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EFFECTIVENESS OF FUNCTIONAL KNEE BRACING FOLLOWING ACL RECONSTRUCTION: A NARRATIVE REVIEW

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ABSTRACT

Anterior cruciate ligament (ACL) reconstruction is a frequently performed orthopedic procedure, especially among physically active individuals. Postoperative use of functional knee braces is still a topic of debate, due to the mixed findings about their clinical value. This review aims to evaluate the reasons for brace use following ACL reconstruction based on current scientific evidence, focusing on clinical outcomes, biomechanical factors, proprioception, and the risk of reinjury. The findings indicate that use of functional braces does not result in significant advantages over rehabilitation alone in most cases. Braces seem to have minimal effect on joint stability, range of motion, muscle strength, or time to return to sport. Nonetheless, particular patient subgroups - such as young athletes, individuals with poor neuromuscular control, or those engaged in pivot-heavy sports - may benefit from bracing. In such cases, braces might enhance proprioception, reduce shear forces during activity, and provide psychological reassurance. Some studies also suggest a potential role in reinjury risk reduction, especially with prolonged use lasting from six to twelve months. Recent innovations in brace design, such as dynamic bracing systems, may further improve their clinical applicability. In conclusion, the evidence does not support routine brace use for all patients following ACL reconstruction. Instead, brace prescription should be individualized, and tailored to the patient's functional demands, activity level and reinjury risk. Further high-quality studies with long-term follow-up are needed in order to refine recommendations and to better define the role of bracing in postoperative rehabilitation.

KEYWORDS

ACL, Anterior Cruciate Ligament, Functional Brace, ACL Reconstruction, ACL Rehabilitation, Knee Stabilization, Injury Prevention, Proprioception

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1. Introduction:

Anterior cruciate ligament (ACL) reconstruction is a frequently performed orthopedic procedure, particularly among physically active individuals. The ACL plays a vital role in stabilizing the knee, especially during twisting movements and sudden changes in direction. Due to its limited capacity for spontaneous healing, complete ACL rupture often results in surgical intervention. The gold-standard treatment is ACL reconstruction (ACLR), typically using tendon grafts harvested from the semitendinosus and gracilis muscles via a small medial incision. An alternative method involves the central third of the patellar tendon (BTB graft). Two primary techniques are used in ACLR: the single-bundle technique, where a single graft replaces the damaged ligament, and the double-bundle technique, which anatomically replicates both functional bundles of the native ACL.

The goals of ACLR include restoring mechanical knee stability, prevention of secondary damage to menisci and cartilage, and patients' return to their pre-injury activity levels. A structured and comprehensive rehabilitation program is crucial for successful recovery, and functional bracing is usually considered as a supportive measure. These "hinged" knee braces are commonly prescribed during the postoperative period, despite ongoing debates about their clinical efficacy [1].

The theoretical basis for using functional braces post-ACLR is their ability to mechanically shield the graft from excessive anterior shear and rotational forces during everyday or athletic movements. Limiting the range of motion—especially during early rehabilitation - is believed to protect the graft while enabling safe joint mobilization [2].

Biomechanical research has proved that bracing can reduce stress on the ACL graft, particularly anterior shear forces and internal tibial rotation, especially under non-weight-bearing conditions [3].

Functional knee braces can also increase neuromuscular control and proprioceptive feedback, which contributes to better joint stabilization during rehabilitation. Several studies report improved movement

symmetry, increased confidence, and enhanced postural control in brace users [4]. Furthermore, certain high-risk populations - such as skiers - have shown reduced rates of ACL reinjury while using knee braces [5].

Nevertheless, multiple studies suggest that routine brace use after ACLR does not result in consistent benefits regarding long-term clinical outcomes, muscle strength, or joint function [6]. Despite widespread clinical use, clear evidence-based guidelines concerning indications for bracing are lacking [7].

