

# Clinico-Radiological Study of Polycentric Knee Brace in Osteoarthritis of Knee

Ram K Shah,  
Mahesh P Shrivastava and  
Vijayendra Adhikari

Department of Orthopaedic Surgery,  
Nepal Medical College Teaching Hospital,  
Kathmandu, Nepal

## Abstract

**Introduction:** Osteoarthritis (OA) of knee causes considerable pain and disability. It has been observed that symptomatic pain relief and cartilage regeneration are possible in OA joints that have been pulled apart or distracted for prolonged periods of time. The knee brace is used to modify joint loading during rest and activities.

**Material and methods:** The study included total of 310 patients, at Nepal Medical College Teaching Hospital, Kathmandu, Nepal from September 2009 to August 2012, with osteoarthritis of the knee of different grades (II, III and IV). The patients were followed up at 6 weeks, 3 months, 6 months and 1 year after the use of polycentric knee brace. The clinical and radiological findings were recorded, tabulated and analysed by WOMAC scoring for symptomatic improvement and deformity correction.

**Results:** After one year 263 (84.83%) patients were still using the brace but 37 (15.17%) patients had discontinued the use of brace after some months. There was 54% improvement in WOMAC score. It showed symptomatic relief of pain, stiffness and improved physical function in grade II and III whereas prevented further radiological deterioration in all grades of osteoarthritis knees.

**Conclusion:** The polycentric knee brace can be a cost effective alternative to the treatment of osteoarthritis of the knees. The treatment with a knee brace can provide significant improvement in pain, stiffness and increased physical activity levels and no radiological deterioration in early stages. But the knee bracing should not be used alone, but in addition to other therapeutic modalities for better results.

**Keywords:** Osteoarthritis; Disability; Cartilage; Knee brace; Polycentric knee; Therapeutic modalities; Connective tissue

**Corresponding author:** Ram K Shah

✉ rkshah786@gmail.com

Head of Department, Orthopaedic Surgery,  
Nepal Medical College Teaching Hospital,  
Kathmandu, Nepal.

**Tel:** +97714781557

**Citation:** Shah RK, Shrivastava MP, Adhikari V. Clinico-Radiological Study of Polycentric Knee Brace in Osteoarthritis of Knee. J Bone Rep Recommendations. 2016, 2:3.

**Received:** August 16, 2016; **Accepted:** September 07, 2016; **Published:** September 11, 2016

## Introduction

Osteoarthritis (OA) is one of most common forms of arthritis and is responsible for a huge burden of pain and disability [1]. Osteoarthritis is characterized by both degeneration of articular cartilage and simultaneous proliferation of new bone, cartilage and connective tissue [2]. It is the most prevalent form of arthritis and is the principal cause of disability in the elderly [3-6]. The area of local damage occurs in those parts of the joint subjected to maximal mechanical Stretch [7].

The OA of the knee is a common medical condition that is often seen in general practice and the second leading cause of disability,

in which 10% are males and 13% are females affected [8]. In Asia, prevalence rates of osteoarthritis knee were found to be high, approximately 6% of the population of 30 years or older and 12% of the population aged 65 years or older has osteoarthritis of knee [9,10].

Patients with osteoarthritis of knee usually present with major involvement in one compartment, with the medial compartment involved nearly 10 times more often than the lateral compartment may be due to medial compartment of a normal knee joint bears approximately 70% of body weight whereas the lateral and patella femoral compartment bears the remaining weight [11].

The patients with osteoarthritis of the medial compartment often have progressive loss of cartilage and joint space in this compartment, typically resulting in various alignments, which cause the mechanical axis/ground reaction force vector to pass more medially to the knee joint centre during gait. This result in increased loads across the medial compartment [12]. Whereas in the lateral compartment generally have a valgus alignment and the mechanical axis and load bearing passes through the lateral compartment. Misalignment increases risk and progression of osteoarthritis of knee and results in decline in physical function [13].

The radiological classification of knee osteoarthritis, according to Kellgren-Lawrence Grading System [14], is based on x-rays and consists of normal, Grade I, Grade II, Grade III and Grade IV. Grade I is unlikely narrowing of the joint space, possible osteophytes, Grade II is Small osteophytes, possible narrowing of the joint, Grade III is Multiple moderately sized osteophytes, definite joint space narrowing, some sclerotic areas, possible deformation of bone ends and Grade IV is Multiple large osteophytes, severe joint space narrowing, marked sclerosis and definite bony end deformity [14].

