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A Systematic Review of ACL Reconstruction Rehabilitation

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ABSTRACT

Background: Anterior Cruciate Ligament (ACL) reconstruction is a well-known surgical knee procedure performed by orthopaedic surgeons. There is a general consensus for the effectiveness of a postoperative ACL reconstruction rehabilitation program, however there is little consensus regarding the optimal components of a program

Objective of the Study: to assess the merits and demerits of current ACL reconstruction rehabilitation programs and interventions based on the evidence supported by previously conducted systematic reviews.

Methods: a Systematic search in the scientific database (Medline, Scopus, EMBASE , and Google Scholer) between 1970 and 2017 was conducted for all relevant Systematic reviews discussing the primary endpoint (ACL reconstruction rehabilitation) studies were analyzed and included based on the preset inclusion and exclusion criteria. Study screening and quality was assessed against PRISMA guidelines and a best evidence synthesis was performed.

Results: the search results yielded five studies which evaluated eight rehabilitation components (bracing, Continuous passive motion (CPM), neuromuscular electrical stimulation (NMES), open kinetic chain (OKC) versus closed kinetic chain (CKC) exercise, progressive eccentric exercise, home versus supervised rehabilitation, accelerated rehabilitation and water based rehabilitation). A strong evidence suggested no added benefit of short term bracing (0-6 weeks post-surgery) compared to standard treatment. Whilst a moderate evidence reinforced no added advantage of continuous passive motion to standard treatment for boosting motion range. Furthermore, a moderate evidence of equal effectiveness of closed versus open kinetic chain exercise and home versus clinic based rehabilitation, on a range of short term outcomes. There was inconsistent or limited evidence for some interventions including: the use of NMES and exercise, accelerated and non-accelerated rehabilitation, early and delayed rehabilitation, and eccentric resistance programs after ACL reconstruction.

Conclusion: short term post-operative bracing and continuous passive motion (CPM) introduce no benefit over standard treatment and thus not recommended. A moderate evidence suggested equal efficiency for 1) CKC and OKC are equally effective for knee laxity, pain and function, at least in the short term (6-14 weeks) after ACL reconstruction and 2) home based and clinic based rehabilitation. Nevertheless, the degree of physiotherapy input remains unclear.

Keywords: ACL rehabilitation, pre-operative rehabilitation, post-operative rehabilitation.

INTRODUCTION

Dynamic knee stability is affected by both passive (ligamentous) and active (neuromuscular) joint restraints. Among the contributors to knee joint stability, the anterior cruciate ligament (ACL) has long been considered the primary passive restraint to anterior translation of the tibia with respect to the femur[1]. Moreover, the ACL contributes to knee rotational stability in both frontal and transverse planes due to its specific orientation[2]. The ACL has been the focus of many biomechanical/anatomical studies and is among the most frequently studied structures of the human musculoskeletal system over the past decades.

Prevalence of ACL injuries

Injuries occur frequently among young athletes, with knee injuries accounting for 10–25% of all sports-related injuries[3]. Athletes involved in jumping, pivoting, or cutting, such as skiers or soccer players, are at increased risk for serious knee injuries including anterior cruciate ligament (ACL) tears. An estimated 250,000 ACL-related injuries occur annually in the United States [4], leading to 80,000 to 100,000 surgical ACL reconstruction surgeries per year [5].Additionally, female athletes are 2 to 8 times more likely to injure their ACL compared to their male counterparts[6]. Serious knee injury may result in

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instability, damage to menisci or cartilage, reconstructive surgery and early osteoarthritis [7].

Anterior cruciate ligament (ACL) injury occurs with a four to six fold greater incidence in female athletes compared to males playing the same landing and cutting sports[8]. The elevated risk of ACL injury in females coupled with the 10-fold increase in high school and 5-fold increase in collegiate sport participation in the last 30 years has led to a rapid rise in ACL injuries in females[9]. This increase in ACL injuries in the female sports population has fueled intense examination of the mechanisms responsible for the gender disparity in these debilitating sports injuries[10].

ACL Injuries Treatment Options

The majority of patients fall on of the below listed two sets of criteria [11], therefore treatment should always be assessed for on an individual basis

1. Non operative treatment is preferred for patients who are older than 35 years age and are not highly active with no or minimal anterior tibial subluxation and no additional intra-articular injury.
2. Operative treatment is for younger than 25 years patients who are heavily active with an additional intra-articular damage and marked anterior tibial subluxation.

