e-ISSN: 2319-9865
p-ISSN: 2322-0104

RESEARCH AND REVIEWS: JOURNAL OF MEDICAL AND HEALTH SCIENCES

Osteoarthritis of the Knee–Need for Risk Factor Modification.

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Review Article

Received: 04/08/2014
Revised: 20/08/2014
Accepted: 29/08/2014

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Keywords: Knee osteoarthritis, risk factors, risk factor modification.

ABSTRACT

Osteoarthritis of the knee is a common problem among the elderly population. Therapy of osteoarthritis includes use of non pharmacological, pharmacological and surgical approaches. In management of osteoarthritis, it is important that we know all the risk factors responsible for it. The purpose of this article is to provide a review of risk factors and the therapies modifying these factors based on the established literature, as well as recently available literature. PubMed, Cochrane databases and Science Direct search was performed and relevant articles were identified. This review provides an overview of evidence based guidelines for risk factor modification approach in osteoarthritis.

INTRODUCTION

Osteoarthritis (OA) of the knee is a common cause of disability in elderly population worldwide and is essentially a failure of an organ, the synovial joint. As OA develops, articular cartilage and joint structures such as subchondral bone, periarticular muscles, ligaments and synovium are affected [1]. These structures normally act as cartilage protectors and their failure is a major risk factor for OA. In most cases OA arises without an obvious cause and is hence called as primary OA. When degenerative changes occur due to traumatic or autoimmune causes such as rheumatoid arthritis it is called as secondary OA.

Osteoarthritis is now considered as a mechanically driven disease in which the consequences of abnormal joint mechanics produce biochemical changes in the joint structures. If this adverse mechanical environment remains unchanged, repair of the cartilage is not possible. Thus it is unlikely that a drug altering biochemical pathways will solve the problem of OA. On the other hand, if the abnormal stresses on the joint are corrected, intervention with a structure-modifying drug could be successful [2]. It is important to understand the role of these risk factors and ways to modify them in order to manage osteoarthritis successfully.

A search of literature was done using PubMed, Cochrane databases, and ScienceDirect for the last seven years (2005-2012).

Risk Factors

Several risk factors are suspected to play an important role in the causation of primary OA [3].They can be classified as non-modifiable and modifiable. Non-modifiable risk factors for OA are age, sex, genetic influences and race. On the other hand; modifiable risk factors include occupation, nutrition, muscle weakness, knee instability, malalignment and joint loading (including obesity). If obesity has been genetically determined in a patient, then it cannot be altered by lifestyle modifications and it becomes a non modifiable factor. In this article we will try to focus more on the modifiable factors.

e-ISSN: 2319-9865
p-ISSN: 2322-0104

Occupation

It is the level of physical activity involved in a particular occupation rather than occupation itself which is a risk factor for OA. Heavy daily physical activity and occupational stresses like prolonged knee bending, squatting and lifting heavy loads can increase the risk of knee osteoarthritis [4-6].This is because the muscles that become exhausted by repetitive tasks are not able to serve as joint protectors. But this risk factor is not correlated well with the symptom severity.

Sports activities are often associated with other injuries such as knee ligament tears and meniscal injuries [7].In women; OA is more common among housemaids and farm workers. In men, OA tends to occur more commonly in farmers, masons and toddy tappers. Repeated standing from a sitting position was found to be a risk factor for OA in women [8].

Nutrition

Antioxidants like vitamin E are thought to confer protection against the progression of osteoarthritis. High intake of vitamin C may be associated with a lower risk of knee osteoarthritis progression. Low levels of vitamin D may affect bone repair, predisposing to progression of osteoarthritis [9].

Muscle Weakness

Individuals with OA of the knee show marked weakness of the quadriceps muscles as compared to their controls. This muscle weakness is not only due to its atrophy, which is believed to be secondary to arthrogenic muscle inhibition (AMI) [10] but also due to age-related decrease of muscle volume [11, 12]. AMI is the inability to fully activate the quadriceps muscle caused by a change in the discharge of articular sensory receptors due to factors such as swelling, inflammation, joint laxity, and damage to joint afferents [10].Greater baseline quadriceps strength may protect against incident knee pain and cartilage loss [13].

Knee instability

Knee instability is defined as a sensation of buckling, shifting, or giving way at the knee during functional activities. It may be due to increased capsule-ligamentous laxity, altered lower extremity muscular strength and neuromuscular control [14].

About 60–80% of patients with knee osteoarthritis report knee instability. Self-reported knee instability has been suggested to be a cause of knee OA onset and progression [15].

Knee laxity is displacement or rotation of the tibia with respect to the femur. Passive varus / valgus laxity appear to be more prevalent in knee OA than anterior- posterior laxity. This laxity results from reduced tension in the joint capsule and ligaments. Sharma et al reported that greater amounts of passive varus/valgus laxity were associated with greater amounts of bony attrition and joint space narrowing of the knee [16].