This review aims to summarize the current scientific literature on the function, appropriateness, and clinical effectiveness of functional bracing following ACL reconstruction and assess if its use is truly justified in modern rehabilitation practice.

2. Methods and materials:

A literature search was conducted in PubMed and Google Scholar using keywords related to ACL bracing, postoperative outcomes, proprioception, and reinjury prevention. A total of 213 records were identified, of which 46 were removed as duplicates and 10 were excluded due to irrelevance or lack of full text. After screening and eligibility assessment, 32 peer-reviewed studies were included in the final analysis. Articles published in English were considered without restrictions regarding their publication date. The review focused on scientific publications that met at least one of the following criteria:

- Randomized controlled trials (RCTs),
- Systematic reviews or meta-analyses,
- Prospective or retrospective studies with comparison groups,
- Biomechanical investigations (in vivo, in vitro, or in silico) analyzing the impact of bracing on force transmission or knee joint kinematics
- Studies assessing neuromuscular control, proprioception, balance, or psychological aspects of brace use,
- Articles examining the preventive role of bracing in secondary ACL graft injuries

Additionally, clinical practice guidelines and orthopedic surveys regarding bracing protocols were included. Materials selection was conducted in two stages - initially through title and abstract screening, followed by full-text analysis. Special attention was given to study heterogeneity, follow-up duration, graft type, and rehabilitation phase during which bracing was evaluated. Key outcomes of interest included joint stability, range of motion, muscle strength, proprioception, pain levels, return-to-sport time, and secondary injury incidence. Studies regarding the biomechanical function of novel brace designs, such as dynamic tensioning systems, were also reviewed.

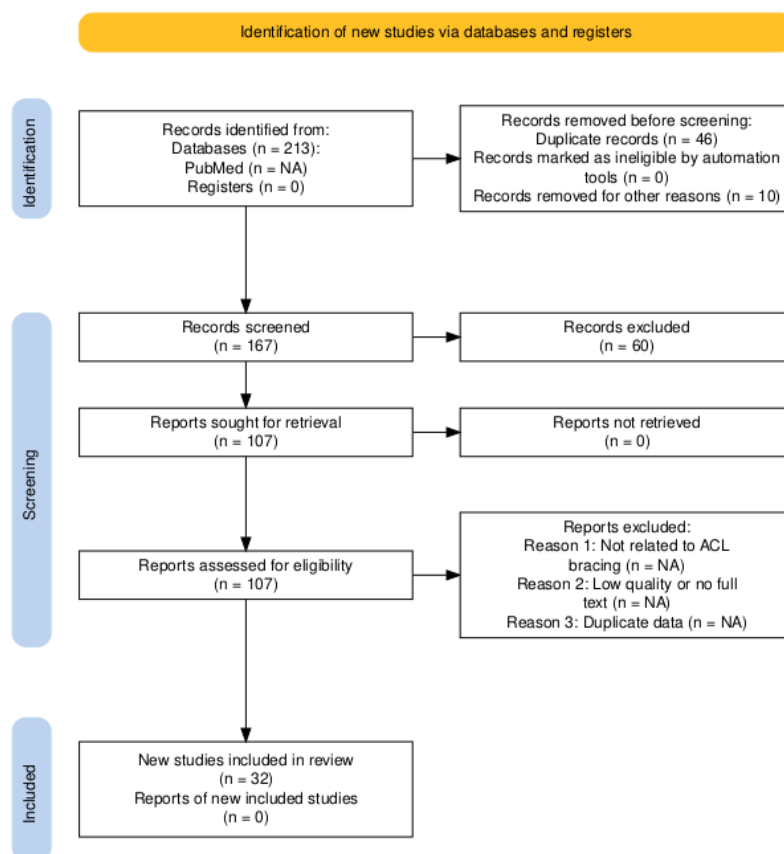


Fig. 1. PRISMA flowchart.

Results and Discussion

3. Divergent Study Findings Regarding Postoperative Bracing After ACLR Do Braces Improve Clinical Outcomes Following ACL Reconstruction?

