

Osteoarthritis -Importance of understanding the disease process and management



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Osteoarthritis is defined as idiopathic, slowly progressive disease of synovial joints occurring late in life and characterised pathologically by focal degeneration of articular cartilage, subchondral bone thickening (Sclerosis) marginal osteochondral outgrowths (Osteophytes) and joint deformity. Clinically it is characterised by recurring episodes of pain, effusion due to synovitis, stiffness and progressive limitation of motion.

Osteoarthritis is a degenerative process of unknown etiology affecting articular cartilage of a previously healthy joint occurring mainly in elderly people is commonly known as primary osteoarthritis. Although it occurs in older people without any obvious cause, there is a common belief that it is inevitable in old age this is not true that all older people must have osteoarthritis. The articular cartilage of the older people possesses morphological, chemical, metabolic and physical characteristics separate and distinct from those of osteoarthritic joint.

Secondary Osteoarthritis is a degenerative process of articular cartilage that is precipitated by specific factors like incongruity of the joint, chemical insult.

Primary Osteoarthritis:

Although the cause is not known there are predisposing factors

(A)Age: Begins at second decade but becomes apparent by middle age and symptomatic by

55 to 65 yrs. of age.

(B)Sex: Till menopause, the pattern of involvement is similar in male and female, there after it is more severe and generalized in female.

(C)Obesity: Twice as prevalent in the obese and affects mainly in weight bearing joints.

Areas of involvement:

Any synovial joint may be affected but the most severe degeneration occurs in joints subjected to greatest compression. Those affected by weight bearing and compression forces include the lower spine, knees, hips, and cervical spine. The initial osteoarthritis changes occur in the non-pressure areas.

Biologic characteristics of normal articular cartilage

Isolation:

Articular cartilage is aneural and alymphatic and has no contact with the vascular system. Nutrition to the cartilage comes through two diffusion barriers to reach chondrocytes, synovial vascular plexus → synovial membrane → synovial fluid → matrix of hyaline cartilage @ chondrocytes.

Hypocellularity:

Cell density of articular cartilage is low, the chondrocyte is metabolically active cell that continually synthesizes matrix component as well as participates in the degradative catabolic process.

Matrix Biochemistry:

Articular cartilage is hyperhydrated tissue whose water content is as high as 80%. The remaining constituents are collagen and prostaglandin. The cartilage collagen macromolecule is a triple helix consisting of three $\alpha 1(\text{II})$ chains.

The PG consists of a series of high molecular weight compounds separately synthesized intracellularly and extracellularly are aggregated through a glycoprotein link about a central hyaluronate core. The smallest PG subunit has linear protein "back bone" about 200 nm (2000 Å) long to which 50 or more long side chains polydimeric sugars (Glycosaminoglycans) are attached at right angles. At least three GAGs have been identified in articular cartilage (I) Chondroitin-6-sulfate (II) Chondroitin-4-sulfate (III) Keratan sulfate.

Metabolic activity:

Metabolic activity of chondrocytes of normal cartilage is quite high, with features like extensive network of rough surfaced endoplasmic reticulum, dilated cisternae, vacuoles and Golgi components, suggestive of synthesis of various matrix components synthesis and intracellular assembly of components of PG's and collagen which are then extruded into the extracellular matrix which results in continuous renewal of extracellular matrix. Proteoglycan has a half life of 8 days and collagen a much slower turnover rate.

Changes in osteoarthritic articular cartilage:

There is increase in synthetic activity in osteoarthritic articular cartilage. Increased rate of sulfate (SO_4) incorporation in chondrocytes is indicative of an increased rate of proteoglycan synthesis. The synthesis of protein and GAG is doubled in Osteoarthritic cartilage. The rate of PG synthesis is directly proportional to the severity of the disease process. As the disease worsens, a point is reached at which the rate of PG synthesis falls off markedly indicating that the

capacity of the cell to respond has been exceeded and the reparative function fails.

Biochemical alterations:

PG content is reduced and the decrease is proportional to the severity of disease. The total content of GAG is decreased but the chondroitin-4-sulfate is increased. The collagen content is unchanged. Osteoarthritic chondrocytes synthesize not only type II collagen [$\alpha 1(\text{II})$] 3 chains but also substantial amount of type I [$\alpha 1(1)_2\alpha 2$]. Therefore the pattern of collagen synthesis produces fibres more closely resembling those of skin and bone than of cartilage. The collagen of osteoarthritis are larger in diameter and their distribution is more variable than in normal tissue particularly at surface zones. Osteoarthritic cartilage has a significant increase in water content.