ACL Reconstruction

The unsatisfactory outcomes of the ACL primary repair have led to unanimous abandonment of suture repair and widespread adoption of ACL reconstruction. ACL reconstruction has remained the gold standard of care for ACL injuries, especially for young individuals and athletes who aim to return to high-level sporting activities[12].

The goals of reconstructive surgery are to restore stability and to maintain full active ROM. The functional stability provided by the normal ACL is both in resisting anteroposterior translation as well as rotational subluxation. Reconstruction techniques vary as do the graft materials which can be used. The option of surgical management can vary depending on the patient's symptoms and their level and type of activity. i.e. if their sport involves rotating movements. Conservative management is an option, but the long term prognosis isn't as favorable [13].There is no gold standard for reconstruction with different surgeons using different techniques and with outcomes of more recent techniques still inconclusive for long term results [14].Different techniques include arthroscopic *vs* open surgery, intra *vs* extra-articular reconstruction, femoral tunnel placement, number of graft strands, single *vs* double bundle and fixation methods[14]. Extra-articular reconstruction has been used to address pivotal shift, initially at least, which is greater than that provided by intra-articular reconstruction, but lacks residual stability. Intra-articular became the method of choice, but it doesn't restore the normal knee kinematics. Double bundle considered more anatomical and supportive especially during rotatory loading reproducing anteriomedial and posteriolateral bundles using gracilis and semitendonosis as the single bundle method (of the AM portion) is reported to have rotator instability in the longer term[15] ,For this goal it is essential that all ligaments and capsular restraints are isometric within a full ROM[16]. The isometric function of the ACL is achieved by the configuration of its 2 fiber bundles, (anteriomedial and posteriolateral) and their attachments[17]. The ACL is not just a single cord, it has bundle of individual fibers which assume spiral configuration and fan out over broad attachment areas. Due to its complex structure, ligament attachment sites should not be altered during reconstruction[18].

Nevertheless, existing surgical treatment of ACL injury is pricey, with inconstant outcomes[19] and is associated with high risk of post-traumatic OA within two decades of injury[20]. While few athletes are able to resume sports at the same level without surgery[19], the surgical reconstruction is also not always successful at returning patients to their pre-injury activity level[21]. Likewise, those athletes who successfully return to activity are at high risk of a second knee injury[22] with notably less favorable outcomes[23] and thus, a compelling need for a preoperative and post-operative ACL surgery rehabilitation arose.

ACL surgery rehabilitation

Rehabilitation of patients following anterior cruciate ligament (ACL) surgery has evolved dramatically over the last several decades. During this time, clinicians have gradually changed their approach from absolute immobilization and no muscle activity to minimal range of motion (ROM) restrictions with immediate muscle activation following

surgery [24]. Rehabilitation is both pre-operative and immediate post-operative.

The major goals of rehabilitation of the ACL-injured knee are:

- Repairing muscle strength (Closed kinetic chain exercises (CKC) and Open kinetic chain exercises (OKC) play an important role in regaining muscle (quadriceps, hamstrings)
- Gaining good functional stability and strength and knee stability.
- Reaching the best possible functional level and decrease the risk for re-injury.

A consistent approach to rehabilitation after ACL reconstruction can yield predictably good outcomes, such as a return to previous levels of activity and normal knee function. Furthermore, rehabilitation after ACL reconstruction has continued to move away from surgery-modified rehabilitation, in which surgery constrains the rehabilitation progression, and toward rehabilitation-modified surgery, in which the reconstruction techniques are robust enough to withstand early mobilization and strengthening[25]. Modifications of the surgery over the past 16 years –for example, soft tissue fixation- warrant a re-examination of the rehabilitative management of patients after ACL reconstruction.

In the present review we aim to assess the merits and demerits of current ACL reconstruction rehabilitation programs and interventions based on the evidence supported by previously conducted systematic reviews.

MATERIALS AND METHODS

Literature search

This Systematic Review of literature is reported in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Data Sources: electronic databases were searched: Scopus, EMBASE , and Google Scholar) , PubMed/MEDLINE, Scopus, The Cochrane Library, and Web of Science from 1970 to 2017.