The osteoarthritis progressively affects the aging population in the world in about 10% people [15]. Presently, there are no pharmacological agents for the prevention or treatment of OA; the only medical option for OA involves pain management. In this context, cartilage tissue engineering has not held the high promises of therapy in OA [16] and the potential for cartilage regeneration through stem cell therapy has not yet fully materialized [17]. Accordingly, total joint replacement, though expensive, is considered a final option for relieving pain and regaining function in patients with OA [18].

The Articular cartilage is thought to have limited regeneration potential. However, it has been observed that symptomatic pain relief and cartilage regeneration are possible in OA joints that have been surgically pulled apart or distracted for prolonged periods of time [19]. This might have been a clue that cartilage regeneration is possible in OA joints. However, the mechanism by which cartilage growth might occur in the distracted joint space is not well known.

Mechanical factors are involved in the development and progression of osteoarthritis. If "loading" is a major cause in development and progression of osteoarthritis, then "unloading" may be able to prevent progression. There is evidence that unloading may be effective in reducing pain and slowing down structural damage. The unloading by bracing (nonsurgical), unloading by osteotomy (surgical) and unloading by joint distraction are the alternative methods of management of OA. Many reviews in these three fields have been published over the past few years. Recent studies argue for the usefulness of a biomechanical approach to improve function and possibly reduce disease progression in osteoarthritis [20,21].

A wide variety of other managements are available such as weight reduction, hydrotherapy, footwear and walking aids, other rehabilitation measures, physical therapy, systemic drug therapy, intra-articular drug therapy and surgery [22-

28]. In addition to the consequences for the patient, it forms a considerable burden for society because of its chronic course and the high costs of interventions, especially in the context of socioeconomic status of our country. Therefore, the current managements for osteoarthritis of knee are targeted to alleviate pain by attempting to correct mechanical misalignment of the knee joint [29].

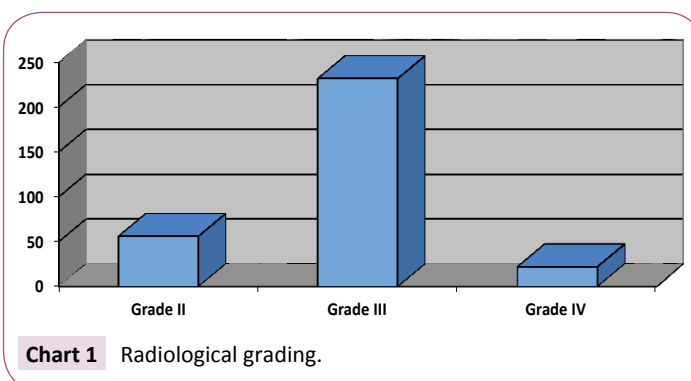
The general purpose of knee braces in osteoarthritis of knee is to decrease pain, improve physical function and possibly slow disease progression [30].

We report on a clinical trial of osteoarthritis of the knee treated with polycentric knee brace, by analysing the pain, stiffness, physical activity through WOMAC (Western Ontario McMaster universities Osteoarthritis Index) and radiological evaluation of the joints after 1 year use of polycentric knee hinged brace to patients with varying grades osteoarthritis of the knee in our setup.

## Materials and Methods

It is a prospective study which was conducted in Nepal Medical College, Kathmandu, Nepal from September 2009 to August 2012. The study included total of 310 patients, 83 (26.77%) male and 227 (73.22%) female, who did not get satisfactory results with conservative treatments and having grade II, III and IV radiological changes in knees. Those patients who had fixed flexion and various deformity more than 10 degree, having significant hip, back or contralateral leg symptoms and physical or mentally inability to comply with the requirements of wearing braces were excluded from the study. Among 310 patients, 56 (18.07%) had grade II, 232 (74.84%) grade III and 22 (7.09%) grade IV osteoarthritis of knees which were diagnosed clinically and radio logically (**Chart 1**).