ENZYMES:

Enzyme degradation is a major factor in the production of osteoarthritis. Either a hyaluronidase or a protease can act on PG to initiate degradation. An acid cathepsin is present in the lysosomes of chondrocytes and has a powerful hydrolytic action on the protein core of the PPS macromolecule. The protein core is cleaved initially and later some enzymes like polysaccharidases, sulfatases, hexoaminadases degrade the GAGs.

Physical alteration:

Depletion of the GAG fraction with subsequent disruption of collagen fibres in the superficial zone is an early disease process. The creep modulus, a measure of the stiffness of a viscoelastic material shows close correlation with the GAG content and a low correlation with collagen content. Cartilage from visually normal areas showing degenerative changes becomes less stiff with increasing severity of the disease. The change in the creep modulus precedes the appearance of fibrillation.

Fatigue of cartilage:

Mechanical abnormality of a joint can produce secondary OA. eg. in meniscectomy will increase contact pressures on that side there by

increasing the chances for development of osteoarthritic process.

Incongruity of the hip congenital or acquired increases contact pressures by reducing contact area. There by increasing the liability to OA. As the age increases, the articular cartilage shows decrease in strength and stiffness.

Cartilage is loaded cyclically and in compression normal to the surface. Cyclical loading raises the possibility of fatigue failure. Fatigue is the process by which a loaded structure may fail mechanically in the face of a load of the same magnitude applied on numerous occasions where as a load of the same magnitude if applied once does not produce failure. Cartilage is prone to fatigue and the fall on fatigue resistance increases with age. A cyclically applied compressive load produces fragmentation of the surface of the loaded cartilage, producing an appearance similar to fibrillation.

Although the amount of collagen of cartilage matrix does not decrease with advancing age with the onset of OA, the mechanical integrity of the mesh work fails.

Clinical Presentation of an osteoarthritic

1. Pain - Mild to moderate
Dull aching to deep and throbbing
On activities after rest and relieved by rest progresses to rest pain
2. Stiffness: OA joints are stiff especially after rest.
- In severe case restriction in range of motion.
3. Joint crackling: Also known as crepitus occurs generally in advanced cases.
4. Deformity and joint swelling.

Difference both Aged joints and Osteoarthritic Joints

Aged Joints

1. Deterioration occurs on non weight bearing cartilage surface
2. Minimal physical and chemical changes in the cartilage matrix.
3. No increase in tissue volume
4. No change in the liquid content of the cartilage
5. Pigment in cartilage
6. No eburnation
7. No obvious bony changes

Osteoarthritic Joints

1. Deterioration occurs on weight bearing cartilage surface
2. Significant physical, chemical and degradative changes in the cartilage matrix.
3. Increase in tissue volume
4. Early and dramatic increase in the liquid content of the cartilage
5. No pigment in cartilage
6. Eburnation present
7. Bone changes including new bone formation (Osteophytes)

Joints commonly affected by osteoarthritis are

1. Knee
2. Hip
3. Lower lumbar region
4. Cervical spine
5. Small joints of the fingers

Investigations

- Routine blood examination (TLC, DLC, ESR, Biochemistry) is normal
- Synovial fluid examination is if necessary done to differentiate from other conditions like Rheumatoid arthritis, septic arthritis, etc, it is normal.

X-ray of involved joint

Which shows

- Joint narrowing
- Sclerosis of subchondral region
- Osteophytes
- Bone cyst

How to fight with Osteoarthritis

1. Have a thorough consultation with orthopaedic surgeon.
2. Improve your biomechanics to counteract stress of your joints.
3. Exercise daily.
4. Eat a healthful, joint preserving diet.
5. Maintain your ideal body weight
6. Fight depression.
7. Medication as necessary.
8. Maintain a positive attitude.

Have a Through Consultation with Orthopaedic Surgeon.

A great many conditions may mimic OA. Lots of people have suffered a lot because of incorrect diagnosis and advise. Understanding the nature of the disease is very important in prevention of deterioration of the disease and management. So, consult an orthopaedic surgeon, get the disease correctly diagnosed and have a proper preventive and curative advice.

Improve your Biomechanics to counteract stress to your joints:

Biomechanics is the mechanical forces exerted to the body by movement. Improper alignment or incorrect use of muscles, bones, tendons, ligaments and joints can cause excessive wear and tear on the body leading to injury. If underlying cause is not corrected the disease can

not be get rid of. Bony mal-alignment can be treated with corrective osteotomy. Faulty way of walking leading to the problem can be corrected simply by correcting the gait pattern. Good body mechanics is aided by eliminating faulty posture, applying shoe supports, and performing graduated exercises of all joints.