Search terms included anterior cruciate ligament or ACL and ACL rehabilitation in combination with systematic review or meta-analysis.

STUDY SELECTION

Study Selection:

Search results were screened by scanning abstracts for the following:

Inclusion Criteria

1. Study design: systematic reviews only.
2. Gender: both males and females were included
3. Age: 16 years and older
4. Condition/ Symptoms: had a post-traumatic ACL reconstruction either by a hamstring or patella tendon auto-graft.
5. Intervention: any physiotherapy intervention from the day of surgery.
6. Outcomes: pain, ROM, strength, function, Return to work (RTW), and RTS.
7. Level of Evidence: systematic reviews needed to state the level of evidence for their recommendations, or provide sufficient information to allow a level of evidence grading.

Exclusion Criteria

1. Design: RCTs, prospective, retrospective and case studies; narrative reviews.
2. articles not published in English
3. Interventions: pre-operative interventions.

Data Synthesis and Levels of evidence

Outcomes of interventions were closely investigated in the reviews and were given a level of evidence consistent with van Tulder *et al.* [27] criteria as follows:

- Strong: Consistent findings among multiple high quality (HQ) RCTs.
- Moderate: consistent findings among multiple low quality RCTs and/or Clinical Control Trials (CCTs) and/or one high quality RCT.
- Limited: low quality RCT and/or CCT Conflicting; inconsistent findings among multiple trials (RCTs and/or CCTs).
- No evidence from trials: no RCTs or CCTs. The level of evidence for each intervention outcome was therefore dependent on the number of RCTs and the quality of the RCTs for each intervention.

This best evidence synthesis was performed to determine if the conclusions made by review authors were based on the quality of the evidence i.e. the conclusions made were consistent with the evidence reviewed.

RESULTS

Study selection

The initial search was broad, accepting any article related to pre and post ACL reconstruction rehabilitation to ensure a comprehensive view of available work. Searches identified 46 publications in addition to another 8 publications

that were found through manual research. After removal of duplicates, abstracts and titles 31 publications were assessed as identified from title and abstract, 12 papers were again excluded after another scrutinizing round, 3 papers with the same cohort and another 5 articles were also excluded because they did not have the same endpoint (didn't conclude or touchbase on the study objectives and outcomes; ACL Reconstruction Rehabilitation).

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines in reporting the results [26].

Figure 1

Finally 5 eligible articles [28,29,30,31,32] met the inclusion and exclusion criteria and detailed as the focus for the present study.

