Volume 1 • Issue 3 • 2017

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Editorial

Orthopaedic Surgery and Traumatology

ISSN: 2573-4962

Knee Osteoarthritis: Overview

Ramji Lal Sahu*

Professor, Department of Orthopaedics, SMS&R, Sharda University Greater Noida UP India

***Corresponding Author:** Ramji Lal Sahu, Professor, Department of Orthopaedics, SMS&R, Sharda University Greater Noida UP India.

Received: January 05, 2017; **Published:** January 06, 2017

Volume 1 Issue 3 January 2017

Abstract

Background: Muller-Weiss disease (MWD) is a rare entity that refers to spontaneous avascular necrosis of tarsal navicular bone in adults [1, 2]. This is usually underrecognised and hence treatment guidelines are unclear. Here we report a case of Muller Weiss syndrome that presented in its early stages and underwent open drilling and decompression and cancellous bone grafting, with a two year follow up.

Case presentation: A 32 year old gentleman presented with pain over the dorsal aspect of left foot of four months duration. The pain got aggravated on weight bearing walking. There was no history of any trauma or constitutional symptoms. On clinical examination , there was tenderness over the navicular bone. Radiographs showed sclerosis of the navicular bone with a subtle lucency (Figure 1). CT confirmed a fracture in the navicular bone (Fig 2 and 3). A possibility of spontaneous avascular necrosis of navicular bone is considered.

Joint Alignment

There is now general agreement that the principal etiology of degenerative arthropathy is mechanical, not inflammatory. Direct clinical evidence of a cause-and-effect relationship between malalignment and arthrosis has not been possible, but substantial evidence from the orthopedic literature supports this hypothesis. 20 The total load on the joint, as well as how that load is distributed over the articular surface contact area, determines the magnitude of stress sustained by articular cartilage. Any intense stress concentration in the contact area will play a primary role in tissue degeneration. High contact pressures between the articular surfaces reduce the probability of fluid film lubrication. Subsequent actual surface-to-surface contact of aspirates causes microscopic stress concentrations that are responsible for further damage.

The load on a joint is a function of the alignment of the bones relative to that joint. Significant changes in the axial alignment of the femur or tibia may influence the load distribution in the knee joint. Malalignment causes asymmetric transmission of weightbearing forces across the knee. Research has shown that fluctuations in the pattern and magnitude of compressive loads experienced by the chondrocyte affects its biomechanical environment, and thus its synthesis of matrix macromolecules. Although some studies have shown a relationship between forces observed at the knee and limb alignment others have not and therefore, their relationship remains ambiguous. Our study demonstrates a significant, direct relationship between the alignment of the lower limb as measured by the mechanical axis and the peak adduction moment (an indicator of knee medial compartment loading) during early stance phase in normal subjects. Subjects who have a varus alignment tend to have a high knee adduction moment and those who have a neutral or valgus alignment tend to have a low adduction moment. There are several combinations of muscle forces, adduction moments, and lateral soft tissue forces that can lead to higher medial joint forces.

The adduction moment is likely the single most important extrinsic load factor leading to higher medial compartment loads. The dynamics of malalignment are based on the combination of the static limb alignment and the dynamics of loading at the knee during walking and other activities of daily living. The loads that are generated during these dynamic activities are substantially greater than the loads that can be generated during static postures. Therefore, limb alignment based on static radiographic measurements provides one component to the complete analysis of the factors influencing loading at the knee joint. This study provides reliable and reproducible data that suggest that lower limb alignment and foot position affect coronal knee moments. Perhaps in the future, non-surgical methods to alter gait mechanisms, such as foot orthesis, knee bracing, or gait retraining, may be an effective means of addressing particular arthritic and pain problems of the lower extremity.

