THE TORONTO CENTRE FOR SPORTS MEDICINE & PREVENTATIVE HEALTH

Osteoarthritis in the athlete

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Special points of interest:

- The prevalence of OA ranges from 10% of adults over the age of 50 years to up to 1 in 3 adults.
- OA is more common in high level sports and post injury.
- MRI is a very useful tool for detecting early chondral changes and instituting protective measure to minimize further chondral damage.
- Rehabilitation is the mainstay of treatment in almost all cases of OA.
- Most cases of OA will not require surgery.
- Supplements, HA injections and various surgical procedures have been useful in treating early OA and possibly slowing its progress.

Inside this issue:

Overview of osteoarthritis

OA is thought to affect more than 20 million people in the United States. Studies reveal that from 10% of adults over the age of 50 years to up to 1 in 3 adults have OA. It is expressed equally across races and more frequent in women. 2% of women and 1.4% of men develop radiographic changes of osteoarthritis each year with half developing symptomatic disease. It is estimated that most of us will have some degree of osteoarthritis by age 60-70 years. OA is one of the leading causes of disability and dysfunction in the elderly. The total cost for OA in the U.S.A. is estimated at 2% of the GDP.

Symptoms of OA include pain, stiffness, swelling, loss of range and decreasing function of the affected joint. The diagnosis is traditionally made on the basis of symptoms and radiographic findings. With the advent of MRI, early changes in the cartilage, especially after injury can be detected and appropriate treatment instituted before the disease progresses to the typical radiographic changes and function deteriorates.

The entire pathophysiologic mechanism of OA has yet to be elucidated. Genetics makes one more susceptible. Athletes suffering significant injuries or subjected to chronic high level load bearing stresses are more prone to developing osteoarthritis in later years. Athletes participating at moderate levels do not seem to have an increased risk of OA.

A review of OA in athletes and available treatments is the goal of this newsletter. The focus will be on OA of the knee as this joint has been the most studied. Surgical options will be reviewed but since most patients with OA will not require surgery, the emphasis will be on non surgical approaches to treatment. Rehabilitation remains central to any treatment option, even surgery.

Representation of the changes of OA in the knee.

Despite the increased risk of OA in athletes at high levels of participation or in those who sustain injuries, active individuals remain healthier at older ages and consume less health care dollars than their inactive counterparts.

Cartilage structure

Hyaline cartilage is responsible for absorbing shock and reducing friction between bone ends. It is approximately 5 to 20 times slicker than ice. It is made up of type II collagen, proteoglycan aggregates, chondrocytes and water. Chondrocytes make up only 5% of it's wet weight but are responsible for its maintenance. The solid component of cartilage is comprised primarily of the network of collagen fibrils which contribute to its sheer and tensile properties. The collagen fibrils interlink and are maintained in a spatial arrangement by the proteoglycan aggregates and account for 10 to 20% of the wet weight of cartilage. These protein aggregates are able to trap water causing high interstitial fluid pressurization and contributes to more than 90% of the load transmission function of cartilage. The chief proteoglycan is aggregan. This consists of a long protein core of up to 100 chondroitin sulfate and 50 keratin sulfate glycosaminoglycan chains. These aggregan molecules bind onto a protein core of hyaluronate resulting in a large molecule known as a proteoglycan aggregate. The water trapped by these molecules make up about 65-80% of the wet weight of cartilage.

Pathophysiology

Histological appearance of normal cartilage (above) and chondral wear (below).

OA is increasingly seen as a mechanically driven but chemically mediated disease process. Mechanical loads may ultimately be responsible for the initial physical damage which is thought to also stimulate soluble mediators of inflammation leading to further cartilage destruction. Macroscopically the early changes progress from softening or chondromalacia to fibrillation and erosions or ulcerations. Biochemically OA is a process directly linked to the loss of collagen and proteoglycan content of cartilage. There is an initial disorganization of the collagen molecules followed by a breakdown in the proteoglycan architecture leading to a more permeable solid matrix with less load compressibility. This results in decreased load bearing capacity leading to further mechanical damage and a continuous cycle of progression. Later changes of OA include all the structures of the joint including subchondral bone thickening synovial fluid changes and synovial membrane inflammation.