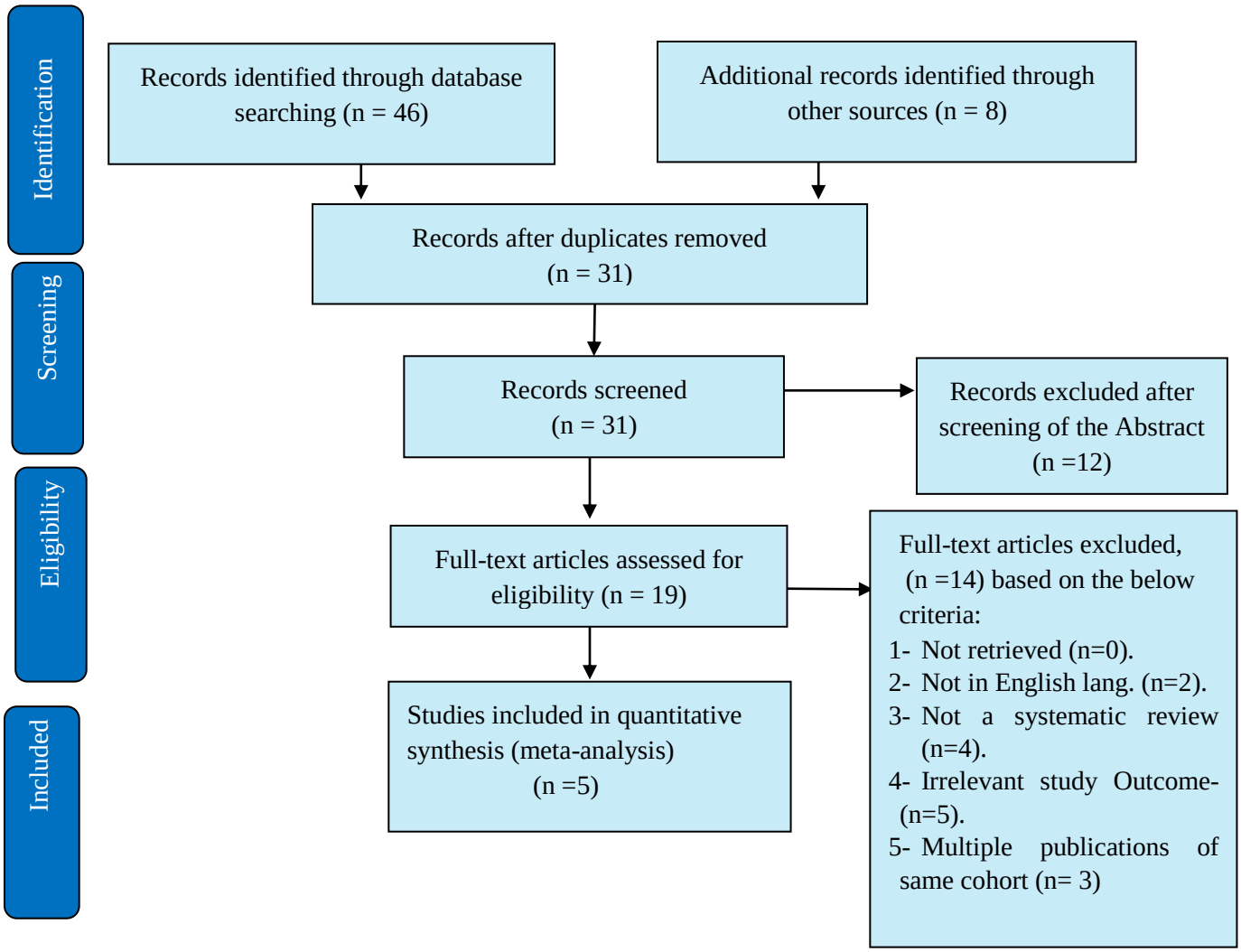

Figure 1: PRISMA flow diagram showing the selection criteria of assessed the studies[26].

A total of eight specific interventions were reported on within these five reviews: bracing, continuous passive motion (CPM), neuromuscular electrical stimulation (NMES), open kinetic chain (OKC) versus closed kinetic chain (CKC) exercise, progressive eccentric exercise, home versus supervised rehabilitation, accelerated rehabilitation and water based rehabilitation (**Table 1**).

Table 1: Characteristics, scope of the review, interventions, outcome and authors conclusion of the included systematic reviews.

Authors	Year of Study	No. of studies	Interventions	Outcomes	Conclusion of the review
Trees *et al.*[28]	**2005**	7	3 RCTS: Home versus supervised Rehabilitation 2 RCTS: CKC versus OKC 1 RCT: SCKC versus combined CKC and OKC 3 RCT: Land versus water programme	RTW and pre-injury level of function were the primary outcome measures (at six months and one year) These could have included, outcome scales such as the Tegner Activity scale and Cincinnati Knee Rating System	1) No evidence of a significant difference between home and supervised exercise (at 6 months on the Lysholm score; 2 RCTS) No difference for any other outcome measures except knee ROM at weeks 18 and 24, 1 RCT) 2) CKC versus OKC trials reported no difference in knee function 6 weeks post-surgery (1 RCT), pain severe enough to restrict activity at one year (1 RCT) and knee laxity at one year (1 RCT) 3) CKC versus combined CKC and OKC return to pre-injury level of sport at 31 months more common in combined group. No difference for secondary measures of strength and knee laxity at 6 months. 4) Higher Lysholm score was observed in the water group versus the land group at 8 weeks. No difference reported in strength, except isokinetic strength which was greater in the land group
Smith & Davies[29]	**2007**	8	Standard Rx versus Standard Rx þ CPM	1) joint laxity, 2) ROM, 3) function 4) radiological changes, 5) muscle atrophy,, 6) ecchymoses, 7) joint position sense, 8) pain, 9) swelling, 10) blood drainage, 11) post-operative complications 12) length of hospital stay outcomes	Unclear whether the application of CPM post-operatively amongst ACL reconstruction patients is of any benefit, especially relating to joint laxity, ROM, function, IKDC or radiological changes, 5) muscle atrophy and ecchymoses 6) outcomes, 7) Significantly better joint position sense in non-CPM users at day 7. Studies assessing CPM protocols, efficacy of CPM after HT graft, functional outcomes and QOL of CPM and non-CPM groups recommended.