All the patients were initially examined by expert orthopaedic surgeons in outpatient department including the assessment of range of motion and wasting of quadriceps muscle. They were advised for AP (standing view) and lateral views to evaluate the radiological grading of the osteoarthritis changes in the respective knees. Once they were diagnosed, they were given the treatment options with their benefits and disadvantages. After evaluating the nature of the work, living standard of the patient, all the patients were thoroughly counselled regarding the proper application of the brace, duration of use of the brace, its mode of action,



benefits of regular knee exercises. Then the patients were sent to Sir John Wilson Prosthetic & Orthotic centre for manufacturing tailor-made polycentric knee brace after the ethical approval. Once the patients were fully satisfied, the proper measurements were made for custom made polycentric knee brace regardless of the joint involvement. The patients were again asked to visit the centre where the patients were thoroughly taught how to apply the brace into their affected knees. They were also given a leaflet mentioning the steps of application of the brace with images. Immediately after the application of the brace, the patients were asked to use for average of 12 h per day and to go the physiotherapy department to learn the knee exercises to be done on regular basis and was supplemented with analgesics. The brace were used for average of 12 h per day and all the patients were instructed to go for regular physiotherapy. The polycentric knee brace is simple weight bearing device consisting of a mechanical joints over both sides of the knee with side bars attached to two plastic flaps (made of 4 mm Polypropylene) which in turn are provided with Velcro straps. The plastic flaps meant for the snugly fit into thigh and upper legs are made by moulding technique and cushioned inner side with 3 mm of Ethaflax. The thigh plastic flap is further moulded over the lower and medical part so that flap could snugly fit over the condyle to prevent slipping of the device while walking.

The technique of the polycentric knee brace is to transfer the weight from the anatomical knee joint to polycentric knee joint, to prevent further deformity and to decrease pain. The brace is to be worn externally from the ventral surface of the lower limb adjusting the mechanical knee joint exactly parallel to the anatomical knee joint and the Velcro straps are snugly tightened so that the brace does not become loose and slips out while walking This device is light in weight, cost effective and the manufacturing process is simple (Figure 1).

The patients were followed up at 6 weeks, 3 months, 6 months and 1 year, where the clinical findings were recorded, tabulated and analysed by WOMAC, there were 5 questions relevant to "pain", 2 "stiffness" and 17 "physical function" and point 0 represents lightest symptoms and point 4 the severest symptoms for each questionnaire. That means total score of the severest symptom for "pain" will be 20, for "stiffness" will be 8 and for "physical function" will be 68 and consequently "total" will be 96, score for each category and for "Total" will decline when the symptoms is improved. The radiological findings like deformity correction and change in joint space were also viewed during the subsequent follow up.

The mean age was 64.2 years (50-82) and weight was 70.85 kg (50-90). The joint involvement were 67 (21.66%) in left, 36 (11.61%) in right and 207 (66.77%) in B/L joints. 211 (68.06%) patients had various deformity and none of them had valgus deformity. The 37 (11.93%) patients had taken Injection Steroids prior to treatment, as their pain was not improved. so, polycentric knee brace was used. The polycentric knee brace was mainly given to osteoarthritis grade II (56) and III (232) (18.07% and 74.84%), and 22 (7.09%) had osteoarthritis grade IV as they were given the choice of arthroplasty but they refused to go for surgery due to financial crisis and lack of expertise, they were provided knee

brace as a trial. The clinical findings were recorded, tabulated and analysed by WOMAC score and the radiological findings like deformity correction and change in joint space were also viewed during the subsequent follow up.

## Results

When evaluated all the patients after one year, 263 (84.83%) patients were still using the brace and 47 (15.16%) had discontinued the use of brace after some months and lost in follow up. There was improvement of pain and physical function in 96.29% (n=52) in grade II, 85.34% (n=198) in grade III and 13.63% (n = 3) in grade IV of OA Knee. There was 54% improvement in the Womack score, which was  $78 \pm 13$  initially and later it decreases to  $26 \pm 9$  after the use of polycentric knee brace in a 1 year follow up (Table 1) probably due to decrease in compressive loads transmitted to the joint surfaces in the knee compartment (Figure 1).

It showed symptomatically relieved pain, stiffness and improved physical function in grade II and III osteoarthritis whereas prevented further radiological deterioration in all grades of osteoarthritis knees. Radio logically there was improved in few cases but it was almost identical in the radiographs taken before bracing ( $0.6 \pm 0.4$  mm; range 0.2–1.7 mm) and after the use of brace in a 1 year follow up ( $0.7 \pm 0.5$  mm; range 0.4-1 (Figure 2).