The current scientific literature presents an extensive but overall inconclusive picture about the efficacy of functional bracing after ACL reconstruction. On one hand, numerous clinical trials and systematic reviews do not show its superiority over standard rehabilitation alone. On the other hand, biomechanical studies and subgroup analyses suggest certain areas in which bracing may be helpful.

Analysis of Studies Not Supporting the Clinical Efficacy of Bracing After ACL Reconstruction

A significant portion of scientific literature indicates that the use of functional bracing following ACL reconstruction does not result in meaningful clinical benefits.

One of the most influential studies was a multicenter, randomized controlled trial conducted in 2004 to assess whether the use of a functional knee brace after ACL reconstruction impacts functional outcomes, muscle strength, joint stability, and return to sport [1]. The study included 125 patients from various clinical centers across the United States, which ensured diverse participant representation and greater universality of the findings. Patients were randomized into two groups: one using a functional brace and one without. All participants followed an identical rehabilitation protocol, consistent with postoperative standards of that time.

Patients were evaluated at various, multiple time points up to 24 months after the surgery. Assessment criteria included:

- Objective joint stability (Lachman test, pivot shift test),
- Subjective knee function (International Knee Documentation Committee, IKDC),
- Isokinetic strength testing (flexors and extensors),
- Return to sport timeline and activity level (Tegner scale),
- Patient-reported comfort and pain.

Results showed no statistically significant differences between the braced and non-braced groups across any measured criteria. Participants who used a brace did not experience better or worse results than patients rehabilitating without external stabilization. Notably, some brace users reported more difficulty walking during the early weeks, which the authors attributed to mechanical limitations on joint mobility resulting from the brace use.

It was concluded that there is no basis for routine recommendation of functional knee bracing following ACL reconstruction, especially in active individuals who undergo standard rehabilitation [1]. The study's multicenter design, sample size, and long follow-up period made it an important reference in the debate over brace use post-ACLR.

Another important clinical study was a prospective, randomized controlled trial conducted in 1999 aiming to evaluate the impact of functional bracing on rehabilitation outcomes following ACL reconstruction [6]. Forty patients (mean age: 27) were randomized into two groups: one received a functional knee brace to be worn for 12 months postoperatively, and the other used no external stabilization. Both groups followed the same rehabilitation protocol.

The study aimed to determine if bracing leads to superior results in terms of joint stability, muscle strength, subjective knee evaluation, and overall function. A variety of objective and subjective measures were used, including:

- KT-1000 arthrometer for anterior tibial translation,
- IKDC scoring,
- Tegner activity level scale,
- Isokinetic strength testing.

After 24 months, no significant differences were found between the braced and control groups in any of the assessed parameters. Knee stability measured via KT-1000 was comparable, as well as functional outcomes and physical activity levels. Moreover, some brace users reported restricted range of motion and stiffness, which suggests potential discomfort and functional limitations in daily life.

No differences in muscle strength gain or performance in functional tests were observed, leading to the conclusion that functional bracing is not an essential component of post-ACLR rehabilitation, at least in young and active populations [6].

Further support for this conclusion comes from a randomized controlled trial that was conducted in 2002, which challenged the routine use of bracing after ACL reconstruction [8]. This comparative study evaluated

two different early postoperative knee stabilization strategies: functional bracing versus traditional immobilization using a plaster splint.

Participants who underwent arthroscopic ACL reconstruction using a bone-patellar tendon-bone (BTB) graft were randomly assigned to:

- Group A: Functional knee brace with gradually increasing range of motion,
- Group B: Plaster splint immobilization in full extension for a defined postoperative period.

Evaluations were conducted after the rehabilitation phase and at many follow-up points, assessing:

- Clinical stability (Lachman and pivot shift tests),
- Range of motion (goniometric measurements),
- Functional scales (IKDC and Lysholm scores),
- Patient-reported knee function, stiffness, and pain.