Smith & Davies[30]	**2008**	7	Post operative bracing vs no post-operative bracing	1) Knee laxity, 2) dynamometry, 3) ROM, 4) function, 5) pain, 6) post-operative complications, 7) muscle bulk, 8) patient satisfaction,	No significant difference in bracing compared to no bracing in terms of 1) joint laxity, 2) isokinetic torque, 3) ROM and 4) function measured using Tegner and Lysholm scales at any point in time. Not bracing in early stages post operatively appears to provide significantly better 3) ROM and 4) functional outcomes also significantly less swelling and 7) loss of muscle bulk
Anderss on *et al.* [31]	**2009**	34	Rehabilitation techniques : 1) Bracing versus no brace (7 articles) 2) Early versus Delayed Rehabilitation (6 Articles) 3) Accelerated versus Non-accelerated (1 article) 4) Home based versus supervised (7 articles) 5) OKC versus CKC exercises (8 articles) 6) Early progressive eccentric exercise versus standard rehabilitation 7) Protonics device and knee brace versus knee brace (1 article), Brace at 5 compared to brace at 0 (1 article),Knee brace versus Neoprene sleeve (1 article)	'clinical tests' including: ROM, strength, laxity, Lysholm knee score, Tegner activity level, 1-leg hop test, IKDC score, pain and RTS.	1) A post-operative knee brace does not affect clinical outcome and does not reduce the risk of subsequent intra-articular injury after ACL reconstruction. Only one study used the HT graft. 2) Early versus Delayed Rehabilitation: a well-designed RCT with a follow-up of at least 1 year is needed. 3) Inconclusive whether there is a difference between an accelerated and a non-accelerated rehabilitation program. 4) Home-based and supervised clinic-based rehabilitation programs produce equal clinical outcomes in short term, however multiple methodological flaws noted in reviewed RCT's. 5) CKC exercises produce less pain and laxity and better subjective outcomes than OKC exercises after PT reconstruction. No trials that have used the HT graft. 6) Eccentric resistance training might yield better muscle function in key muscles, but further studies are required.

Kim *et al.* [32]	**2010**	8	NMES versus control treatment	1) Strength, 2) Function, 3) Self-reported function	1) NMES compared to exercise alone or EMG, may result in equal to moderately positive effects on quadriceps strength during the first 4 weeks post-operatively (grade 2b evidence) 2) There is no evidence to suggest that NMES has an effect on functional performance tests. 3) NMES has a moderate effect on self-reported function compared to standard treatment at 12e16 weeks post-surgery.

LEVELS of evidence

As previously mentioned in the present review, outcomes of interventions were closely investigated in the reviews and were given a level of evidence consistent with van Tulder *et al.* [27] criteria.

The strength of evidence ranged from strong evidence of no difference between interventions to limited evidence of effectiveness of an intervention. No evidence was found to strongly or moderately support a particular treatment and is explained in details in (**Table 2)** for all studies.

Table 2: Level of evidence for the effectiveness of the interventions/outcomes

	LEVEL OF EVIDENCE					
Authors	**Year of Study**	**Strong**	**moderate to strong**	**Moderate**	**Limited**	**Inconsistent**
Trees *et al.* [28]	**2005**	No differences between brace and no brace on ROM, strength, laxity, function, and pain at 4 month to 5 years follow up.	OKC and CKC show no significant difference ROM, Laxity, Pain, and function in short term (6e14 weeks) Limited evidence CKC significantly better outcomes of pain, laxity, subjective outcomes and RTS at 1 year. Limited	No significant difference between home and supervised exercise in short term on ROM, laxity, function and strength (6 monthse1 year). Limited evidence of no significant difference for, Hospital for Special Surgery score, and thigh atrophy	1. No significant difference between accelerated (19 weeks) and non-accelerated (32 weeks) rehabilitation on function (IKDC, hop test, Tegner), KOOS, and arthrometer at 2 year follow up. 2. Knee brace does not reduce the risk of intra-articular injuries. Limited evidence brace at 5 compared to normal brace prevents loss of extension at 3 months. 3. No difference between a brace and a neoprene sleeve on function and ROM. 4. 12 weeks of eccentric resistance training might yield better outcomes	Early versus delayed rehab at 1e2 years follow up.