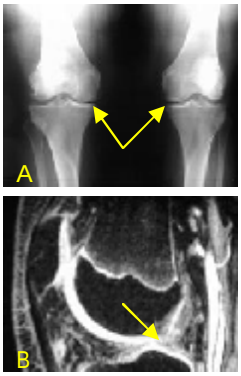
A family of proteolytic enzymes, the metalloproteases (MMP's) produced by the chondrocytes themselves play a central role in cartilage degeneration through digestion of the matrix. Collagenases including collagenase I (MMP-1)and collagenase III (MMP-13) are involved in type II collagen degeneration. MMP-3 and aggreganase-1 have been shown to play a primary roll in degradation of proteoglycan aggregans. MMP activity is usually controlled by activators such as plasminogen/plasmin and cathepsin B and the tissue inhibitors of MMP's (TIMP's). Recent studies have shown that cyclical loading can increase MMP expression and activity in cartilage. Cytokines such as interleukin-1β and TNFα, secreted by synoviocytes and monocytes in the synovium disrupt cartilage homeostasis by facilitating the progressive MMP mediated digestion of cartilage. Clinical trials assessing the efficacy of interleukin-1 blockade are currently underway and have shown promising effects. Interestingly doxycycline has been shown to inhibit MMP activity and is currently being investigated as a disease modifying agent in OA.

Does physical activity increase the risk of OA?

Moderate intensity activity does not predispose athletes to OA.

There seems to be a positive correlation between the development of OA and level of physical activity especially in the lower extremity. There is also a correlation with age, sex, genetics and previous injury. There are higher rates of OA in professional athletes independent of history of injury. Soccer, rugby and football have increased incidences of hip and knee OA (25-30%) which is 3-5x that of amateurs and controls. Weight lifters and those in heavy lifting occupations are susceptible to hip and L/S OA. Studies tend to show evidence of increased OA of the knee with running distances of over 20 miles per week however other studies of marathoners have shown no increased incidence of OA. It seems that moderate level activities have not been shown to predispose to OA. Despite the increased risk of OA due to athletics those athletes that remain active are healthier and consume fewer health care dollars than their inactive counterparts.

Imaging



A. Plain radiograph showing decreased medial joint space in early OA. B. MRI showing a full thickness cartilage fissure in a patient with a normal radiograph.

Plain radiographs provide an indirect evaluation of cartilage loss as with weight bearing views of the knee. Typical changes are thinning of the joint spaces and later osteophyte formation. It is known that pain does not correspond to the degree of radiographic changes as many patients present for the first time with significant changes of OA on x-ray with a very short history of pain. An early determination of the degree of cartilage wear helps plan early management with a view of slowing the progression of OA. This is possible with the MRI which has a sensitivity of 87% and specificity of 94% for early cartilage lesions in the knee. MR or CT arthrogram are even more sensitive in picking up early surface changes in cartilage. MRI is also useful in determining the anatomical and functional characteristics of osteochondral lesions and in post operative cartilage replacement procedures.

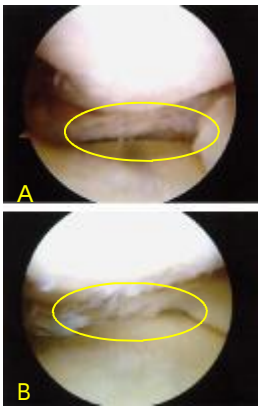
In skeletally immature individuals one must search diligently for cartilage injuries. In children an acute knee injury results in chondral damage in a higher percentage of cases than adults who tend to suffer a higher incidence of ligament and meniscal injuries. The MRI is an excellent tool to identify the presence and degree of cartilage injuries in suspected cases. Radiographs will only provide evidence of fractures or swelling after an acute injury to cartilage.

OA after sports injuries or surgery

An isolated tear to the ACL can have a significant impact on an athlete's ability to perform. Not so clear is whether ACL reconstruction is helpful in preventing OA. Irrespective of the type of reconstruction there seems to be a higher incidence of OA compared to those knees treated conservatively! *It is thought that the initial injury produces chondral damage which initiates the cascade to eventual OA visible on radiographs within 10 years.* It may therefore make sense to limit further mechanical loads and inflammation after such injuries to reduce the degree of cartilage damage and the risk of development of OA.