Alignment Bracing

Using gait analysis techniques, it has been shown that individuals with severe unicompartmental gonarthrosis can benefit from using it valgus knee bracing to alter the biomechanics of knee function to more normal levels. Both kinetic and kinematic gait laboratory data support this finding. Abnormal adduction moments about the knee can also be significantly reduced, with medial tibiofemoral load can reaching normal ranges. These changes appear to be the foundation for significant decreases in pain and increases in functional scores. Findings also demonstrate that valgus knee bracing is a mechanically valid method of treatment of medial compartment gonarthrosis. Therefore, treatment of angular deformities of the tibiofemoral joint using orthosis reduce the malalignment, in turn reducing the joint forces to a greater extent than with a non-corrective brace. Furthermore, valgus orthosis are shown to share a significant proportion of load bearing (33%) during the majority of stance phase. Adjusting the location of the center of gravity can effectively alter load transmission across the knee. This dynamic compensation involves either an external support or gait modification. Shifting the upper body center of mass to a position directly over the involved limb can decrease the medial compartment force by 50%, compared with its value, when the center of gravity is positioned in the midline.

Exercise

Often, patients are told not to exercise for fear of increasing their symptoms. Studies have shown that patients with osteoarthritis are able to tolerate weight-bearing exercises, especially walking. Hyaline-fibrocartilaginous healing is dependent on motion and hydrostatic pressure changes. The motion and pressure changes must be induced by weight-bearing exercise, which increases intra-articular diffusion of nutrients. Dynamic loading of articular cartilage can promote the circulation of interstitial fluid. The forced circulation of interstitial fluid during cyclic compression might benefit cartilage metabolism by promoting the transport of various macromolecules necessary for cartilage metabolism. Intermittent negative hydrostatic pressure, within the extracellular matrix during cyclic dynamic loading, may promote healing by stimulating the metabolic activity of chondrocytes. It has been well documented that mechanical forces can regulate the metabolic response of articular cartilage. For example, immobilization or reduced loading of a joint results in a decrease in proteoglycan synthesis, whereas moderate exercise leads to an increase in proteoglycan synthesis and thickening of the cartilage matrix. However, severe mechanical loading can cause a thinning of cartilage matrix and leads to degenerative changes. Aerobic training involving major muscle groups may help decrease active inflammatory disease, including osteoarthritis. This may be done as a result of decreasing obesity, increasing bone density, or increasing muscle strength and tone. Since obesity is a definite risk factor for osteoarthritis of the knee aerobic exercise such as cycling is recommended. However, keep in mind that acute inflammation or joint swelling should be an absolute contraindication to initiate such exercise. Cryotherapy following exercise remains and important measure in controlling post-exercise induced inflammation.

Quadriceps Function

In some cases, osteoarthritis may be do to deficiencies in the biomechanical mechanisms that minimize joint peak forces, e.g., the active processes of joint flexion and muscle lengthening of the quadricep. Normally, the quadricep muscles contribute significantly to knee extension (concentric contraction) as well as controlled knee flexion (eccentric contraction). Knee hyperextension with weak quadricep muscles reduces knee stability during weight bearing, as they are unable to restrain hyperextension. Since the quadricep muscles become relatively inactive in the stance phase, additional weakness further compounds the patient's subjective descriptions of knee instability and giving way. It is well established that pain-free joint effusions, whether induced experimentally or secondary to acute or chronic joint pathology, prevent full volitional activation of muscles across the effused joint. This phenomenon has been called arthrogenous muscle inhibition (AMI). AMI has been shown to be present in pain-free joints clear of clinical effusion following traumatic and degenerative joint pathologies.

AMI is more than likely elicited by abnormal afferent information from the damaged joint, thus resulting in decreased motor function to muscle groups that cross that joint. AMI may undermine effective rehabilitation by preventing increases in strength of the affected muscle groups. Therefore, until inflammation and joint effusion is decreased strength losses may be partly irreversible, exposing the joint to further structural damage. GAIT Although static malalignment is readily documented on long standing radiographs, it has not been a reliable means of predicting outcome following corrective osteotomy. The clinical situation is far more complex, as simple activities of daily living can create dynamic loading conditions that reflect additional considerations, including joint instability, quality of muscle contractions, and individual idiosyncrasies of gait. Gait analysis is being used more frequently to assess the dynamic aspects of malalignment, but this technology has not been widely available. Unfortunately, most of the literature to date is representative of static assessments of malalignment. Knee flexion is necessary to absorb shock during the load acceptance phase of gait. Therefore, any limitation of normal knee flexion is intrinsically pathologic to OA. A limb that is hyperextended during this phase transfers body weight directly from the femur to the tibia without the muscles absorbing energy and cushioning necessary to protect the joint (i.e., abnormal high compressive forces). Long term patterns of knee hypertension frequently cause pain in the medial tibiofemoral joint and posterolateral ligamentous structures. Our over-all finding related to the major gait variables was that strength of the quadriceps femoris muscle was positively and significantly correlated with flexion and extension excursions of the knee during the stance phase of gait. We believe that the observed alterations in the gait of the patients in the present study represent an adaptation related to weakness of the quadriceps femoris. This weakness closely predicts functional outcome.