			evidence combination of CKC and OKC compared to CKC alone results in better strength and RTS no time points given		regarding muscle volume, quadriceps strength and function (1 leg hop test) after 1 year. 5. no difference between neoprene sleeve and standard treatment on function, and ROM (at 6 months, 1 year and 2 year follow-up). Limited evidence of a significant difference between bracing at 5 and a brace at 0 preventing extension loss at 3 months.	
Smith & Davies[29]	**2007**				1. significant effects of NMES on function (lateral step, anterior reach, and squat) at 6 weeks 2. significant effects of NMES on self-reported function at 12 weeks and 16 weeks.	strength outcomes
Smith & Davies[30]	**2008**			no significant difference for 1) joint laxity and 2) ROM. Limited evidence of no significant difference for 3) function using the IKDC, 4) radiological changes, 5) muscle atrophy after 6 weeks or 6) ecchymoses at 15 days.	a significantly better 7) joint position sense in the non-CPM group on day 7.	regarding effects on 8) pain from 24 h to 3 days, 9) swelling at 6 weeks, 10) blood drainage within 24 h, 11) post-operative complications, and 12) length of hospital stay.
Andersson *et al.*[31]	2009	no significant difference at any time point for 1) joint laxity, 2) isokinetic torque, 3) ROM, and 4) function including		no significant difference at any time point for 5) pain or 6) post-operative complications	: 4) greater leg hop at 25 weeks but not at one year in the no-brace group; less swelling in the non-brace group (8 mm less) but this was not significant at 6 weeks; 7) greater decrease in muscle bulk at 3 months in the brace (7%) group at 3 months,	

		the Tegner scale and Lysholm scale at any time point			this was not significant at follow up; 8)for no difference in patient satisfaction.	
Kim *et al.* [32]	2010			no significant difference between home and supervised exercise (Lysholm score) at 6 months. Limited evidence of no significant difference for muscle strength (3 and 6 months), joint laxity (6 months) and ROM (6 and 12 weeks)	1. no significant difference between CKC and OKC on function (6 weeks), patellafemoral pain and joint laxity (1 year). 2. A significantly better effect on function with water based exercise (8 weeks) and no difference on muscle strength (8 weeks) except 90/flexion better with land exercise.	

Results of this review are concurrent with a study conducted by Lobb R *et al.* [33].

DISCUSSION

The present review aims at assessing existing systematic reviews of literature conducted on ACL reconstruction rehabilitation approaches and different interventions using internationally standard assessment protocols.

In addition to that, level of evidence was critically evaluated in order to best evidence ensure that the authors conclusions were consistent with the evidence reviewed. The highest levels of evidence are discussed as follows.

1. A strong level of evidence was reported in this review for no additional benefit of bracing compared to standard treatment for the outcomes of ROM, strength, laxity, pain, function, and RTS in the short (6 months) and longer term (2-5 years) [30,31]. The RCTs reported no overall significant difference between the bracing and non-bracing groups for these outcomes, when any with isolated differences in one RCT were reported they were not maintained at longer term follow-up. For both standard treatment and bracing groups RCTs employed accelerated rehabilitation; the participants had undergone patella tendon auto-graft reconstructions and in bracing groups the duration of wearing the brace ranged from 3 to 12 weeks, the most common duration was 6 weeks. The rationale for using a brace is often to promote full extension of the knee and to protect the graft from shear forces whilst the quadriceps muscles are weak [30]. Whereas other authors rationalise that a brace may actually increase joint stiffness and muscle weakness [30].

   From the evidence reported in this review neither of these theories can be supported, as there was no difference between bracing or not on the outcomes of ROM, strength, and laxity. Given these findings the use of bracing as an adjunct to accelerated rehabilitation in a post - operative ACL rehabilitation program is not supported.