Meniscectomies increase the contact stress in the compartments by up to 300%. Even after only partial meniscectomies, radiographic deterioration is evident within 5-15 years. It is also felt that concomitant cartilage injuries may have occurred at the time of the original meniscal injury. This also seems to be the case with shoulder dislocations where stabilization procedures have not reduced the incidence of OA and in some studies have increased the risk. The most important post-op factor seems to be whether external rotation is overly restricted.

OA of the great toe is also common in athletes and results from acute trauma or repetitive hyperextension forces especially on artificial turf. Extension is restricted to below the 65-75° needed for walking. Treatment starts with modifications in shoe wear but may eventually require surgery.



A. Partial meniscectomy of a torn meniscus. B. Result after debridement.

Rehabilitation bracing and orthotics

The goal of rehabilitation is to minimize discomfort, improve function and limit further injury. Components of the rehabilitation program include education, pain control, optimizing range of motion and functional strengthening of the entire kinetic chain. Aerobic exercise and use of assistive devices such as canes and orthoses which consist of braces and foot orthotics are best coordinated by the rehabilitation specialists. Only a minority of people with osteoarthritis progress to require surgery.

Pain leads to avoidance of motion which leads to increased soft tissue tightness and further loss of motion causing abnormal force distribution and accelerated cartilage damage. Education enhances patient compliance with rehabilitation programs. Activity modification is also essential in reducing pain and swelling and preventing further injury in most cases. Weight loss is significant in OA of the knee. During stair descent there is a force equivalent of 3-8 x body weight through the knee. Aerobic exercise performed 3x/wk for 20 min./ session over 4 months has been shown to reduce pain, improve balance, walking ability, mood and functional capacity by 30-40% in individuals independent of their physiotherapy and strengthening program.

Addressing deformities in the lower extremity involves physiotherapy as well as bracing and orthotics. A varus alignment of the knee is common in medial compartment arthritis. This could be caused by an uncompensated rearfoot or forefoot varus or from a retroverted hip due to tight hip external rotators. Conversely valgus deformities cause overload to the lateral compartment. Causative factors could include a compensated forefoot varus deformity or increased forefoot pronation and anteverted hip or weakness of the hip external rotators or abductors. OA unloading braces are designed to shift weight bearing to the unaffected compartment and have been shown to be most helpful in unicompartment OA.

Biomechanical studies indicate that patients with OA of the knee have decreased walking speed, shorter stride length, reduced peak vertical ground reaction forces and a longer stance phase compared to control groups. These changes are likely due to compensatory mechanisms. Therefore focusing on the entire kinetic chain is extremely important. Proprioceptive exercises have been shown to improve function and reduce symptoms. In medial compartment OA a15˚ toe-out stance while walking has also been shown to decrease the adduction moment (the forces through the medial compartment of the knee) while walking. This can also be achieved using an orthotic with a 5° valgus heel wedge. A varus heel wedge is used for patients with lateral compartment OA. Patients with primarily OA of the patella do well with neutrally aligned orthotics. Use of shock absorbing insoles and shoes with good stability and good cushioning are essential in reducing the impact through the knee. Shock absorbing insoles have resulted in a 42% reduction in the amplitude of shockwaves through the knee while walking. Wearing high heels increases the peak knee flexor torque in the knee by 30% compared to walking barefoot indicating that the routine use of high heels is not recommended for women with OA of the knee.

Comprehensive rehabilitation is the most important component in the treatment of OA as most patients to not end up requiring surgery.

Rehabilitation should address strength, aerobic fitness, biomechanical faults, excess weight and functional activities.

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The emphasis in management of OA is to prevent OA from developing or slow its progress through the use of rehabilitation, orthoses, supplements or various surgical procedures.

Mosaicoplasty of the knee in an isolated chondral lesion.