Proprioception is the conscious and unconscious perception of joint position and movement that maintains joint stability under dynamic condition [17].Participants who were older and had more knee pain at baseline are more likely to have proprioceptive deficits at that time. Poor proprioception leads to abnormal joint loading and subsequently increases joint pain [18].

Malalignment

Knee alignment is knee position in reference to the hip and ankle. A 4–6% increase in varus alignment increases loading in the medial compartment by up to 20% [19].

Excessive varus alignment results in 4 fold increase in the odds of medial compartment OA progression whereas excessive valgus alignment results in a 5 fold increase in odds of lateral compartment OA progression [20]. Uneven weight distribution secondary to malalignment increases focal stress on the cartilage.

The external knee adduction moment (KAM) during walking gait is a measure of medial compartment loading [21].The KAM has two peaks: a first peak during early stance and a second peak during late stance. The first, and the larger, peak in the KAM has been linked to progression of knee OA [22].

Joint loading

Interstitial fluid pressurization during loading protects the cartilage matrix from excessive stresses and reduces friction at the articular surfaces [23].Repeated impact loading causes cumulative damage, initially inducing necrosis, followed by apoptosis and collagen degradation in cartilage explants [24].The two most important loading factors are obesity and repeated joint use (as described earlier).

Obesity

Forces transmitted across the knee joint during normal walking range between 2 and 3 times body weight. This is in part due to the kinetics of acceleration, the high moments generated at the knee, and simultaneous contraction of multiple muscles. Therefore the net effect of each additional kilogram in body weight is multiplied 2 or 3 times at the knee [25].Overweight (Body mass index (BMI) 25–29.9 kg/m^2) and obesity (BMI >29.9 kg/m^2) have been identified as major OA risk factors [26, 27].For every 2 units of BMI gain (equivalent to about 5 kg), the risk of OA of the knee is increased by 36% [28].

Sharma et al reported that greater BMI at baseline increases the risk of either having lower physical function scores or actually regressing in physical function scores over a 3 year period [29].A study showed there is increased incidence of obesity in patients who undergo total knee arthroplasty (TKA). The obese patients are significantly younger with a higher proportion of obese TKA patients being women [30].

Another study of patients undergoing primary TKA over a 2-year period found that hospital inpatient costs were significantly higher in obese patients both during the index admission and in the following 12-month episode of care [31]. Berend et al found an increased rate of tibial component loosening and implant migration in obese patients undergoing TKA [32].

Obesity can mechanically induce joint load and at the same time can induce certain biochemical changes.

Obesity induced adipokines

Adipose tissue is now considered to be an endocrine organ that releases a large number of factors, including cytokines, such as IL-1 and TNF-α, as well as adipokines [33].Adipokines are biologically active substances found in the adipocytes of white adipose tissue that include a variety of pro-inflammatory peptides which contribute to the “low-grade inflammatory state” of obese subjects. The best studied of this family are leptin, resistin and visfatin [34].These adipokines increase the inflammatory status by means of various mechanisms thereby leading to apoptosis of chondrocytes, as well as cartilage matrix degeneration [35].

Obesity-associated diabetes mellitus

Obesity may be associated with formation of advanced glycation end products (AGEs) in articular cartilage which lead to increased stiffness of collagen due to AGE cross-linking [36].

Obesity and atherosclerosis

Microvascular changes occuring secondary to obesity associated atherosclerosis in subchondral bone during osteoarthritis leads to vascular obstruction. The resulting intraosseous hypertension reduces the ability of the cartilage to absorb shocks leading to cartilage breakdown [37].

Footwear and joint load

Foot position awareness declines with advancing age [38].Moderate-heeled shoes were found to increase the forces that strain both the tibiofemoral and patellofemoral joints during walking [39].Recent evidence suggests that wearing shoes significantly increases medial knee load compared with walking in bare feet [40, 41].The natural flex of the foot when it contacts the ground probably decreases the impact on the joint, compared to the artificial 'stomping' movement created by a stiff-soled shoe.

e-ISSN: 2319-9865
p-ISSN: 2322-0104

Risk Factor Modification (RFM) Approach in OA Therapy

The main aim of RFM approach is to preserve joint protectors and normalize joint loading. These therapies are important because:

- Prolonged inactivity because of osteoarthritis leads to obesity and increased risk for cardiovascular disease. Exercise improves cardiovascular endurance [42].
- The pharmacological therapy for pain works best in combination with non-pharmacologic strategies [43].
- Exercise may reduce the need for painkillers, knee arthroplasty and intra-articular injections [44, 45].
- Exercise therapy enhances glycosaminoglycans content, and protects against cartilage degeneration in subjects with knee OA [46].
- It may also help to rearrange the neurophysiological processes which were constructed during OA pain development.
- It may have positive effect on the post-TKA knee function [47].