Results showed no significant differences between the groups. Knee stability was comparable in all tests. ROM and functional scores (IKDC and Lysholm) showed no statistically important differences. Moreover, neither stabilization method showed a clear advantage in terms of return to activity or subjective knee function.

Additionally, the authors observed that brace users more frequently reported early rehabilitation difficulties, such as limited mobility and stiffness, which was attributed to the mechanical restrictions from the brace use, as opposed to the more predictable and uniform immobilization achieved with the traditional cast. These findings align with broader literature trends that indicate limited effectiveness of bracing in standard ACLR patient populations.

In one of the most recent and well-designed clinical trials, a randomized controlled trial was conducted in 2023 to determine the impact of functional bracing on rehabilitation outcomes following ACL reconstruction using an autologous semitendinosus tendon graft [9]. The study involved 54 patients aged 18 to 50, who were randomly assigned to one of two groups:

- The intervention group used a postoperative knee brace.
- The control group received no external stabilization.

All participants followed a standardized rehabilitation protocol under physiotherapist supervision, based on current clinical guidelines. Functional assessments were conducted at multiple time points - at 6 weeks, 3 months, and 6 months after the surgery.

Outcome measures included both objective parameters such as:

- Lower limb muscle strength (isokinetics),
- Range of motion (ROM),
- Functional tests (e.g., single leg hop test, drop jump),

and subjective measures such as:

- International Knee Documentation Committee (IKDC) score,
- Knee Injury and Osteoarthritis Outcome Score (KOOS),
- Pain levels (VAS).

After six months, no statistically significant differences were observed between the groups in any of the assessed measures - including muscle strength, ROM, joint stability, or patient-reported knee function. Both groups showed similar rates of return to sport and complication incidence. The authors concluded that "The use of a postoperative knee brace did not lead to superior clinical outcomes when compared to rehabilitation alone following ACL reconstruction with hamstring autograft." These findings reinforce earlier conclusions, which were presented in previous trials, suggesting that, with modern rehabilitation protocols, bracing does not offer additional functional benefits and should not be routinely recommended [1,6].

In a separate study conducted in 2008, the effectiveness of a functional brace was compared to a neoprene sleeve in patients who had undergone ACLR using a semitendinosus graft [10]. The study enrolled 150 patients and assessed them at 6, 12, and 24 months postoperatively using the ACL-QOL for quality of life, KT-1000 for joint stability, hop tests for functional ability, and the Tegner scale for activity level.

No significant differences were found between the groups on any measured outcomes. After two years, the differences in quality of life, mechanical stability, and sports activity were of no statistical importance. Interestingly, brace users reported a greater subjective sense of safety and stability; however, the authors emphasized that these perceptions did not correspond with objective clinical improvements and could reflect a psychological effect rather than a physiological one. Their conclusion was clear: "Current evidence does not support the recommendation of using an ACL functional knee brace after ACL reconstruction."

Additional support for these findings comes from several systematic reviews. A meta-analysis published in 2019 found no significant differences in knee function, pain, stability, or return-to-sport timelines between

patients who used functional braces and those who did not [11]. Similarly, a 2016 review of 28 studies concluded that there is no strong evidence for the routine use of functional bracing after ACL reconstruction. It was noted that many recommendations are based more on clinical tradition than on solid scientific data [12].

Likewise, a 2013 narrative review highlighted that despite a lack of clear evidence of efficacy, bracing remains widely used in clinical practice. It was suggested that this may be largely due to the psychological belief, held by both patients and physicians, in the protective value of bracing, even in the absence of concrete evidence [13].

Several contemporary clinical trials and systematic reviews challenge routinely employing braces after ACL reconstruction. A 2022 clinical study evaluated the effects of rehabilitative knee bracing on quality of life, functional outcomes, and time to return to activity post-ACLR [14]. The results showed no statistically significant differences between braced and unbraced groups across all measured parameters. Moreover, it was noted that brace use did not provide perceivable benefits in comfort or subjective rehabilitation progress.

