

Efficacy of Orthotic Treatment in Knee Osteoarthritis: A Review from 2000 to 2020

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ABSTRACT

Background: The knee is the most frequently impacted weight-bearing joint by osteoarthritis. There are various operative and non-operative treatment options available for knee osteoarthritis out of which direct and indirect management by the orthosis is most commonly used for the person having osteoarthritis on the either side of the tibiofemoral compartment (medial or lateral). The aim of direct and indirect management is to minimize the articular contact stress in the most involved tibiofemoral compartment.

Objective: This literature review aims to review the efficacy of orthotic treatment in knee Osteoarthritis.

Study Design: Literature Review

Significance: This review was done to investigate the use and efficacy of orthotic management in Arthritic knee patients as wedged insoles and realigning knee braces is to reduce articular contact stress in the more involved tibiofemoral compartment.

Method: An electronic database search was conducted using Google scholar, Science direct, Pub Med, Cochrane Library and reference lists from all retrieved articles.

Result & Discussion: Bracing at the knee and foot is a reasonable option for patients who can tolerate wearing the device and who aim to reduce pain and swelling or to delay knee surgery. The use of lateral wedge insoles of between 5° and 15° inclination reduced peak knee adduction moments by between 4% and 14% during walking compared with the corresponding values either without insoles or wearing even thickness control insoles.

Conclusion: This review summarizes the present state of understanding the extent to which direct and indirect orthotic management can improve malalignment, knee joint pain and physical function in knee osteoarthritis, and also offers clinical suggestions for prescribing orthosis in order to optimize efficacy.

Keywords: Osteoarthritis, Orthotic management, Foot insoles, Sole wedges, Knee brace, Efficacy

INTRODUCTION

Osteoarthritis is a degenerative disease occurring in older adults. Osteoarthritis affects 33.6 percent of the persons older than 65 years of age. This is characterized by articular cartilage degradation, and bone hypertrophy in the margins (i.e. osteophytes). The overall effect of these changes is to alter the distribution of the loads over the articular surface. The most

common symptom in individuals with knee osteoarthritis is pain that is worse with use and better with rest, other symptoms include crepitus, swelling and limping. In advanced cases, patients may present with instability symptoms or genu valgum or genu varum. Varum deformity is more common than the valgum deformity because the medial compartment of the knee is most commonly involved and also during mid-stance phase

of the gait, approximately 70-80% of the joint load passes through medial knee compartment.^{1,2}

Adverse loading of the articular surface plays a very important role in the development of the OA, which can occur because of abnormal biomechanics acting on the normal cartilage and bone or because of normal biomechanics acting on the abnormal cartilage and bone. There are many non-operative treatments available for knee osteoarthritis which includes physical therapy, exercise, knee orthosis and sole wedges. Therefore, this review is confined to the use of the orthosis in the management of knee osteoarthritis either direct by knee orthosis or indirect by sole wedges, which will be useful in improving orthotic clinical prescription for knee osteoarthritis.^{3,4}

Malalignment of the lower limb mechanical axis contributes to shrinking of the joint space, reduction of cartilage and decrease knee malalignment in people with or at danger of OA to decrease contact stress, pain and functional constraints and potentially slow the development of the disease. The main role of the orthosis is to keep joint balance, stabilize the joint, decrease the stress of articular contact, and decrease negative muscle contraction. It also enhances particular sensorimotor function in knee OA patients. Therefore, this review will be confined to use of dynamic bracing of the knee and foot, which allows joint movement.^{5,6}

METHOD

A computerized search was conducted in Google Scholar, Science Direct, PubMed and Cochrane Database. The search queries used were – ‘OA AND Orthotic management’, ‘OA AND indirect orthotic management’, ‘OA AND foot insoles AND efficacy’, ‘OA AND direct management’, ‘OA AND Knee braces AND efficacy’, ‘OA AND different sole wedges height’, ‘OA AND Unloader Knee braces’, ‘OA AND Knee Sleeves’, ‘OA AND Footwear designs’.

RESULT

Total 19 articles were taken and reviewed. Of which 10 were studied for indirect orthotic management in which different foot insoles were used as lateral sole wedge, medial sole wedge, Wedged insole with subtalar straps and 5 ° lateral sole wedges and 9 were studied for direct orthotic management in which different knee braces were used as knee sleeve, valgus knee brace, unloader knee brace, custom generation brace and distraction rotation knee brace. The descriptions of the papers reviewed are listed in the table provided 1 and 2.