However these measures are usually neglected due to the pressures on the time available to the doctor to explain these measures, lack of enough evidence to prove their benefit, lack of trained physiotherapists to individualize patient therapy, additional therapy cost for patients and issues of long term patient compliance.

The RFM approach includes

- *Dietary modifications*
- *Behavioral Interventions*
- *Exercise therapy*

  Range of motion=Active/passive
  Strengthening=Isometric/Isotonic/Isokinetic
  Aerobic=Low intensity/low impact

- *Support Devices* =shoe inserts, knee brace, canes, footwear

Dietary and lifestyle modifications

It is important to eat more foods with anti-inflammatory oils (found in nuts, seeds, and cold-water fish). Avoid food that causes free oxygen radical accumulation (refined foods, reused cooking oil, cookies, and cakes). Phytonutrients have been shown to have a protective effect in patients with hip OA [48]. Eat more fruits, vegetables, and whole grains. Cigarette smoking has been associated with cartilage loss [49].Avoid alcohol and tobacco.

Weight loss -All patients with symptomatic knee OA who are overweight should be counseled regarding weight loss. Weight loss improves mobility and reduces pain. For every one pound of weight lost, there is a 4-pound reduction in the load exerted on the knee for each step taken during daily activities [50]The loss of body fat is more closely related to symptomatic benefit in osteoarthritis than is the loss of body weight [51]Lowering BMI to the normal range would reduce the number of OA cases by more than 50%. If all overweight and obese people reduced their weight by 5 kg or until BMI was within the recommended normal range, 24% of surgical cases of knee OA might be avoided [52].Among 80 obese patients with OA, 50% of patients randomized to a low-carbohydrate (low-energy) diet (LED) plus weekly dietary education sessions for 8 weeks achieved a weight loss of ≥10% compared with 0% of patients randomized to a conventional hypo-energetic, high-protein diet [53].

Behavioral Interventions

The Arthritis Self-Management Program is a community-taught, peer-led intervention in which patients gain skills and self-efficacy to manage the consequences of their disease. The aim is to provide patients with an understanding of the disease process, its prognosis and the rationale and implications of managing their condition [54].A 2004 meta-analysis suggested that mindfulness training may enhance the ability to cope with distress and disability associated with chronic diseases [55].

e-ISSN: 2319-9865
p-ISSN: 2322-0104

Exercise therapy

The 3 principal types of therapeutic exercises are Flexibility (also called "stretching" or "range of motion (ROM)"), Strengthening (muscle conditioning) and Aerobic (or cardiovascular) [56].

Flexibility exercises

These are stretching exercises performed daily in a low intensity manner. They help to increase mobility, which prepares a person for strengthening exercises. It decreases morning stiffness and joint pain. Passive ROM exercises involve movement of muscles or joint by the therapist or apparatus whereas active exercise is performed by the patient himself under guidance of therapist. Passive ROM exercise can increase joint inflammation.

Strengthening exercises

These should be performed on alternate days, giving the muscles time to rest. They can be done with the weight of the body, with elastic bands, or with hand held weights or machines.

- Isometric Exercises- Involve contraction of muscles while they are at a fixed length, such that little or no joint motion is taking place. Isometric exercises are a reasonable initial approach for strengthening in patients with painful, inflamed joints. The functional benefits from isometric contraction exercises might be limited to a small range around the joint angle of training.
- Isotonic Exercises-Involve joint movement through its ROM, against a constant weight or resistance.
- Isokinetic Exercises-Involve constant speed of motion throughout the joint range during muscle contraction, whereas the amount of resistance may vary throughout the range. Infrequently used because of equipment requirements and uncertain correlation to functional activities.

Isotonic are probably the more beneficial exercises in patients with osteoarthritis than the gentle isometrics. Isotonic exercise is suggested for maximal strengthening in patients with OA with exercise knee pain, and isokinetic exercise is suggested for improving joint stability or walking endurance at a later time [57]. In overweight patients undergoing dietary-induced weight loss, strength training is important to minimize loss of lean muscle mass that would otherwise exacerbate muscle weakness [58].

Aerobic conditioning

Aerobic exercise should be performed 3 to 5 days per week. It includes walking, biking, dancing, walking, swimming and water aerobics. Basically they improve the decreased cardiovascular endurance and create a feeling of overall wellbeing. Walking also adds minor degree of joint loading, which helps cartilage to obtain necessary synovial nutrients through imbibition.