Similar conclusions were drawn in a 2024 prospective study which compared knee function and quality of life during the first 6 and 12 weeks post-surgery, based on brace use [15]. No significant differences were demonstrated between groups in range of motion, pain levels, functional testing, or objective knee stability. Interestingly, patients who did not wear a brace scored higher on the SF-12 mental health scale, suggesting that absence of external constraints could enhance perceived comfort and independence during the recovery period.

These conclusions were further supported by a 2018 systematic review which included 14 clinical studies [16]. No substantial effects of bracing were reported regarding major clinical outcomes such as muscle strength, range of motion, or overall knee function. Table 1 summarizes the key findings from selected clinical trials and reviews that evaluated the effectiveness of functional knee bracing after ACLR. These studies vary in methodology, population, and outcome measures but they consistently point toward limited or context-dependent benefits of postoperative brace use.

Table 1. Key Findings from the Literature Review on Functional Knee Bracing After ACL Reconstruction

Area of Analysis	Key Findings	Clinical Implications
Knee Joint Stability	Most RCTs show no significant differences between braced and unbraced groups	No justification for routine brace use in all post-ACLR patients
Muscle Strength and Range of Motion	Braces do not improve strength or ROM compared to physiotherapy alone	No additional functional benefits
Proprioception and Neuromuscular Control	Some studies report improvements in balance, muscle activation, and joint position sense	Possible benefit for patients with proprioceptive deficits, especially in early rehab phase
Biomechanical Graft Protection	Reduction in shear forces and tibial rotation demonstrated in in vitro and fluoroscopy studies	Potential graft protection during early post-op period
Reinjury Prevention (re-ACL)	Some retrospective studies show reduced rerupture rates in young brace users	Potential preventive role in patients <18 years or returning to pivoting sports
Psychological Value	Some patients report greater confidence and perceived safety	Important during late-stage rehab and return to sport
Practical Recommendations	No consistent clinical guidelines on brace selection or duration	Use should be individualized based on risk and activity level

While some studies pointed out potential biomechanical benefits - such as reductions in shear forces acting on the graft - these did not bear clear functional advantages in the studied populations. The review emphasized that current scientific data do not strongly support the routine brace use in standard postoperative protocols.

Studies focusing on neuromuscular and physical performance outcomes also question the utility of functional bracing. Key investigations in this area were carried in 2011 and 2020 [17,18]. One study examined quadriceps muscle activity in post-ACLR patients during simulated physical exertion. Participants cycled for 10 minutes, followed by electromyographic (EMG) assessment of muscle activation. The results showed a significant reduction in muscle activity post-exercise, with no correlation to the brace use. Bracing did not alleviate this decline or support neuromuscular function, leading to the conclusion that it offers no significant benefits in motor control or fatigue prevention.

A 2020 study assessed the effects of bracing on physical performance tests among athletes returning to sport after ACLR [18]. Participants underwent single-leg hop tests, agility drills, and lower-limb strength examinations. All participants showed functional improvement over time, which reflected normal rehabilitation progress. However, brace use did not bear any additional advantage in motor tests. No differences of statistical significance were reported in strength generation, postural control, or agility.

Both studies are in line with the view that bracing does not positively impact neuromuscular parameters or dynamic knee function, which questions its utility in late-stage rehabilitation or return-to-sport phases.

Further insight into real-world clinical practice regarding postoperative bracing is presented in a 2019 survey [19]. A questionnaire was distributed to orthopedic surgeons specializing in ACL injuries in patients under 25 years of age. Respondents were asked about their preferences, treatment protocols, and reasoning for recommending functional braces after the surgery..

Analysis showed that approximately half of the surgeons routinely recommend bracing after ACLR. Importantly, the survey pointed out a significant lack of consensus on key aspects such as duration of use (ranging from a few weeks to a year), intended goals (mechanical stabilization, improved proprioception, psychological reassurance), and patient selection criteria (age, activity level, sport type).