ORTHOTIC TREATMENT FOR KNEE OA

INDIRECT MANAGEMENT (SOLE WEDGES)

Lateral sole wedges are commonly prescribed because of the frequent prevalence of the medial knee osteoarthritis; the goal of this is to increase foot pronation and to shorten the moment arm between the ground reaction force and the knee joint centre, and thereby reducing load at medial knee compartment. Several studies reported the reduction the external knee adduction moment in healthy adults and in patients with mild to moderate knee osteoarthritis immediately or after 1-3 months of use.^{7,8}

Properties of laterally wedged sole such as material (e.g. Rubber, cork, foam), length, tilt angle and the addition of strapping can have both the beneficial as well as adverse effects.^{9,10}

There are evidences that laterally wedged insoles may reduce the relative load on the medial knee compartment and symptoms in at least some patients with mild or moderate medial compartment knee OA, However more evidences are needed to guide clinicians regarding the specifications of the laterally wedged insoles.¹¹

BIOMECHANICS

Lateral wedge insoles (that is, a wedge inclined on the outside of the foot) were proposed as an intervention technique

to minimize the moment of knee adduction when walking and to alleviate the development of medial knee OA. A lateral shift in the center of pressure, which has the effect of reducing the moment arm of the ground reaction force around the knee in the frontal plane, is the predominant mechanism responsible for the decrease in the moment of adduction observed with lateral wedge insoles. This lateral change in the middle of the pressure also raises the moment of ankle

eversion, likely by up to 93%. Adding a medial arch support to lateral wedge insoles helps to normalize step distance. Moreover, caution should be emphasized, as the use of a medial arch support alone (as often recommended by health professionals) potentially enhances the moment of knee adduction significantly and may therefore intensify knee OA. The decrease in moment of knee adduction observed using lateral wedge insoles¹²

Table 1 Details of the reviewed articles

Author	Title	Type of Foot Orthoses	Study design	Result
Joaquin A. Barrios, Robert J. Butler, Jeremy R. Crenshaw et al. (2013)	Mechanical Effectiveness of Lateral Foot Wedging in Medial Knee Osteoarthritis after 1 Year of Wear	Lateral wedge insole	Case Control study	Lateral wedging aid in maintaining baseline frontal plane knee mechanics over a 12-month time period in patients with medial knee OA as compared to neutral devices. ¹³
Kim L Bennell, Kelly-Ann Bowles, Craig Payne et al. (2011)	Lateral wedge insoles for medial knee osteoarthritis: 12 month randomised controlled trial	Lateral wedge insole	RCT	Despite the strong biomechanical advantages of wedge insoles in reducing medial knee pressure, more work is required over a longer time frame to determine unequivocally the effects of lateral wedge insoles on joint structure. ¹⁴
Rana S Hinman, Kelly Ann Bowles, Kim L Bennell (2009)	Laterally wedged insoles in knee osteoarthritis: do biomechanical effects decline after one month of wear?	Lateral wedge insoles	Prospective cohort	A significant impact for disability, whereby insoles greatly decreased the moment of adduction. ¹⁵
Joaquin A. Barrios a, Jeremy R. Crenshaw b, Todd D. Royer et al (2009)	Walking shoes and laterally wedged orthoses in the clinical management of medial tibiofemoral osteoarthritis: A one-year prospective controlled trial	Lateral Wedge Insole	RCT	The findings indicate that both neutral and laterally wedged orthoses can be helpful in the management of osteoarthritis in the medial knee when used with walking shoes. Late changes were nevertheless correlated with the introduction of lateral wedging. ¹⁶
Priscilla T. Rodrigues, Ana F. Ferreira, Rosa M. R. Pereira (2008)	Effectiveness of Medial-Wedge Insole Treatment for Valgus Knee Osteoarthritis	Medial wedge insole	RCT	The use of medial-wedge insoles was highly effective in reducing pain at rest and on movement and promoted a functional improvement of valgus knee OA. ¹⁷
Rana S. hinman, craig Payne, Ben r. Metcalf et al. (2008)	Lateral Wedges in Knee Osteoarthritis: What Are Their Immediate Clinical and Biomechanical Effects and Can These Predict a Three-Month Clinical Outcome?	Lateral wedge insole	Cohort	Laterally wedged insoles immediately reduced the knee adduction moment and walking pain in a large group of patients with medial knee OA, but had no effect on static alignment. ¹⁸
Kristin Baker, Joyce Goggins, Hui Xie et al. (2007)	A Randomized Crossover Trial of a Wedged Insole for Treatment of Knee Osteoarthritis	5° lateral wedge insole	Crossover Trial	The effect of treatment with a lateral wedged shoe insoles were not efficacious in patients with medial knee OA. ¹⁹
Yoshitaka Toda, Noriko Tsukimura, Akiko Kato et al. (2004)	The Effects of Different Elevations of Laterally Wedged Insoles With Subtalar Strapping on Medial Compartment Osteoarthritis of the Knee	Wedged insole with subtalar straps	RCT	The degree of change in the femorotibial angle with the subtalar strapping insole was influenced by the lateral wedge tilt. The 8- or 12-mm elevation wedged insoles with subtalar strap can be more comfortable and efficient for constant routine use than the 16-mm elevation wedge ²⁰
Yoshitaka Toda, Neil Segal, Akiko Kato Et Al. (2002)	Correlation Between Body Composition and Efficacy of Lateral Wedged Insoles for Medial Compartment Osteoarthritis of the Knee.	Lateral-wedged insoles	Case Control study	The data show that the nsole with subtalar strapping is more useful for younger patients and those with higher L-LBM per body weight, and less effective for older sarcopenia patients ²¹
D. Casey Kerrigan, Jennifer L. Lelas, Joyce Goggins et al. (2002)	Effectiveness of a Lateral-Wedge Insole on Knee Varus Torque in Patients With Knee Osteoarthritis	Lateral-wedged insoles (5° and 10°)	Crossover	Both wedge insoles reduce the varus torque during walking. Although the effect of the 5° wedge was smaller, it may be more comfortable than the 10° wedge to wear inside one's own shoes. ⁹