NSAID's supplements and viscosupplementaion

NSAID's provide pain and inflammatory relief especially in the short-term. They may have an important role in reducing the inflammatory cascade right after significant cartilage injuries. The significant adverse effects associated with NSAID's, both GI and renal, have not been eliminated by the Cox 2 NSAID's. In addition, athletes often self medicate and use NSAID's while in states of dehydration, increasing the chances of renal damage. Acetaminophen is available for pain control but does not affect the disease process.

Glucosamine, chondroitin and hyaluronic acid (HA) are important components of cartilage. Glucosamine and chondroitin sulfate have been shown to have no appreciable toxicity and have good oral bioavailability. Glucosamine has anti-inflammatory properties affecting interleukin-I and may have some anabolic properties, all factors which may affect the disease process. More studies have been conducted on glucosamine. The results vary from more effective than NSAID's to no effect on pain. Generally mild to moderate arthritis is more responsive to glucosamine. A degree of caution is necessary in sensitive diabetics and in patients on anticoagulants. Purchasing from a reliable producer may ensure that the supplements consistently deliver what they claim to.
Injections of steroids help limit pain and inflammatory reactions in OA for 6 wks-6 months. They usually do not eliminate the pain of weight bearing and do not provide a long term solution for the affected joint.

HA has viscous and elastic properties with analgesic and anti-inflammatory effects equal to indomethacin in some studies. Intra-articular injection of HA may stimulate intrinsic HA production by type B synoviocytes. HA injections are generally well tolerated with a 1-4% incidence of adverse effects - mainly pain and swelling, and provide relief of pain for up to six months.

Arthroscopy & open surgery for OA of the knee

Arthroscopy is considered the gold standard as far as determining cartilage damage in a joint however there is no standard accepted classification system which has been validated. Without specific pathology or symptoms such as locking, arthroscopic lavage or debridement has not been shown to be of any benefit in OA.
Meniscal tears identifiable by MRI are extremely common among individuals over 45 years of age and in patients with OA. Without symptoms of locking or catching meniscal surgery will most likely not be of any benefit. Patients with OA without signs or symptoms of specific pathology should have plain x-rays and rehabilitation, orthotics and braces and supplements/HA injections as indicated. Failure of conservative treatment should prompt the need for an MRI. Specific findings on the MRI may then point to a surgical option amenable to arthroscopic treatment or open surgery.

Attempts at preventing or delaying the development of OA in young individuals with isolated lesions of cartilage has lead to procedures which can be performed arthroscopically. Microfracture of the subchondral bone at the base of a chondral lesion induces bleeding and eventually produces fibrocartilage which tends to break down over time (up to 10 yrs). More advanced techniques such as autologous chondrocyte transplants and mosaicoplasty of bone/cartilage plugs have had improved success but are technically difficult and expensive. Allografts are used for larger lesions due to trauma or osteochondritis dessicans. Lack of correction of biomechanical faults and elimination of excess weight are implicated in failure of these procedures.
Realignment osteotomy of the knee is a procedure which shifts load bearing away from a compartment of the knee with mild OA in an extremity with abnormal alignment. Wedges of bone are either removed or inserted into the femur or tibia depending on the desired resulting alignment and other surgical considerations. Full recovery often take one year. The procedure effectively delays the progression of OA in patients without excessive weight and in those operated on before significant OA has already developed.

Once arthritis has progressed, if conservative treatment is insufficient to alleviate pain or improve functioning, joint replacement procedures are entertained. In the last several years unicompartment joint replacement has become a viable option in patients with unicompartment OA who are not overweight and have no significant biomechanical alignment abnormalities. They demand less post-op therapy and allow for increased activity after surgery compared to total joint replacement. Most importantly they can eventually be revised to a total joint replacement making them a good choice especially in younger patients. Total joint replacement is available for many joints, the most common being the knee and hip. Preoperative rehabilitation, aerobic exercise and achieving normal body weight improves the outcomes. Appropriately selected patients can achieve pain free joint function maintain healthy activities and even participate in mild-moderate intensity sports such as doubles tennis although impact loading activities are generally discouraged. Rehabilitation and appropriate regular physical activities significantly improve the results after surgery.