However some patients, 18.7% (n=58) complained of mild brace discomfort, loosening of the brace was seen in 26 patients and skin irritations (n=38) in initial stage of manufacturing the brace. There was damage of the teeth in 36 patients, which was repaired (Chart 2). The brace was continued after proper counselling and correcting the technical defect in the brace.

Table 1: WOMAC scoring of pre brace and subsequent follow up.

WOMAC	Pain ( 20 )	Stiffness (8)	Physical Function (68)	Total Score (96)
Pre Brace	$16 \pm 4$	$3 \pm 4$	$59 \pm 5$	$78 \pm 13$
6 weeks	$13 \pm 7$	$2 \pm 4$	$47 \pm 8$	$62 \pm 19$
3 months	$13 \pm 6$	$2 \pm 3$	$38 \pm 6$	$53 \pm 15$
6 months	$8 \pm 5$	$1 \pm 3$	$26 \pm 6$	$35 \pm 14$
1 year	$4 \pm 3$	$1 \pm 2$	$21 \pm 4$	$26 \pm 9$



Figure 1 Use of polycentric knee brace.

## Discussion

In our population, patients expect pain relief, improved function and activity level during the course of treatment. Apart from pain and physical activity it was also important to avoid future degeneration of the knee and able to maintain the activity of life. The polycentric knee braces decreased pain in the two to three weeks of time (average 2 weeks) following bracing and maintained improvement throughout the study. The clinical improvements of 54% in the WOMAC score reported in this study are consistent with previous studies that have examined the effects of knee braces on patients with Osteoarthritis (Chart 3).

Initially there were loosening of the braces, the teeth of joint used to get damaged in few months of time (average 4 months) and the patient used to complain itching while using the brace for a longer time especially in summer sessions. Gradually the technicians started making the moulded brace, higher quality of hinge joint could be imported and the patients were instructed to use the talcum powder, body lotion, coconut oil to overcome to itching problem.

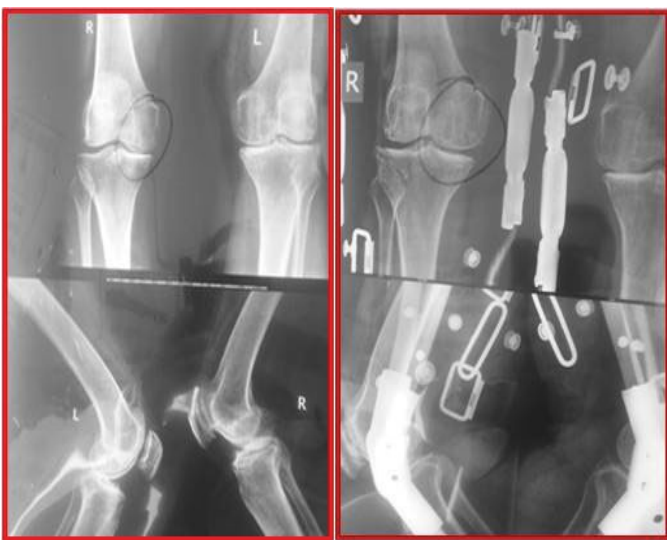
Our [22] patients were not getting relief of pain by taking varieties of pain killer tablets and by doing physical exercises and were having grade III radiological changes. Most of them were socioeconomically poor, not able to bear the higher cost of surgery. They preferred to go for using polycentric knee brace and regular physical exercises. They were followed after 3 months. X-rays were done in all the patients. Some radiological changes (widening of the joint space) were found in seven patients and no further radiological damage of the joint were found in rest of the cases, although there was symptomatically relief of pain and improved function. They continued using the brace and were asked whether they would prefer to for surgery at minimal cost by visiting overseas team. All of them refused to go for surgery and were happy to continue the use of brace for few more months.

Tiku and Sabaawy [17] reported that cartilage regeneration is possible in OA joints that has been surgically pulled apart or distracted for a prolonged period of time.

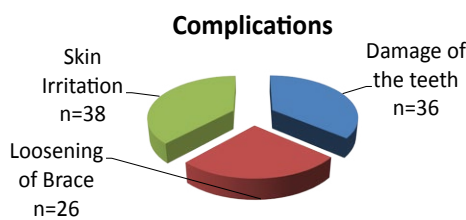
Koshima et al. also documented regeneration of articular cartilage after high tibial valgus osteotomy for medial compartmental osteoarthritis of the knee joint. Widening of the joint space in seven patients in our study might be due to cartilage regeneration by prolonged distraction of the joint by regular use of knee brace [29].