DIRECT MANAGEMENT FLEXIBLE KNEE BRACES

Knee sleeves provide warmth and mild compression, are made of cotton elastic or neoprene, nylon or other synthetic fibres, so that even patients with allergies can find a knee sleeve that is tolerable. Some sleeves have a patellar cutout, an open popliteal fossa, patellar reinforcement with C or J shaped cushions with or without straps. While there is no significant impact on joint alignment or stabilization knee pads have shown efficacy in enhancing OA symptoms. Knee sleeves may be most helpful in treating early knee OA. However, the mechanism of action of knee sleeves remains incompletely understood.^{20,22,23}

CORRECTIVE BRACING: RIGID KNEE BRACES

There is evidence that corrective braces are more effective than knee sleeves when treating knee OA that is moderate or severe but does not involve both the medial and lateral compartments. Corrective braces works on three point pressure system to correct the malalignment. Sagittal plane braces have been altered for individuals with knee OA by angling the hinge in the frontal plane to generate a valgus or varus pressure, with the aim of decreasing pressures. Braces with adjustable patellar sleeve can be useful in alleviating the signs of tibiofemoral and patellofemoral OA by decreasing the load in the more affected compartment, improving proprioception.

The degree of correction can be adjusted by single or double upright hinges, dynamic force straps or femoral condyle pad adjustments. Some knee braces have buckles to enable suspension of the brace on limbs that enable patients with reduced grip strength to adjust the straps.

Other braces have extension stop to prevent painful full extension also the gel pads can dissipate load over a larger area to improve comfort over the femoral condyles. More recent designs are made up of lightweight materials. A single upright brace is not effective in stabilization of the knee joint. These advances have improved tolerance and compliance in comparison with prior brace designs and should be considered in the orthotic prescription²⁴

BIOMECHANICAL PERSPECTIVE OF KNEE BRACING

There are several studies which focus on the effects of bracing in knee OA in terms of pain, pathomechanics and mobility limitations. The cardinal signs of OA are joint space narrowing and progression with the loading, some studies have proved that adjustment of the hinge in the frontal plane has a greater effect on the load in the medial knee compartment than the strap adjustments but both are necessary for the optimal efficacy of the brace. Several studies suggested that there is reduction in the external knee moment of more than 10% with the valgus knee brace^{25,26}

Table 2 Details of the reviewed articles

Author	Title	Type of Knee Brace	Study design	Result
R.F. Moyer y, T.B. Birmingham y, D.M. Bryant et al. (2014)	Biomechanical effects of valgus knee bracing: a systematic review and meta-analysis	Valgus Knee brace	Systematic Review	Valgus knee braces can alter knee joint loads by combining mechanisms with moderate to high effect sizes in biomechanical outcomes. ²⁷
Davy Laroche, Claire Morisset, Clementine Fortunet et al. (2014)	Biomechanical effectiveness of a distraction-rotation knee brace in medial knee osteoarthritis: Preliminary results	Distraction Rotation knee brace	Prospective Interventional	Knee brace with distraction-rotation effects dramatically affects moments of knee adduction and angles of foot movement during gait, which may lead to substantial changes in functional gait and short-term effects on pain in patients with osteoarthritis.. ²⁸
Emily Squyer, Daniel L. Stamper, Deven T. Hamilton et al.(2013)	Unloader Knee Braces for Osteoarthritis: Do Patients Actually Wear Them?	Unloader Knee Brace	Retrospective	Unloader braces are a potential non-surgical solution to predominantly single-compartment knee arthritis. ²⁹
Flavio Fernandes Bryk, Julio Fernandes de Jesu et al.	Immediate effect of the elastic knee sleeve use on individuals with osteoarthritis	Elastic Knee Sleeve		The elastic knee sleeve proved to be effective to immediately improve the functional capacity and pain of individuals with OA. It is an adjuvant resource for treating OA as it is practical, useful,