2. A moderate level of evidence was reported in this review for no additional benefit of CPM compared to standard treatment for knee ROM and laxity in the shorter term (6 months) [29].

   Two low quality RCTs also found no difference in knee laxity between CPM and non-CPM groups [34,35]. CPM is often promoted as a tool for increasing outcomes such as knee ROM, however, it may be argued that it is often reserved for patients with a longer time from injury to surgery due to risk of arthrofibrosis and as these RCTs did not report time to surgery this clearly a shortcoming [29]. This notwithstanding from the evidence reported in this review the routine use of CPM as an adjunct to standard treatment for the improvement of ROM after ACL reconstruction surgery is not supported.

Moderate evidence was reported in this review to show equal effectiveness of two types of strengthening exercise (OKC versus CKC) and the location of exercise (home versus supervised based) in the short term. CKC exercises (where the distal segment is planted on the ground where movement in one joint produces movement in other joints [36] are advocated during rehabilitation because they mimic functional movements used in activities of daily living and sports [31]. OKC exercises (where the distal segment is free from the ground resulting in minimal compression of joints) are believed to increase shear forces across the knee joint in the form of anterior tibial translation [36].

Nevertheless, Three RCTs comparing OKC versus CKC found no significant difference between groups for knee laxity, pain and function in the short term (6-14 weeks) [37,38,39]. Another review on this topic [28] provides limited evidence (one RCT) of no significant difference on function. The reason for these conflicting evidence levels between reviews (moderate versus limited) is the primary outcomes of [28] were function and RTS, limiting the RCTs included in the review.

3. Limited evidence: The one RCT [36] which provided limited evidence at one year of the effect of these exercises on knee laxity reports decreased KT-1000 side to side difference in favour of CKC whereas Lachman's showed no difference between groups. The evidence reported in this review therefore supports the use of either CKC (e.g. leg press) or OKC (e.g. use of ankle weights) leg extensor exercises in the short term, with further longer term RCTs (one year) being required. Home based versus supervised based rehabilitation explores whether the quality of physiotherapy based supervised exercise is attainable in cost saving home based exercise protocols, given to patients on discharge after surgery. Moderate evidence reported in this review supports the finding that both modes of physiotherapy are equally effective as there is no difference between groups for knee laxity, ROM, strength, and function, (time points six months to one year) [31] Again, conflict appears between two reviews on the levels of evidence for some outcomes due to the primary outcomes of one review [28] being function and RTS, limiting the number of RCTS in that review.

Furthermore, Some RCTs indicated that home based rehabilitation groups received six physiotherapy consultations whereas clinic based rehabilitation received 24-40 consultations; other RCTS omitted this information. However, the lack of clarity surrounding the amount of physiotherapy input with home based rehabilitation is important when considering the evidence that a home based exercise program is equally effective as a clinic based program. This review uses methodology which adheres to procedures outlined in accordance with international guidance on the conduct and reporting of systematic reviews [41].

The use of a level of evidence synthesis [27] in this current review permitted the strength of the evidence for a particular intervention to be determined. This clarified instances where author's conclusions contrasted the evidence contain within the systematic review or with other systematic reviews.

LIMITATIONS OF THE STUDY

Nonetheless, while the level of evidence synthesis is based on the quality and number of RCTs conducted on a particular matter it is accepted that no criteria is included regarding statistical power. This is a limitation of the tool as a statistically powered study may attain the same level of grading as a study that is not powered. The methodological rigor of a review is limited by the evidence within it. It is acknowledged that systematic reviews contained within this review did not score very highly on the PRISMA, with one exception [28]. It is therefore reasonable that not all RCTs relating to the interventions under investigation were included in the systematic reviews.

In addition to that, one systematic review only reported RCT's as level II evidence and did not specify the quality of the RCT's [31]. Consequently, some of the RCTs may well have been high quality but we were unable to distinguish which. Therefore the best level of evidence we could extract from that paper was a moderate level of evidence.

CONCLUSION

Short term post-operative bracing and continuous passive motion (CPM) introduce no benefit over standard treatment and thus not recommended. A moderate evidence suggested equal efficiency for 1) CKC and OKC are equally effective for knee laxity, pain and function, at least in the short term (6-14 weeks) after ACL reconstruction and 2) home based and clinic

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