This evident gap between clinical practice and scientific evidence led the authors to a clear conclusion: current bracing recommendations after ACLR often lack a strong evidence base and are instead driven by subjective beliefs, prior experience, and individual clinician preference. Moreover, the absence of standardized protocols and guidelines can result in unnecessary costs, prolonged rehabilitation, and a false sense of security for patients.

The need for well-designed clinical trials to establish clear indications, optimal duration, and actual therapeutic value of functional bracing was emphasized in the study [19]. This work shows a lack of connection between everyday clinical practice and the current scientific knowledge, which may hinder the optimization of care for patients after the ACL reconstruction.

4. Potential Effectiveness of Functional Bracing in Selected Cases **Biomechanical Effects of Bracing – Partial Graft Protection**

In contrast to the studies previously discussed in this review, several scientific articles point to potential benefits of using bracing postoperatively - especially concerning biomechanical protection of the ACL graft. In a 2000 study, functional knee bracing was found to significantly reduce forces acting on the reconstructed anterior cruciate ligament (ACL) [3]. Using precise measurement methods, such as strain gauges installed directly on the ACL graft, the researchers analyzed the impact of bracing on knee loads during both weight-bearing and non-weight-bearing conditions, reflecting daily activities. Their results demonstrated that the brace effectively reduced anterior-posterior shear forces, which are considered particularly detrimental for graft integrity. According to the authors, this stabilizing effect may play a key role in protecting the newly reconstructed ligament, especially in the initial stages of healing and rehabilitation, during which joint structures are most vulnerable to overload.

Similar findings were reported in a 1998 study assessing gait biomechanics in patients after ACL reconstruction, which showed that bracing reduced the knee extension moment [2]. This means that the brace limited the extensor forces acting on the knee- particularly during the heel-strike phase of walking - thus lowering the load on the ACL graft. Such modifications to gait mechanics may represent an important mechanism for protecting the graft during early rehabilitation, promoting safe healing and joint stabilization.

Likewise, a 2018 study employing advanced 3D fluoroscopy showed that bracing effectively limited internal tibial rotation in ACL-deficient knees, especially in mid-flexion angles during lunge exercises [20]. This may be a potential mechanism for improving dynamic knee stability.

A 2021 literature review emphasized that although clinical data are inconclusive, the biomechanical benefits of braces may be especially relevant for athletes engaged in rotational sports (e.g., skiing), where the risk of graft overload is greater [21]. Moreover, a 2020 study assessing a novel spring-assisted brace showed

that patients using it after ACL reconstruction had improved gait patterns and higher levels of muscular activation compared to those using a standard brace or no bracing [22].

A 2017 study employed an advanced methodology which combined biomechanical measurements, computer simulations, and in vitro testing on human cadaveric specimens to assess the effect of a dynamic tensioning system (DTS) ACL brace [23]. The study evaluated knee loads during various physical activities including walking, double-leg squats (DLS), and single-leg squats (SLS). Results showed that the DTS brace effectively reduced peak loads on the ACL graft (by 22–24%) and the meniscus (up to 74%), regardless of whether the knee was intact, reconstructed, or injured. The most significant reductions were recorded during squatting, which mimics the mechanical stress experienced in functional rehabilitation. The authors suggest that such braces may offer not only graft protection but also prevent secondary meniscal injuries in ACL-deficient knees.

Influence on Proprioception, Balance, and Neuromuscular Function

Accurate perception and processing of information regarding joint position, as well as efficient postural control and muscle activation, plays a key role in ACL rehabilitation. Literature suggests that bracing may support such mechanisms, especially in the initial postoperative period when joint stabilization and regaining of motor control are crucial. While the scientific data remain inconclusive, some authors propose potential mechanisms through which external stabilization may support the functional aspects of recovery.

