, it introduces increased chances for bias. Additionally, during the knee pain scale (KAS) questionnaire the therapist and patient completed the form together. Completing a subjective patient survey with the patient may not allow them to document how they truly feel. Rather, the patient may be swayed to document what they feel is viewed most favorably by the therapist. Providing clear instructions, then allowing the participants to complete the KAS privately and individually removes bias. Further, another point of concern was the use of langue. The authors referred to the open chain group as the progressive resistance exercise (PRE) group using the DeLorme technique for exercise progression. PRE and the DeLorme technique aren’t specific to open chain exercises, however this would be unclear to a novice in the field of exercise science reading this article. Further, using the DeLorme technique for both groups would have created a more reliable comparison of the exercise interventions, allowing a consistent tracking of workload between groups. |
| **Interpretation of Results** |
| The results of this study concluded CKC exercises improved functional performance and muscle strength better than an OKC exercises program in patients with knee OA. However, they saw no significant difference in improvements of pain between the two groups. Both groups had significantly less knee pain at the conclusion of the study. Ultimately, the results indicate that both OKC and CKC improve pain, but CKC produces the best strength gains and functional benefits. Unfortunately, I cannot completely buy into this conclusion based on the huge disparities between the amounts of exercise each group may have performed. As mentioned earlier the CKC may have performed more than 3x the amount volume of lower extremity training over the course of the five weeks. However, with the primary goal of improving pain and LE strength I am inclined to use CKC exercises. Both forms of exercise appear to significantly reduce pain, although the exact parameters of frequency, intensity, and duration are unclear from this study. Further, it seems reasonable to conclude that, in circumstances in which a patient’s pain doesn’t allow them to perform CKC exercises initially, starting out with OKC exercises to reduce the pain and progressing to CKC exercises to improve strength and function is appropriate. Lastly, due to the small sample size, detecting significant changes is more difficult; therefore one should still interpret the results with caution due to the low statistical power. Nice! |

**IMPLICATIONS FOR PRACTICE and FUTURE RESEARCH**

|  |
| --- |
| **IMPLICATIONS FOR PRACTICE**  The appraised evidence supports the use of both open and close chain exercises for pain reduction. Ozdincler et al., 2005 and Lim 2002 both failed to see a significant difference pain reduction between groups, as both groups saw a significant improvement in pain post-intervention. However, greater improvements in strength and functional mobility were seen after using CKC exercises. Physical therapist commonly use both open and closed chain exercises as therapeutic exercise and in home exercise programs to strength lower extremities in an effort to decrease knee OA pain. Treating knee OA through physical therapy and exercise is the most cost effective, least invasive type of treatment. Further, this information can be used when designing a program for individuals who are limited by pain during the evaluation or early stages of treatment. Understanding open chain exercises are effective in reducing pain and improving strength (to a lesser extent than CKC exercises) allows a clinician more accurately predict progress. A therapist should anticipate reductions in pain when using OKC exercises, while tailoring expectations for improvements in strength and functional mobility. After pain has decreased, progression can be made to weight-bearing CKC exercises with and an expectation that strength will increase leading to improvements in functional activities such as stair climbing, transfers and gait. As Ozinincler et al discovered, CKC exercise group specifically showed a statistical improvement in the 10-meter walk, step test, and timed 10 squats test. Similar functional outcome measures can be used in conjunction with the WOMAC as seen in past studies. These functional tests are simple, quick, cost effective and reliable. Additionally, literature has identified further benefits to weight bearing exercise such as improved bone health. Unfortunately there is currently a lack of consistency and details describing exercise when comparing these two interventions. In all studies selected authors failed to appropriately identify the frequency, duration and intensity of exercise.  Both OKC and CKC exercises are beneficial in treating patients with knee OA. However, close chain exercises provide the greatest benefit, because they improve pain, strength and functional mobility. Additionally, current evidence is lacking on the most effective and detailed exercise prescription in this population.  **FUTURE RESEARCH**  The current evidence reveals the benefit of both modes of exercises in treating knee OA pain. Future research with larger samples should focus on determining and detailing the appropriate exercise prescription for improving strength, function and pain in knee OA. Further, the majority of current studies include predominantly females, having a sample with a greater representation of males would also be beneficial. Additionally, identifying the benefit of exercises (OKC vs CKC) during various stages of knee OA, can serve as useful information. Perhaps, there is no difference between modes of exercise during the earlier stages of knee osteoarthritis compared to the later stages. Lastly, future research should investigate the long-term benefits of open and closed chain exercises. Current evidence only looks a short-term benefit after a 5-week intervention. Understanding the long-term benefits of exercise in attenuating pain and maintaining function in patients with knee OA can be used to better predict the disease process. Also long-term studies may be able to identify, whether there is a ceiling effect of exercise in treating knee OA, and at what point do benefits plateau even with increased LE strength. |
|  |

**REFERENCES**

|  |
| --- |
| Gbiri CA, Okafor UAC, Alade MT. Comparative efficacy of open-chain and close-chain kinematics on proprioception, muscles’ strength and functional performances in individual with knee osteoarthritis. *Occup Med Health Aff*.  Huang M-, Lin Y-, Yang R-, Lee C-. A comparison of various therapeutic exercises on the functional status of patients with knee osteoarthritis. *Semin Arthritis Rheum*. 2003;32(6):398-406.  Jan MH, Lin CH, Lin YF, Lin JJ, Lin DH. Effects of weight bearing versus nonweight-bearing exercise on function, walking speed, and position sense in participants with knee osteoarthritis: A randomized controlled trial. *Arch Phys Med Rehabil*. 2009;90(6):897-904. doi: 10.1016/j.apmr.2008.11.018 [doi].  Lim BW. A comparative study of open and closed kinetic chain exercise regimes in patients with knee osteoarthritis. *PHYSIOTHER SINGAPORE*. 2002;5(2):34-40.  Lin DH, Lin CH, Lin YF, Jan MH. Efficacy of 2 non-weight-bearing interventions, proprioception training versus strength training, for patients with knee osteoarthritis: A randomized clinical trial. *J Orthop Sports Phys Ther*. 2009;39(6):450-457. doi: 10.2519/jospt.2009.2923 [doi].  Ozdincler AR, Yeldan I, Kinali P. The effects of closed kinetic chain exercise on pain and functional performance of patients with knee osteoarthritis. *Pain Clinic*. 2005;17(1):107-115.  Tanaka R, Ozawa J, Kito N, Moriyama H. Efficacy of strengthening or aerobic exercise on pain relief in people with knee osteoarthritis: A systematic review and meta-analysis of randomized controlled trials. *Clin Rehabil*. 2013;27(12):1059-1071.  Verma S. Comparing open kinetic chain with closed kinetic chain exercise on quadriceps strength and functional status of women with osteoarthritic knees. *Sports Medicine Journal / Medicina Sportivâ*. 2012;8(4).  Recommendations for the medical management of osteoarthritis of the hip and knee: 2000 update. American College of Rheumatology subcommittee on osteoarthritis guidelines. Arthritis Rheum 2000;43:1905–15  Unver B, Ertekin O, Karatosun V. Pain, fear of falling and stair climbing ability in patients with knee osteoarthritis before and after knee replacement: 6 month follow-up study. J Back Musculoskelet Rehabil. 2014;27(1):77-84  Ratsepsoo M, Gapeyeva H, Sokk J, Ereline J, Haviko T, Paasuke M. Leg extensor muscle strength, postural stability, and fear of falling after a 2-month home exercise program in women with severe knee joint osteoarthritis. Medicina (Kaunas). 2013;49(8):347-53 |
|  |