Thrusting hyperextension motion at the knee is associated with an abnormally high adduction moment, which tends to increase medial compartment compression forces and lateral distraction forces. A knee brace limiting knee hyperextension may be useful initially; however, the patient needs to accomplish dynamic gait restraining and not push backward into the brace, using it as a passive limit to hyperextension. Subconscious control of limb position, such as foot placement, active muscle contraction, passive soft tissue stability, as well as the speed of walking, can influence dynamic loading at the knee.

Proprioception

The multi-factorial etiology of osteoarthritis predominately involves molecular, biological, and mechanical changes as well as traumatic, genetic, and hormonal factors. The decline in proprioception also forms an important part of this pathogenetic process. The common finding of altered gait, which often cannot be attributed solely to pain, is an early sign of impaired proprioception. Proprioception has clearly been shown to decline with age. The age-related decline in proprioception appears to be present even in a clinically and radiologically normal joint; the degenerative process exacerbates this impairment. Changes in the gait of elderly subjects are partly explained by the decline in proprioception, even where no evidence of osteoarthritis exists. Patients with osteoarthritic joints have clearly been shown to have worse proprioception than control patients of corresponding age. In animal studies, deafferentation of structurally intact, stable joints does not accelerate joint degeneration. However, in unstable joints, deafferentation greatly accelerates joint degeneration. Muscular atrophy, very marked in some cases, was observed in almost all the investigated knee joints, and the deterioration in proprioception is thus partly do to muscular factors. A reduction of AMI following rehabilitation, allied with marked subjective and objective improvements, may reflect an improvement in muscle proprioception. Thus, rehabilitation incorporating proprioceptive retraining may be effective in retarding or reversing disease progression.

Electrical Stimulation

Application of a pulsing direct current to rabbit joints, in which an osteochondral defect was surgically created, resulted in an apparent improved quality of repair of the articular cartilage. The evaluation of the efficacy of the electrical signal used in this study was based on the presence of a superior repair tissue, i.e., fibrocartilage and hyaline cartilage vs. fibrous tissue in treated or untreated defects, respectively. Our data does not provide definitive evidence of possible mechanisms of action whereby electrical signals enhance the quality of the cartilage repair response. A reasonable postulate is that such treatment stimulates differentiation of mesenchymal cells derived from marrow elements into chrondrocytes and induces proliferation of existing chondrocytes located at the wound margins. Our results demonstrated that intermittent pulsed electrical stimulation, delivered at night for 4 weeks, provided significant short-term improvement in knee pain, function, knee flexion, and duration of morning stiffness for patients with osteoarthritis of the knee. The use of neuromuscular electrical stimulation to activate muscle could short-circuit the effects of reflex inhibition of the quadriceps. External activation of the motor units most easily activated by electrical stimulation may have an effect on subsequent voluntary utilization of these same motor units. Volitional muscle strengthening may be unable to overcome the effects of this reflex inhibition during volitional exercise, regardless of the level of rehabilitative training. Perhaps irreversible muscle atrophy or an alteration in muscle cells occurs. Possibly patients are not encouraged to contract the muscles vigorously enough during exercise. We, as well as others, have demonstrated that neuromuscular electrical simulation after reconstruction (of the anterior cruciate ligament) increases the strength of the quadriceps more than a similar regimen of volitional exercise. Perhaps the neuromuscular electrical stimulation overcomes the patient’s tendency not to contract the quadriceps fully.

Rehabilitation Goal

The objective of rehabilitation for the knee osteoarthritis patient is to quickly and efficiently return the patient to the highest level of pre-injury activity as is reasonably possible with minimized risk of increased signs and symptoms, other related complications, or predisposing them to re-injury.