Evidence points that brace use may improve both static and dynamic balance as well. A 2016 study showed that patients undergoing ACL rehabilitation demonstrated significantly better postural control, which was attributed to enhanced mechanical stabilization and sensory-motor support [5]. Similarly, a 2019 study reported that athletes in the initial stages of recovery demonstrated improved limb strength symmetry and more balanced jump distances in functional tests when using braces. Such effects may be crucial in reducing the risk of reinjury during return-to-sport phases [4].

A 2015 literature review noted that although most studies were limited in sample size and methodology, some findings supported a beneficial impact of bracing on proprioception following ACL reconstruction [24]. Brace use might enhance a patient's ability to precisely detect knee position in space, which is especially useful during the early rehabilitation stages, when joint position sense is impaired by pain, swelling, and muscle inhibition. Similar conclusions can be found in a 2018 systematic review of 14 studies, which highlighted improved neuromuscular control among brace users in some trials [25]. While this improvement did not always translate into better functional scores or muscle strength, it was associated with increased activation of stabilizing muscles, suggesting a potential reinjury prevention mechanism.

Further empirical support comes from a 2016 study that assessed the performance of the dynamic ACL-Jack brace in patients with acute ACL injuries [26]. The use of this brace significantly reduced anterior knee instability, which was measured both clinically and through imaging. In some cases, achieved functional results were comparable to those observed after surgical ligament reconstruction. This implies that properly designed braces could not only aid biomechanical function but also partially compensate for deficits in functional stabilization.

Further perspective is offered by a 2022 study which investigated the use of resistance bracing as part of a strength training protocol following ACLR [27]. Patients exercising with the added resistance provided by the brace experienced significantly greater quadriceps strength gains. Moreover, bracing was shown to support limb control and stability during dynamic tasks. Such support may be especially important in the final phase of rehabilitation, where neuromuscular control and functional strength are essential for a safe return to sport and prevent from reinjury.

A comprehensive 2013 review analyzed both biomechanical and clinical data concerning the use of functional knee braces after ACL injury and reconstruction [28]. Even though presented findings were mixed, the review concluded that bracing may enhance knee stability and proprioception - particularly under low-load conditions such as daily activities. The authors cited studies that demonstrated decreased anterior tibial translation and improved muscle activity patterns (e.g., increased hamstring activation and decreased quadriceps activation during heel strike). Moreover, a study on elite skiers showed that brace users had a significantly lower risk of secondary knee injuries - up to 2.7 times less than those who did not use a brace. It was suggested that high-risk populations (e.g., women or athletes in pivoting sports) could especially benefit from bracing, even though objective outcomes from randomized trials were limited.

Prevention of Secondary Injuries (Re-ACL)

Among the most compelling arguments for the use of functional braces is the potential to prevent secondary ACL injuries. A 2006 study analyzing data from skiers post-ACLR pointed out that individuals who used functional knee braces had a significantly lower risk of re-injury compared to those without bracing [29].

Even more convincing findings were presented in a 2019 retrospective study involving 219 young patients [30]. It was demonstrated that wearing a brace for 12 months following ACL reconstruction was associated with a significantly reduced risk of graft rerupture, especially in the pediatric population. Despite lacking the randomization, the study employed a large sample size and a substantial average follow-up period of 5.6 years.

Further support for this view is presented in a 2021 systematic review assessing the efficacy of functional knee bracing in preventing secondary ACL injuries, particularly among adolescent populations [31]. While no conclusive evidence of reduced re-injury risk was found in the general patient population, a potential benefit was identified in the pediatric group, especially among those aged 17 years or younger. These conclusions were primarily based on retrospective analyses and a limited number of prospective studies. The authors highlighted the need for further high-quality research.

A recent review by Geeslin et al. (2024) offers an additional perspective. The study examined current clinical practices and opinions of experts concerning the use of functional braces after ACLR. This narrative review, rather than a systematic one, focused on consensus statements and clinical observations from sports medicine and clinical orthopedic practice.