(2011)			RCT	and of easy clinical use, and can aid in the practice of therapeutic exercises. ³⁰
Shih-Hung Chuang, Mao-Hsiung Huang, Tien-Wen Chen et al. (2007)	Effect of Knee Sleeve on static and dynamic balance in patients with knee Osteoarthritis	Knee Sleeve	Cross sectional	In both static and dynamic conditions, OA patients wearing knee sleeves may experience increased ability to balance. The improvement might prevent knee OA patients from falling down and increase their sense of security during physical activities. ³¹
Dan K Ramsey, Kristin Briem, Michael J Axe et al. (2007)	A Mechanical Hypothesis For The Effectiveness Of Knee Bracing For Medial Compartment Knee Osteoarthritis	Custom Generation II Unloader Brace	Crossover	Neutral alignment worked as well or better than alignment with valgus, minimizing excursions to pain, injury, muscle co-contraction and knee adduction. Pain relief may result from diminished muscle co-contractions rather than so called medial compartment unloading. ³²
Louis Draganich, Bruce Reider, Todd Rilmington et al. (2006)	The Effectiveness of Self-Adjustable Custom and Off-the-Shelf Bracing in the Treatment of Varus Gonarthrosis	Self-adjustable custom and off-the-shelf Brace	Crossover	Patients with knee varus gonarthrosis may benefit greatly from pain relief and decreased stiffness from the use of either brace. ³³
J. D. Richards, J. Sanchez-Ballester, R. K. Jones et al. (2005)	A comparison of knee braces during walking for the treatment of osteoarthritis of the medial compartment of the knee	Valgus brace and Hinged Brace	Crossover	The valgus brace showed substantial improvements in pain, work, and loading and propulsive forces. ³⁴
Nicholas J. Giori (2004)	Load-shifting brace treatment for osteoarthritis of the knee: A minimum 2.5year follow-up study	Load-shifting brace	Retrospective cohort	Load-shifting brace use had a survival rate of 76% at 1 year, 69% at 2 years, and 61% at 3 years.. ³⁵

DISCUSSION

Bracing at the knee and foot is a reasonable option for patients who can tolerate wearing the device and who aim to reduce pain and swelling or to delay knee surgery. During high-impact activities, patients with moderate OA will only require a brace, whereas those with more severe knee OA will need to wear a brace for all weight-bearing activities. Each wedged insole and knee brace has unique properties that influence both efficacy and tolerance by subgroups of patients. Providers should be aware of features that will enhance patient clinical outcomes and compliance.³⁶

TREATMENT RECOMMENDATION

OA is a chronic disease and primary cause of disability in the older adults and knee is the most commonly affected joint. Orthosis is likely to be underused because of the lack of knowledge or poor compliance of patients. Knee sleeves are a simple and inexpensive orthotic intervention that may effectively reduce knee pain and also it is simple and easy to use but it is ineffective in enhancing joint stability and realigning knee joint which is effectively reduced by corrective knee bracing, considering the fact that it is expensive, less

comfortable as compared to flexible knee sleeves. Contraindications for bracing includes contracture which is more than 10⁰, peripheral vascular disease or dermatitis. Patients who spend majority of time sitting and standing can be benefitted by the lateral sole wedges but again that to in the case of early stages of OA. Direct and indirect orthotic management in the OA is for those patients who can tolerate wearing device better and aim to reduce pain, swelling or delay in surgery. Patient with mild OA may only require bracing during high impact activities and patients with moderate to severe OA should wear brace in all the weight bearing activities.³⁵

CONCLUSION

Conservative management of knee braces and foot orthoses may have a beneficial effect on the costs of health care and on the economic efficiency of the people affected. Laterally wedged insole should be worn by the patient in the early stages of OA and it should be full length with 6-8 degrees of tilt angle for its effectiveness and acceptance, whereas knee bracing should be worn by the patients with moderate to severe OA and should be worn

by the patients in all the weight bearing activities. Treatment with knee braces and foot orthoses has insignificant adverse effects, and this common chronic disease will reduce morbidity.

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