Review Article

KineSpring Knee Implant System: A New Insight into Treatment of Knee Osteoarthritis

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Abstract | Various methods of treatment have been used for patients suffering from knee osteoarthritis (OA). Among them total knee artroplasty is being practised frequently. This method is suitable especially for elderly subjects with limited degree of physical activity. However, most of young subjects are not recommended to be treated with this method owing to high level of physical activities. KineSpring knee implant system was designed for young subjects with knee OA to reduce knee pain, improve stability and knee function. The aim of this review article is to screen for the available information on knee implant system and to propose a suitable remedy for effective management of such ailments. Out of the available and applied implants, none of them was evaluated by motion analysis system. It has been shown that severity of pain and overall function of knee joint were improved following the use of this implant. Although it has been mentioned that KineSpring knee implant is an effective method to relieve pain and improve function in Knee OA, there are incomplete evidences to support this claim. Therefore, it is recommended to perform high-resolution clinical trials to evaluate the efficiency of this method.

Editor | Mohammad Taghi Karimi, Department of Orthotics and Prosthetics, Faculty of Rehabilitation, Isfahan University of Medical Sciences, Isfahan, Iran.
Received | October 15, 2015; **Revised** | December 22, 2015; **Accepted** | December 25, 2015; **Published** | February 16, 2016
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Citation | Mohammadi, A., M. H. Ebrahimi (2016). Kinespring knee implant system: A new insight into treatment of knee osteoarthritis. *Health Rehabil.* 1(1): 11-16.
Keywords | Knee OA, KineSpring knee implant

Introduction

Osteoarthritis is one of the most common joint disorders which influence the human joints especially hip, knee and ankle joints (Wilson, 1989). The prevalence of this disease varies between 19.2% and 27.8% depends on the age of population (Wilson, 1989). Based on WHO reports, osteoarthritis becomes the fourth leading cause of disability by 2020 (WHO, 2008). It has been shown that more than 13% of Americans aged 55-64 and more than 18% with 65-74 years have knee OA associated with pain and functional limitations (reduced knee and hip joint range of flexion, extension and reduced walking speed) (Wilson, 1989, Zhang and Jordan, 2010, Esrafilian et al., 2013). Altered ground reaction force (GRF) transmitted through knee, altered activity pattern of key lower extremity muscles in gait and altered mechanical alignment of knee joint are some problems associated with knee OA (Childs et al., 2004, Harrington, 1983, Roos and Lohmander, 2003).

Based on the various research studies the loads applied on the knee joint is the main reason for the degenerative change of this joint (Astephen and Deluzio, 2005). One of the most important loads applied on the knee joint is adductor moment. There is a significant correlation between severity of knee OA

(based on Lawrence grade) and adduction moment (Astephen and Deluzio, 2005; Baliunas et al., 2002; Foroughi et al., 2009; Hurwitz et al., 2002; Mundermann et al., 2005).

Various methods have been used for the patients with knee OA including surgery and conservative treatments (Fantini et al., 2010; Matsuno et al., 1997; Fang et al., 2006; Kristin et al., 2007; Ramsey and Russel, 2009). Offloading knee brace have being prescript for patients with moderate to severe OA. Although offloading knee braces seems to reduce knee pain, decrease instability and reduce the loads applied on the knee joint, most of subjects windrow to use it due to some problems (Wilson et al., 2011).

Both conservative and surgical treatments are currently available for the patients with knee OA. Surgical treatment used for knee OA includes high tibia osteotomy (HTOA) and knee replacement especially total knee artroplasty (London et al., 2012).Total knee artroplasty used especially for elderly subjects due to limitation in terms of efficiency (cost effectiveness and economic impact) (Gabriel et al., 2012, Li et al., 2013). Therefore, this procedure cannot be employed for young subjects suffering from knee OA. The main reasons are high level of physical activity of young subjects and duration of use of knee which is significantly more than that of elderly. Therefore, use of other methods for treatment of OA for younger subjects has been recommended to decrease the applied loads on the knee, improve performance and reduce knee pain. It has been shown that young patients who received unsuccessful conservative treatment are not in good condition to receive irreversible surgical procedures. Therefore, there should be a gap between the time of widraw of conservative treatment and total joint replacement surgery (London et al., 2012, Bowditch et al., 2012). KineSpring implant system is a method which can be used as a selective method to decrease the loads applied on the knee, to improve performance, to reduce pain in young subjects with OA (Gabriel et al., 2012, Li et al., 2013, Bowditch et al., 2012). This is actually a novel implantable load absorber introduced in 2008. This system has being used for patients with mild to moderate knee OA who are not candidate for joint replacement surgery due to age, activity level and costs (Gabriel et al., 2012). It should be emphasized that this method of treatment is based on reducing the loads applied on the knee joint and increasing the joint space. This is a new method to fulfill the treatment gap for young subjects with knee OA. Therefore, the aim of this review article is to find the relevant information about this system and to review the ideas behind it.