Exercise Regularly:

Regular life long exercise fends off a host of health problems; it burns off calories and loses weight. Exercise is an excellent means of helping to keep joints healthy. Regular exercise is strong protection against osteoarthritis when you bear down on a joint as it is done during exercise, the nutrient rich fluid in the cartilage is squeezed out then, when you release the pressure this fluid rushes back into the cartilage both nourishing it and keeping it moist. The continual rushing in and out of fluid is critical to the health of the cartilage, without this the cartilage is thin, dry and more susceptible to injury.

Exercise is an wonderful remedy for existing osteoarthritis. It keeps the nourishing fluid flowing into the affected joint and reduces pressure on the joint by strengthening supporting structuring (muscles, tendons, ligaments) and increases the range of motion, shock absorption and flexibility of the joints. Strong well-toned muscle and flexibility of the joints can bear the brunt of the force that crashes into the joints as we move, while helping the bones support the body. In fact the majority of the load that the joint bear can be transferred to these supporting structures, allowing the articular cartilage to maintain its integrity.

Exercise has many other benefits to mind and body like;

- * Improving physical capabilities.
- * Preventing joint deformities.
- * Better emotional health.
- * Reducing stress.
- * Enhancing sleep.
- * Promoting relaxation.
- * Improving body composition.
- * Increasing resistance to other

- medical problems.
- * Building up a reserve capacity.
- * Improving sexual function, satisfaction and body image.
- * Improving balance.

Designing your exercise programme

Finding the right exercises that strengthens your bones and supporting structures can be a little more complicated. If you have already damaged one or more joints, strained the supporting structures and have muscle imbalance; you should seek the advice of the physician and learn proper exercise. Few important tips about exercise are:

- (a) Never exercise through joint pain.
- (b) Stop exercising if you feel dizzy or sick.
- (c) Never over do it.
- (d) Keep breathing while you do exercise.

Types of exercises:

Those are useful especially for osteoarthritis joints.

- (a) Walking.
- (b) Bicycling.
- (c) Water exercise and muscle strengthening exercise for specific joints.

Healthful diet

"You are what you eat". "Food is the best medicine."

Human body needs many different nutrients to keep running in peak form including protein, carbohydrate, fats, fiber, vitamins, minerals and phytochemicals. These are found in different combinations and different amount in various foods. Here would like to emphasize on food which help to keep the joints healthy and some, which are harmful.

Some unstable molecules called **free radicals** roam about the body attacking and destroying healthy tissues, including the tissue found in the joints. Free radicals are unstable because they have lost electrons and are erratic and very reactive with their environment. Osteoarthritis may be the result of free radical damage; so prevention of free radical damage is a critical features in treating and preventing osteoarthritis.

Anti-oxidants serve as antidotes to one of the free radicals most commonly found in the body - oxygen, which is not regular oxygen we use but this is special, unstable form of oxygen-called singlet oxygen. The anti-oxidants include vitamin A Vit 'C' Vit 'E' and the mineral selenium. So foods that contain any of the **Four ACES** are powerful weapons for combating free radicals and the havoc that they wreak.

Foods rich in the above mentioned elements are recommended for patients with OA.

Bioflavonoids, a group of substances found in virtually all plant foods are essential for healthy capillary walls and the metabolism of Vitamin 'E'.

Foods containing fatty acids can alter the inflammatory process either for the better or the worse: eg **Arachidonic acid** which is found in meat, poultry, dairy products, egg yolk, can increase inflammation. So they should be avoided.

The inflammation fighter fatty acids are:

- (I) Alpha linolenic acid (ALA) is found in green vegetables, and foods of plant origin.
- (II) Gamma linolenic acid (GLA) which is found in black currant oil, primrose oil, Sorage oil,
- (III) Linolenic acid which is found in plant oils such as corn, Soybean, Sun flower, soft flower
- (IV) Eicosapentaenoic oil is found in marine plants and fish.

Food containing these elements help to fight the inflammatory process and reduces symptoms. The powerful antiosteoarthritis diet are foods filled with anti oxidants and bioflavonoids, foods that counter the ill effects of medications, foods reducing inflammation and food that keeps your weight under control.