The preference for aquatic exercises or land-based exercises should be based on patient preferences. A recent study by Cadmus reported beneficial effects of aquatic-based exercise only for obese patients but not for non-obese. Due to the buoyancy of water, it is possible to exercise without experiencing full body weight [59]. Exercising in a standing or weight-bearing position may aggravate symptoms in patients with knee OA. Hence non–weight-bearing interventions like proprioception training and strength training are used to improve proprioception and knee extensor muscle strength respectively [60]. Greater knee extensor strength was associated with a decreased risk of symptomatic but not radiographic knee OA [61].Both home-based exercise programs and programs administered by physical therapists have resulted in significant improvements in functional ability and 6-minute walk distances with improvements sustained for up to 1 year [62].Exercise therapy plus manual joint mobilization was found to be superior to either strength training or exercise therapy alone in medial knee OA [63].

Kinesthesia, balance and agility (KBA) technique

KBA techniques are designed to improve dynamic joint stability using a series of physical activities which challenge a participant's neuromuscular system to maintain balance and coordination. It is a promising stand-alone intervention that may result in more rapid symptom relief and functional improvements in comparison to traditional therapeutic exercise [64].

e-ISSN: 2319-9865
p-ISSN: 2322-0104

Adherence to exercise

The patient adherence to exercise reduces rapidly over time and thus may reduce the long-term effectiveness of exercise for patients with OA [65].Reluctance to participate in an exercise program is mainly due to laziness on the part of patient to follow up exercises for a long time. Patient expects the tablets to take care of everything which is actually not possible in chronic diseases. The motivation of the patient to start with exercise should come from the treating physician. Regular reinforcement by the physician and physiotherapist is necessary to ensure adherence. The patient may stop exercises if there is no improvement in pain and if he feels that exercise aggravates pain. It is not uncommon for patients to experience some discomfort at the affected joint during exercise and patients should be assured that this does not indicate a worsening of their OA disease. The use of painkillers during the initial few weeks of an exercise program will improve patient compliance. Initial long-term goals (e.g. to postpone an operation or to live independently for as long as possible) rather than short-term goals (e.g. to decrease pain) are related to greater adherence to performing activities in the long term. The goal should be to integrate exercise into daily living with patients playing an active role while physiotherapists have a coaching role [66].

Support devices

Braces are medical devices made of combinations of metal, foam, plastic, elastic material and straps designed to support or correct deformity. Orthoses are insoles that fit inside your shoes and correct deformity. According to a 2005 Cochrane review, brace and insole have small beneficial effect in medial compartment osteoarthritis. Wearing a knee brace increases the distance you are able to walk but may not lead to any difference in pain and knee function. There is no available evidence for their effectiveness of bracing or orthoses in treating lateral compartment knee osteoarthritis. There is no evidence whether a brace is more effective than an insole [67].

Braces

The commonly used external bracing devices for OA are unloading knee braces and patellar taping and bracing. Active patients with varus or valgus knees might benefit from knee unloader braces [68].Patellar taping done by applying adhesive, rigid, tape to position the patella or patellar bracing done with an external device has been suggested for use in patellofemoral knee osteoarthritis. This by improving impaired neurosensory input around the joint may improve motor function [69].

Braces are an underused treatment for OA because long term adherance is low among older persons especially due to due to skin irritation and bad fit. They are difficult to fit for obese or short patients and are expensive.

Orthotics

Patients with lateral compartment OA need to wear medially wedged insoles, while those with medial compartment OA need to wear laterally wedged subtalar strapped insoles. The patient should be instructed to use the insole whenever wearing shoes, for between 3 and 6 hours each day. A 2-year follow-up concluded that lateral-wedged insoles decrease the degree of varus malalignment at the knee by causing ankle pronation [70].The lateral wedged insole with subtalar strapping induces correction of the femorotibial angle (the angle formed by the axes of the distal one-third of the femur and the proximal one-third of the tibia) and provides symptomatic relief in patients with varus-deformity knee OA [71].

Favorable responses have been demonstrated in patients who are less obese, and have less severe disease [72].A laterally wedged insole may be an alternative to valgus bracing for treating symptoms of medial knee OA [73].Foot orthoses are easy to use and with good adherence, lesser cost than knee bracing.

Footwear

Educating elderly patients about selection of footwear is very important. The 'mobility' shoe is a flexible light-weight shoe designed to mimic essential features of natural foot motion via specialized grooves placed at the major foot flexion points [74]. Flat, flexible footwear significantly reduces the load on the knee joints compared with supportive, stable shoes with less flexible soles [75].

e-ISSN: 2319-9865
p-ISSN: 2322-0104

CONCLUSION

Through this article we want to stress the importance of risk modification approach in the management of osteoarthritis. This approach will provide a primer for the use of pharmacological and at the same time surgical options in osteoarthritis.

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e-ISSN: 2319-9865
p-ISSN: 2322-0104

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