Polo et al. reported 33 % improvement in the WOMAC score [30]. Similarly, Kirklees et al. reported a 20–30 % improvement in the WOMAC score over 3–6 months of brace usage [31]. A recent review by Beaudreuil et al. [32] found 16 studies of unloading-knee braces. Unfortunately, these studies were of poor quality and the recommendation for using an unloading-knee brace was again based on the Kirklees study. However, the review found short-term and mid-term benefits for pain and disability with the effectiveness of unloading-knee braces higher than that with neoprene knee sleeves and a short-term improvement in quality of life. The studies have also shown unloaded braces to be effective in not only reducing symptoms but also in shifting the weight bearing load. Other studies have also reported statistically significant improvements in clinical outcome as a result of brace usage, using outcome measures such as the visual analogue pain score or Hospital for Special Surgery Score.

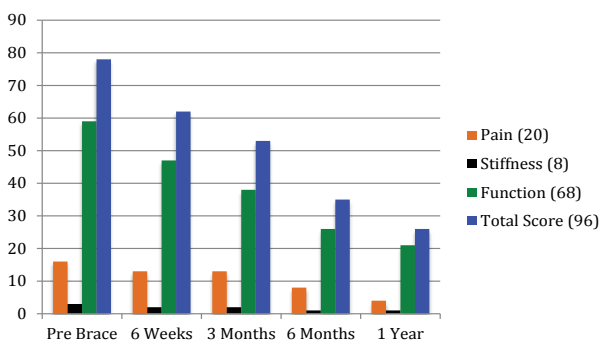
In early stage of osteoarthritis of the knee, involving either medial or lateral compartment, simple unloading - knee brace with mechanical hinge joint over the medial or lateral side of the joint is commonly used. But, in our study, we used moulded brace with mechanical hinge joints over the both side of the knees irrespective of the compartment involved which helped the patients with more comfort.



**Figure 2** Radio logically changes in joint space. a) Pre bracing; b) Bracing after 1 year.



**Chart 2** Complications after using brace.



**Chart 3** WOMAC score.

## Conclusion

The treatment of osteoarthritis of knee with a polycentric brace can provide significant improvement in pain, stiffness and increased physical activity levels and no radiological deterioration

with few complications. The polycentric knee brace can be a cost-effective alternative to the other treatments of osteoarthritis of the knees. However, the knee brace should not be used alone, but in addition to other therapeutic modalities.