Ostioarthritis Fighters:

- (I) Foods that contain Anti oxidants (Vit 'A', C, E + Selenium).
- (II) Foods that contain bioflavonoids (Citrus fruit, berries, green tea,

(III) cherries and plums and whole grains. Foods that counter the adverse effects of NSAIDS, steroids and other medications. (Vitamin 'C' iron liver, heart, Kidney, dried beans, peas, leafy vegetable fish, poultry, whole grain bread and cereals) folic acid (brewer's yeast, dark green leafy vegetables, orange juice, Liver, Avocados, Broccoli) Phosphorus (meat, organ meat, fish, poultry, eggs nonfat milk, yogurt, soybeans and peanut butter phosphorus, (meat, fish, poultry, eggs, nonfat milk, low fat yogurt, soybeans and peanut butter), zinc (oysters, lean meat, poultry, fish, organ meat, breads, cereals) Potassium (Lean meat, potatoes, Avocados, bananas, apricots, orange juice, dried fruits and peas.

(IV) Foods that reduce inflammation Omega 3 fatty acids. The most effective one is EPAS found in cold water fish (Mackerel, Anchovies, Herring, salmon, Sardines, Lake trout and tuna are good source of EPA.)

(V) Keeping your weight under control Concentrate on low fat, nutrient rich foods, don't skip meals.

Fighting depression:

People suffering from OA are more prone to get depressed because of the chronicity of the disease, not being able to perform the routine activities because of nagging pain being exacerbated off and on. To fight depression, patient should fully understand the nature of the disease and the preventive and curative means so that individual help himself to fight depression. Sometime help of a psychotherapist is needed.

Summary of the treatment of osteoarthritis:

Treatment is divided into two groups:

- A. Non surgical (Conservative)
- B. Surgical.

Non surgical/ Conservative:

It is aimed at retarding progression, alleviating pain and stiffness, preventing deformities and improving motion and stability.

1. Rest: During acute inflammatory phase involved joint should be rested to relax capsule and ligamentous structure till the phase of acute inflammation subsides.
2. Range of motion: Full range motion several times daily is important preventing deformities and for nutrition the articular cartilage.
3. Weight bearing: During acute inflammatory phase avoiding weight bearing (joint involving lower extremity) with the help crutch / Canes helps in subsiding inflammation.
4. Traction: Useful during acute inflammatory to stretch the soft tissues around the joint and keeping two articular surfaces apart.
5. Physiotherapy: Moist heat followed by massage and range of motion exercise (passive and active) and isometric exercise to strengthen muscle power which minimise joint stress help to reduce stiffness and pain as well as decrease load on the joint.
6. Body Mechanics: Good body mechanics aided by eliminating faulty posture appropriate shoe supports and performing graduated exercises of all joints.
7. Orthopaedic appliances: removable splint provides rest and permits daily physiotherapy. Spine is supported with spinal corset. Simple elastic bandages in joints of upper and lower extremities.
8. Corticosteroids: During acute inflammatory phase intra articular injection of corticosteroid controls inflammation within few hours so that pain, swelling is reduced range of motion of the joint improves. The effect last for few days to months sometimes years.

Intra articular steroids have deleterious effect on articular cartilage impairing synthetic activities of the chondrocyte causing decreased content of the proteoglycans in the matrix so repeated intra articular steroid injection is not advised.

9. Graduated exercised: Muscle imbalance creates abnormally high stress concentrate on one side of the joint accelerating degenerative process. Graded active exercises are designed to improve an

10. balance muscle power acting about the joint. Drug therapy: Analgesics and anti-inflammatory drugs have been used very frequently to relieve pain, stiffness and swelling but none of those drugs halts the progression of the disease process. A good number of drugs in this group are available but none of them have been found to be safe enough for long term use because of their side effects.

11. Glucosamine and chondroitin sulfate: These two dietary elements stimulate the synthesis of new cartilage which simultaneously keeping the cartilage busting enzymes under control. This helps to normalize the cartilage matrix in essence treating the disease at the cellular level. The combination of these two elements enhance cartilage cell macromolecule synthesis (GAG, PG, Collagen, proteins RNA and DNA, hyaluronon (which gives the joint fluid its thick viscosity providing lubrication). They inhibit the enzymes that degrade the cartilage cell macromolecules, mobilize thrombi, fibrin, lipids, cholesterol deposits in synovial spaces resulting reduced synovitis and joint pain.

Surgical Treatment:

Surgical measures are aimed at relieving pain, improving and maintaining joint movement, correcting deformities and mal-alignment, reducing vertical loads and shear stress, removing intra articular causes of erosion of articular surface and in advanced cause when proper indications occurs replace the joint with artificial implants.

Most commonly performed surgical procedures for an osteoarthritic joints are:

1. Corrective ostiotomy.
2. Arthrotomy and joint debridement.
3. Arthroscopic joint debridement.
4. Arthrodesis
5. Total / partial joint replacement

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