The authors emphasized that, in the absence of strong clinical trial evidence, many orthopedic sports specialists continue to recommend bracing in high-risk populations, including adolescents, female athletes, and sport professionals. Bracing was considered particularly relevant in sports involving complex biomechanical demands such as alpine skiing, soccer, and basketball.

Although a 2024 analysis did not present new empirical data, it emphasized a gap between scientific evidence and clinical application [32]. The decision to prescribe braces was found to usually arise from pragmatic considerations - such as individualized risk assessment, clinical intuition, and physician's experience - rather than strictly from randomized trial outcomes. This may partly explain the sustained clinical popularity of functional bracing, in absence of definitive scientific consensus.

Conclusions

Based on the currently available scientific evidence, the routine use of functional knee braces following anterior cruciate ligament reconstruction (ACLR) is not clearly justified. Most high-quality clinical trials, including randomized controlled trials and systematic reviews, demonstrate no significant differences between braced and non-braced patients in terms of joint stability, range of motion, muscle strength, knee function, or time to return to physical activity. Nonetheless, in specific cases - particularly among adolescents, athletes participating in rotational sports, and individuals with neuromuscular deficits or subjective feelings of instability - brace use may provide important benefits. Some biomechanical studies suggest that braces can reduce shear forces on the ACL graft, limit tibial rotation, and enhance proprioception and movement symmetry, especially in the initial stages of rehabilitation during which the graft is most vulnerable. Additionally, for these high-risk patients, braces may serve as psychological assurance by enhancing perceived safety and movement confidence, which in turn could encourage greater engagement in physical therapy. Furthermore, certain studies show that using braces in high-risk populations, especially during the 6–12 months post-operation, may reduce the incidence of secondary ACL injuries.

However, there remain significant research gaps that hinder the erection of definitive recommendations. There is a lack of long-term, methodologically uniform clinical trials involving diverse patient groups with variables such as age, sex, physical activity level, and type of sport. The impact of modern brace designs, including dynamic models, on clinical and biomechanical outcomes is also poorly reviewed. Current literature rarely evaluates brace use in relation to specific rehabilitation phases, which limits the practical application of findings in daily patient care.

Future research should focus on high-risk populations, such as adolescents, females, athletes partaking in rotational sports, and individuals with impaired neuromuscular control. Simultaneously, it is essential to conduct studies involving low-risk patients to identify groups that may truly benefit from bracing. These studies should be prospective in design, with well-defined comparison groups and long follow-up periods. Evaluation should not only focus on short-term effects but also describe the brace's role in reducing reinjury rates, improving quality of life, and ensuring safe return to full physical activity.

Special attention should be given to the final phase of rehabilitation, which is crucial for a safe return to physical activity and sport. During this phase, it is important to assess whether functional braces can offer support - not only by reducing biomechanical loads on the graft but also by providing psychological reinforcement that may aid patients in regaining trust in the operated limb. It is also vital to include subjective patient-reported factors such as confidence, psychological comfort, fear of reinjury, and overall satisfaction with the treatment process. Integration of these with objective functional indicators could provide valuable insights into the therapeutic value of bracing during rehabilitation. Such an approach would enable the development of more personalized, evidence-based clinical guidelines tailored to the needs of patients returning to activity following ACL reconstruction.

In summary, the current body of knowledge does not support functional bracing as a standard technique of post-ACLR management for all patients. The decision to use a brace should be individualized, taking into account factors such as age, activity level, sport type, rehabilitation course, and the presence of subjective instability. Braces may offer supplementary support, particularly in the final stages of rehabilitation and during return to sport, but they should not replace a comprehensive rehabilitation program. In clinical practice, brace use should be deliberate, time-limited, and clearly justified. Patients should be informed that a brace does not eliminate the risk of reinjury, but in selected cases, it may enhance safety and efficacy during rehabilitation.

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