## References

- 1 Dieppe P (1993) Management of osteoarthritis of hip and knee joints. *Curr Opin Rheumatol* 5: 487-493.
- 2 Doherty M, Lanyon P, Rolston SH (2006) Musculoskeletal disorders, Davidson's Principles and practice of medicine. In: Boon NA, Colledge NR, Walker BR (eds.) Edinburgh, Churchill Livingstone 20: 1065-1144.
- 3 Lawrence RC, Helmick CG, Arnett FC, Deyo RA, Felson DT, et al. (1998) Estimates of the prevalence of arthritis and selected musculoskeletal disorders in the United States. *Arthritis Rheum* 41: 778-799.
- 4 Towheed TE (1998) The impact of musculoskeletal disorders in Canada. *Ann Roy Coll Phys Surg Can* 31: 229-232.
- 5 Center for Disease Control (1994) Arthritis prevalence and activity limitations- United States. *MMWR* 43: 433-438.
- 6 Creamer P, Hochberg MC (1997) Osteoarthritis. *Lancet* 350: 503-509.
- 7 Chard J, Dieppe P (2001) The case for non-pharmacologic therapy of osteoarthritis. *Curr Rheumatol Rep* 3: 251-257.
- 8 Heidari B (2011) Knee osteoarthritis prevalence, risk factors, pathogenesis and features: part I. *Caspian J Intern Med* 2: 205-212.
- 9 Felson DT, Zhang Y (1998) An update on the epidemiology of knee and hip osteoarthritis with a view to prevention. *Arthritis Rheum* 41: 1343-1355.
- 10 Hinman RS, Bowles KA, Bennell KL (2009) Laterally wedged insoles in knee osteoarthritis: do biomechanical effects decline after one month of wear? *BMC Musculoskelet Disord* 10: 146.
- 11 Ahlback S (1968) Osteoarthritis of the knee: a radiographic investigation. *Acta Radiol* 277: 7-72.
- 12 Hinman RS, Payne C, Metcalf BR, 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? *Arthritis Rheum* 59: 408-415.
- 13 Sharma L, Song J, Felson DT, Shamiyeh E, Dunlop DD, et al. (2001) The role of knee alignment in disease progression and function in knee osteoarthritis. *JAMA* 11: 188-195.
- 14 Kellgren JH, Lawrence JS (1957) Radiological assessment of osteoarthritis. *Ann Rheum Dis* 6: 494-501.
- 15 Cooper C, Dennison E, Edward M (2013) Epidemiology of osteoarthritis. *Medicographia* 35: 145-151.
- 16 Huey D, Hu J, Athanasiou K (2012) Unlike bone, cartilage regeneration remains elusive. *Scienc* 338: 917-921.
- 17 Tiku ML, HE (2015) Cartilage regeneration for treatment of osteoarthritis: a paradigm for nonsurgical intervention. *Ther Adv Musculoskelet Dis* 7: 76-87.
- 18 Gossec L, Paternotte S, Maillefert A (2011) The role of pain and functional impairment in the decision to recommend total joint replacement in hip and knee osteoarthritis: an international cross-sectional study of 1909 patients. Report of the Oarsi-Omeract Task Force on Total Joint Replacement. *Osteoarthr Carti* 19: 147-154.
- 19 Lafeber F, Intema F, Van Roermund P, Peter M, Marijnissen, et al. (2006) Unloading joints to treat osteoarthritis, including joint distraction. *Curr Opin Rheumatol* 18: 519-525.
- 20 Callaghan M, Parkes M, Hutchinson C, Gait AD, Forsythe LM, et al. (2015) A randomised trial of a brace for patellofemoral osteoarthritis targeting knee pain and bone marrow lesions. *Ann Rheum Dis* 74: 1164-1170.
- 21 Altman RD, Lozada CJ (2004) Management of limb joint osteoarthritis. In: *Practical rheumatology* (3<sup>rd</sup> edn.) London, Mosby Publications pp: 511-19.
- 22 Altman RD, Lozada CJ (2004) Clinical features. In: *Practical rheumatology* (3<sup>rd</sup> ed.) London, Mosby Publications pp: 503-510.
- 23 Svarcova J, Trunavsky, Zvarov AJ (1988) The influence of ultrasound, galvanic currents and shortwave diathermy on pain intensity in patients with osteoarthritis. *Scand J Rheumatol* 67: 83-85.
- 24 Thomas KS, Muir KR, Doherty M, Jones AC, O'Reilly SC, et al. (2002) Home based exercise programme for knee pain and knee osteoarthritis: Randomised controlled trial. *BMJ* 325: 752.
- 25 Hurley MV (1998) Improvements in quadriceps sensorimotor function and disability of patients with knee osteoarthritis following a classically practicable exercise regime. *Br J Rheumatol* 37: 1181-1187.
- 26 Williams FMK, Spector TD (2006) Osteoarthritis. *Med Int* 34: 364-68.
- 27 Chuang SH, Huang MH, Chen TW, Weng MC, Liu CW, et al. (2007) Effect of knee sleeve on static and dynamic balance in patients with knee osteoarthritis. *Kaohsiung J Med Sci* 23: 405-11.
- 28 Brouwer RW, Jakma TSC, Verhagen AP, Verhaar JAN, Bierma-Zeinstra SMA (2005) Braces and orthoses for treating osteoarthritis of the knee. *Cochrane Database Syst Rev*.
- 29 Koshima T, wada S, Ara Y, Saito T (2003) Regeneration of degenerated articular cartilage after high tibial valgus osteotomy for medial compartmental osteoarthritis of the knee. *Knee* 10: 229-236.
- 30 Pollo FE (1998) Bracing and heel wedging for unicompartmental osteoarthritis of the knee. *Am J Knee Surg* 11: 47-50.
- 31 Kirkley A, Webster-Bogaert S, Litchfield R (1999) The effect of bracing on varus gonarthrosis. *J Bone Joint Surg* 81: 539-548.
- 32 Beaudreuil J, Bendaya S, Faucher M (2009) Clinical practice guidelines for rest orthosis, knee sleeves, and unloading knee braces in knee osteoarthritis. *Joint Bone Spine* 76: 629-636.