Method

An electronic search was done in some databases such as PubMed, ISI web of knowledge, Google scholar, Ebsco, Embasco and Medline. The key word was used in this review article was KineSpring knee implant which was used in combination with knee OA. The quality of study was evaluated based on Down and Black tool. The brief review of the methods and results were also provided.

Results

Six papers have been found on introducing and evaluating the new method of OA treatment (one clinical study on suitability of this system on sheep, one case study on method of surgery of this implant, one study on cost effectiveness of this implant, one study of kinematic evaluation of knee implanted with KineSpring on cadaveric study, and two clinical studies with 55 and 79 patients). The quality of the most studies was poor and only one parameter has been evaluated in some studies. Table 1 shows the quality of the studies. Table 2 summarized the methods and results of these studies.

Table 1: *The quality of the research done on KineSpring knee implant system*

Reference	Reporting	External validity	Internal validity	Confounding
(Li et al., 2013)	10	2	0	2
(Gabriel et al., 2012)	9	2	2	3
(Allen et al., 2012)	8	2	3	5
(Bowditch et al., 2012)	10	2	2	3
(Almqvist, 2012)	9	3	3	6
(London et al., 2012)	9	3	3	5

Discussion

Most of the treatments used for knee OA include conservative treatment and operative surgery (total knee replacement and high tibia osteotomy). Knee replacement as the best and successful treatment for OA

Table 2: *Brief review of the studies done on KineSpring knee implant system*

Research	Method	Results
(Li et al., 2013)	The economic impact of OA in Germany was assessed in terms of annual total direct cost and indirect cost to total disease population with this implant.	KineSpring system is a highly cost effective alternative for knee OA compared to current accepted cost effective threshold.
(Gabriel et al., 2012)	Six cadaver knee with knee OA were recruited using Kinematic test. The loads were measured by a thin layer of sensor embedded between joint surfaces.	Load reduction occurred throughout stance phase.
(Allen et al., 2012)	11 sheeps were implanted with this system. The functionality was assessed by use of fluoroscopy. Tissue response was also evaluated.	The results showed no body reaction occurred follow the use of this implant
(Bowditch et al., 2012)	A novel two stages procedure has been investigated for a case with KineSpring knee implant.	Results showed two stages method has less risk of infection.
(Almqvist, 2012)	KineSpring system was implanted in 79 patients with isolated knee OA. Functional improvement and pain relief were measured in this study.	Functional improvement and pain relief occurred.
(London et al., 2012)	KineSpring knee system was implanted in 55 patients. Function and pain were monitored follow the use of this implant.	Functional improvement and pain reduction occur based on WOMAC.

used especially for person over age of 65 (accounted for 69% of replacement in 1997). The number of knee replacement and financial costs exceed 1.3 million and 49$ billion by 2015, respectively. Although, the success rate of this procedure is high for elderly subjects, it is not recommended to be used for younger subjects with knee OA. KineSpring knee implant is a device used for younger subjects who conservative treatment does not improve their performance, reduce pain and increase their knee stability (Gabriel et al., 2012). As this implant is a new method for knee OA treatment, the aim of this review is to collect the studies on the KineSpring knee implant.

KineSpring Knee Implant

This is an implantable, joint unloading prosthesis that has been designed especially for young subjects with knee OA. The main inclusion criteria include for those who conservative treatment approach are unsuccessful and are not candidates to receive total knee artroplasty (London et al., 2012). This consists of three main parts, tibia base, femoral base and an absorber (Figure 1). The tibia and femoral bases are made from titanium alloy. This implant reduces the loads applied on the knee joint during walking. The tibia and femoral bases are attached to the proximal and distal parts of the knee joint by special compression and locking screws (Gabriel et al., 2012, Bowditch et al., 2012).

It should be mentioned that this system is extra articular and extra capsular. The most interesting point regarding this implant is that implantation of this device is achieved without resection of bone, muscle, ligament and joint capsule. The shock absorber component, which is located between femoral and tibial bones, is positioned superficial to the medial collateral ligament. The principle of operation of this system is that it absorbs maximum loads of 29Ib during full knee extension without imposing any force on the lateral compartment of the knee joint (London et al., 2012; Li et al., 2013; Gabriel et al., 2012). It has been reported that this system allows knee joint motions with capacity of less than 60 degrees of internal/external rotation, 50 degrees of varus/valgus angulation and 155 degrees of flexion/extension. There are some contraindications mentioned to use of this device such as: severe infection in the knee joint, Charcot joint, Rheumatoid arthritis of knee joint, joint instability, moderate to severe OA, symptomatic lateral or Patelofemoral OA, varus in knee more than 10 degrees, knee hyperextension, sever deformity and hypersensitivity to metal (Gabriel et al., 2012; Allen et al., 2012).

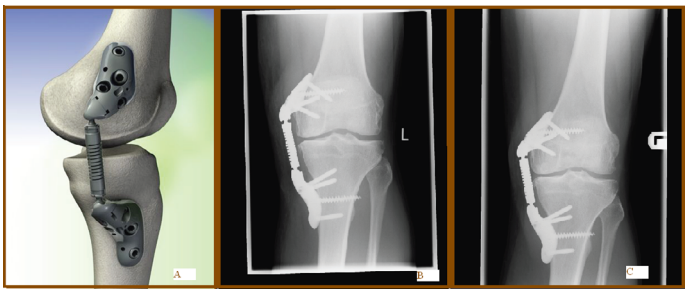

Figure 1: *KineSpring Knee implant (A), none weight bearing (B), weight bearing condition (C)*

The procedures recommended to implant this device include one or two stage procedures. However, it should be mentioned that two stages may have more success rate due to less risk of infection (Bowditch et al., 2012). Postoperative care include three stages varies from wound care, infection monitor, increasing knee range of motion, using crutch and walking and

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returning to daily activities.

Suitability of KineSpring Implant

This implant was designed to reduce the vertical compression loads applied on the knee joint. This system is reported to absorb a maximum load of 29Ib during full knee extension (London et al., 2012). In contrast the other offloading mechanisms such as offloading knee brace are based on decreasing varus moment and creating a valgus moment. For every 1 N.m it was predicted a decrease of 3% in knee adduction moment. For 12 N.m valgus moment, 228 N or 0.3 N/BW reduction of vertical force occurred (Pollo et al., 2002; Self et al., 2000). There is only one research study done on cadaver knees with medial knee OA (grades I, II) (Gabriel et al., 2012). Thin film sensors were implanted to measure the medial and lateral tibio-femoral contact pressures. The results showed a significant load reduction in the medial side (134 N). However, there is no research done on normal walking and measuring the actual loads applied on the knee while walking. The other point is that no research evaluated the magnitude of adduction moment applied on the knee of the subjects who received this kind of implantation. Regarding the effects of this system on the range of motion of the knee joint, there is lack of study in this regard. However, it was claimed that knee flexion range is 135 degrees (Bowditch et al., 2012). Therefore, it is recommended that the moment applied on the knee joint, range of motion be evaluated in the subjects with this implant.

The Success of KineSpring Implant Method

The main reason mentioned to use KineSpring implant is to reduce pain, improve stability and to improve the function of the knee joint. There are a few studies on this method which most of them focus on cadaver or animals. The effects of this implant on extracortical bone apposition were evaluated by implanting this device on 11 sheeps (Allen et al., 2012). The results showed that there was no tissue response against this material. There are only three studies done on patients (Bowditch et al., 2012; Almqvist, 2012; London et al., 2012). In one study KineSpring was implanted in 79 patients. The severity of pain was evaluated before and after implant by WOMAC pain score (Almqvist, 2012). The results of this study showed this system provided pain relief and functional improvement in young and obese patients' population who are not ideal candidate for HTO or artroplasty. In another study on 55 patients, the participants were monitored for more than 2 years. The results of WOMAC pain score showed a reduction in pain and an improvement in function of knee joint (London et al., 2012).

In another study the implanted KineSpring system was monitored in a patient. The results showed an improvement in the performance of the knee joint (Bowditch et al., 2012). As can be seen from the above mentioned study there is no research done to show the effect of this implant on the kinetic and kinematic performance of the knee joint follow the use of this implant. Moreover, in no research the magnitude of the loads transmitted through the knee joint during walking was evaluated. Although the effect of this implant on severity of pain of OA was mentioned, there is no research showed the other side effects such as loosing of screws fallow the use of implant.

In contrast to other methods of offloading such as use of offloading knee braces, there is a need of a study to compare the efficiency of this method. Based on the results of various research studies, offloading knee brace reduce the adductor moment applied on the knee joint, reduce pain and improve the performance. The success rate (usage) of this device reported to be more than 70%. Last but not least the cost of this system is less than that of treatment interventions. Therefore, there is a need to do a study to compare the efficiency of this system with that of offloading knee brace. In one study the cost of this procedure was compared with that of HTO and total knee artroplasty (Li et al., 2013). It seems that the cost of this operation is less than that of other surgical procedures. The mean procedure time is around 76 minutes and means hospitalization was 1.7 days which is less than that of other aforementioned methods.

Discussion

KineSpring knee system is a new implant used to improve the performance of the subjects with knee OA, reduce pain and improve knee stability. This system has been recommended for young subjects with knee OA with failure of conservative treatment. There are some indications to use this method of treatment. There are few studies with a low quality on this implant. Based on the results of these studies, use of this implant reduce the knee pain and improve the performance. It is recommended to evaluate the efficiency of this method in a clinical trial study with a big number of subjects. Moreover, it is recommended to compare

the efficiency of this method with other conservative treatment such as offloading knee brace.

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